Unfavourable Eco-System: Crop Production Under Salinity Stress

Crop Production Under Salinity Stress

Agronomy Division
Bangladesh Agricultural Research Institute
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بسم الله الرحمن الرحيم

Minister
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Foreword

Bangladesh's economic growth largely depends on the vitality of the agricultural economy. Agriculture sector plays an important role in achieving prosperity through increasing productivity, income growth and employment creation in rural areas. It is the main source of food energy, vigor, labor force and intellectual power which are indivisible and interrelated. Due to the relentless efforts of our agriculture and farmer-friendly government under the dynamic leadership of Jana-netri Sheikh Hasina, our country has become self sufficient in producing food and furthermore, it has already started exporting rice in a small scale. In 2014, Cornell University of the United States awarded Hon'ble Prime Minister Sheikh Hasina for her great contribution in attaining self-sufficiency in food production and for taking initiatives in using modern technology in agriculture. Earlier in 1999, in recognition of her contribution to the fight against hunger, the United Nations World Food Programme (FAO) awarded 'Ceres Medal' to Hon'ble Prime Minister Sheikh Hasina. It certainly indicates that whenever Honble Prime Minister Sheikh Hasina is in the driving seat, the country comes out of the clutches of hunger and poverty. Maintaining the continuity of development under the present people- friendly government, we will be able to make our country hunger free, happy and prosperous 'Sonar Bangla' dreamt by the father of the nation, Bangabandhu Sheikh Mujibur Rahman.

The coastal belt of Bangladesh already suffers from high levels of salinity as a result of saltwater intrusion. Recent studies indicate significant increase in saline area. Total salinity affected area increased from 0.83 million ha to 1.06 million ha during the past four decades. The levels of salinity are predicted to rise further under various climate change scenarios, as sea level rises and saltwater intrudes even more. Cultivable land of Bangladesh is deceasing by 1% in every year but population is increasing at an alarming rate. So, to feed the ever increasing population, crop production measures in unfavorable ecosystems like coastal saline areas of Bangladesh should be improved and strengthened for ensuring food security.

It is a great pleasure to me that Agronomy Division of Bangladesh Agricultural Research Institute (BARI) is going to publish a compiled report entitled **Unfavorable Eco-System: Crop Production under Salinity Stress** carried out during the period from 1990 to 2015. The present publication including research findings will contribute to further research for developing technologies and improving cropping system in the coastal areas of Bangladesh. The publication will be helpful to the researcher, extension personnel, students of higher studies, GO and NGO personnel, other agriculture related stakeholder and national planners. I convey my thanks to the scientists of Agronomy Division, Bangladesh Agricultural Research Institute for the valuable research works.

Joy Bangla, Joy Bangabandhu,
Long live Bangladesh.

Matia Chowdhury
(Matia Chowdhury, MP)

Secretary
Ministry of Agriculture
The People's Republic of Bangladesh

Foreword

Bangladesh is facing challenges to feed its increasing population from a rapidly decreasing land for crop production. There is very little scope for horizontal expansion of agricultural land which is decreasing at 1% every year. At present, vast areas of land in Bangladesh under coastal areas are unfavorable for crop production. Salinity has been a typical environmental issue seen in the coastal region, particularly along the coastal belt of south-western region of Bangladesh. It has been considered as a major constraint to agriculture land use in coastal areas of the country. The extent of salinity increase in a particular area within the coastal zone would determine the decrease of agricultural land use in the affected areas. While there are different production alternatives, farmers have a limited set of resources. These resources must be utilized in such a manner that maximize farm productivity, farmers benefit and resource use efficiency in an environmentally sound and sustainable way. A holistic approach to technology generation and packaging is essential to achieve this result through maximizing the complementary interactions among the different farming enterprises/production system and socio-economic environment.

I am very glad to know that Agronomy Division, Bangladesh Agricultural Research Institute (BARI) is going to publish a compiled report entitled "Unfavorable Eco-system: Crop Production under Salinity Stress". The present publication including research findings will contribute to strengthen salinity stress research for developing stress tolerant technologies and disseminating those in the coastal areas of Bangladesh. The publication will be helpful to the researcher, extension personnel, students of higher studies, GO and NGO personnel, other agriculture related stakeholder and national planners. I express my sincere appreciation to the scientists of Agronomy Division, Bangladesh Agricultural Research Institute for this valuable research works.

Mohammad Moinuddin Abdullah
Secretary

Director General

Bangladesh Agricultural Research Institute

Joydebpur, Gazipur

Foreword

Bangladesh is predominantly an agricultural country. With a land area of 147570 sq. km the country has a population of over 150 million with a per capita GDP of US$ 750. Nearly 70% of the total population lives in rural areas and major segment of the rural population depends on agriculture. About 21% of country's GDP comes from agriculture. Agriculture in Bangladesh is highly intensive and diversified. Bangladesh, the largest deltaic flood plain in the world, slopes gently from the north to the south, meeting the Bay of Bengal at the southern end. The whole coastline of 710 km runs almost parallel to the Bay of Bengal. The southern delta is physiographic and ecologically diverse and environmentally vulnerable. A vast coastal and offshore area (2.86 m ha) in the southern part of Bangladesh covers about 49 upazilas of 14 districts. It exhibits soil salinity of various magnitudes due to onrush of salt water from the bay. As a result, most of the areas remain fallow during dry months.

I am very glad to know that Agronomy Division, Bangladesh Agricultural Research Institute (BARI) is going to publish a compiled research report entitled "Unfavorable Eco-system: Crop Production under Salinity Stress" carried out during the period from 1990 to 2015. This report is very much relevant to the context of sustainable crop production in the coastal saline areas coping with national food security. Agronomy Division is the largest division of the institute conducting research for developing sustainable crop production technologies for favorable condition and also for unfavorable eco-system like coastal eco-system. Besides, Agronomy Division also carries out researches on multiple cropping and weed management for sustainable crop production. For developing any new research programme, reviewing of previous research works are essential. In making a stock of previous research findings scientists of Agronomy Division, BARI has done an excellent job through the compilation of previous research results on salinity stress. I firmly believe that this publication will be helpful for the students, scientists and teachers in developing effective research programme on salinity stress. It will also the help extension personnel and policy markers. I express my heartfelt thanks to the scientists of Agronomy Division for their sincere efforts for this publication.

Dr. Md. Rafiqul Islam Mondal

Chief Scientific Officer

Bangladesh Agricultural Research Institute
Joydebpur, Gazipur

Preface

On a global scale, nearly 40% of the earth surface is potentially endangered by salinity problems. Agricultural management plans that involve repeated cycles of brackish or under ground water use and lying fallow the land during dry season further aggravating the situations. However, such types of plan are unavailable, due to lack of fresh water, in some parts of the tropics and sub-tropics. The problem of salinity in agriculture will only increase as population increase and larger tracts of presently unused lands are brought into cultivation. Salinity in arid and semi-arid areas is mainly caused by natural causes: low precipitation, high level of evaporation and existence of saline parent rock. Salinity also resulted from mismanaged amelioration systems, irrigation with salinized water, and accumulation of salts from high doses of mineral fertilization.

Cultivable land of Bangladesh is deceasing by 1% in every year but population is increasing at an alarming rate. So, to feed the ever increasing population, crop production measures in unfavorable ecosystems like coastal saline areas of Bangladesh should be improved and strengthened for ensuring food security. It is a great pleasure to me that Agronomy Division, BARI is going to publish a compiled report entitled "Unfavorable Eco-system: Crop Production under Salinity Stress" carried out during the period from 1990 to 2015. Scientists of Agronomy Division are engaged in developing packages of technologies under salinity stress problem area for the benefit of the farmers and the nation. The results of those research works are published sporadically elsewhere which necessitates to compile those results in systematic way. This report will be helpful to the scientists in reviewing the past research results for preparing effective future research programmes on salinity stress. I am very much grateful to the scientists of Agronomy Division for compiling the results of important salinity stress research. If this publication helps to anybody in any way, then the efforts would be more meaningful.

Dr. Md. Abdul Aziz

SALT TOLERANCE IN MUNGBEAN: SCREENING OF MUNGBEAN GENOTYPES AGAINST SALINITY STRESS AT EARLY VEGETATIVE STAGE

M. A. Aziz[1], M.A. Karim[2], A. Hamid[2], Q.A. Khaliq[2], M. Hossain[2] and A.J.M.S. Karim[2]

Abstract

An experiment with 50 genotypes, available in BARI gene bank was screened for their salt tolerance at the early vegetative stage. The salt solution was applied with an increment of 25 mM NaCl in every alternate day till respective concentration (200 mM) was attained. There were only two accessions BM 01 and BM 07 (tolerant) that produced greater than 90 percent relative total dry weight (RTDW). In the second group (moderately tolerant), there were 4 accessions that had RTDW in the range of 70-90%. In the third (susceptible) and fourth (highly susceptible) groups, there were 21 and 23 accessions that had RTDW in the ranges of 50-70 and <50% respectively. Salt tolerant accessions found in the diverse gerplasm of mungbean, examined in this study, and could be of considerable economic value in increasing yield on saline areas, provided the lines show salt tolerance till maturity.

Key words: Salt tolerance, mungbean genotypes, screening, early vegetative stage

Introduction

Natural salinity is a widespread phenomenon on earth, and through evolutionary process several species of living organisms have acquired special adaptive mechanisms to grow in saline environments. Bangladesh has almost 3 million hectares of land affected by salinity, mainly in the coastal and south-eastern districrs, with EC values ranging between 4 and 16 dS m^{-1} (Zaman and Bakri, 2003). This salinity is caused primarily by seawater intrution in both surface and groundwater. More areas are under threat of slinisation due to the combined effect of sea level rise, coastal subsidence, increased tidal effect and continuous reduction of river flow, particularly during dry period (BBS, 1999; BCAS, 1998; World Bank, 1996; Nishat and Chowdhury, 1986). Cultivation of winter crops is thus very limited due to absence of irrigation water in saline areas. Consequently, most area remains fallow during dry months. To increase pulses area and production especially mungbean these marginal lands should be brought under economic cultivation.

Leguminous crops are generally sensitive to salinity, though there is a considerable difference in salt tolerance between legume species (Maas and Hoffman, 1977). Mungbean is among the most important pulse crops of the world and has great value for food, feed, fodder, fuel (straw), and green manure and as a cover crop. Mungbean is a salt sensitive crop like other legume (Ashraf and Rasul, 1988). Despite its great economic importance insufficient work has been undertaken to improve its salt tolerance. For the improvement of salt tolerance, the existence of genetic variation in a crop is of prime importance. In the present study 50 genotypes, available at BARI gene bank were screened for their salt tolerance at the early vegetative stage to examine the intraspecific variation of salt tolerance of mungbean, and to classify the genotypes into different salt tolerance groups.

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Materials and Methods

The experiment was carried out at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Fifteen bold seeds of respective genotypes were sown in each earthen pot (24 cm × 30 cm) containing 12 kg air dried soil and kept inside vinylhouse under natural light. Compost ($^{1}/_{4}$ th of the soil volume) and 0.27-0.28-0.20 g of urea, TSP and MP per pot were incorporated uniformly into the soil. After seedling establishment five uniform and healthy plants were allowed to grow in each pot. After the 1st trifoliate appear i.e. ten days after emergence, sufficient quantities of salt solutions were applied in treated pot. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 200 mM NaCl solution. Tap water was used as control (0 mM). The salt solution was applied with an increment of 25 mM in every alternate day till respective concentration 200 mM was attained. Treatment solution was applied in excess so that the extra solution dripped from the bottom of the pots.

Ten plants of each genotype per treatment were harvested30 days after sowing (DAS). The samples were oven-dried sufficiently to a constant weight. Salt tolerance levels were calculated from the percent of relative total dry weight (RTDW) of the genotypes using the following formula:

$$\text{RTDW}(\%) = \frac{\text{Total dry weight of salt treated plant of a genotype}}{\text{Total dry weight of the control plant}} \text{X} 100$$

All the genotypes were then categorised as tolerant, moderately tolerant, susceptible and highly susceptible using a range of 0-9 scale following Ashraf and Waheed (1990).

Results and Discussion

The relative TDM per plant (% TDM to control conditions) was significantly reduced due to salinity in all the genotypes tested except in accession BM 01 and BM 07. The accession BM 01 produced 10% higher TDM at 200 mM NaCl salinity than the control (Fig.1). Asharf and Waheed (1990) obtained 7 genotypes of mungbean that produced more than 20% dry shoot biomass under 100 mM NaCl. The minimum reduction in TDM was noticed in BM 07 (8%) and the maximum reduction was in BM 21 (73%). The minimum affected TDM of BM 01 and BM 07 at high salinity could be attributed for the less reduction in the production of stem, petiole and leaf dry matters.

Salt tolerance in plants is most usefully presented in terms of relative production over a range of salinities (Maas and Hoffman, 1977). The accessions examined in this study were classified into ten groups using 0-9 scale and then categorized as tolerant, moderately tolerant, susceptible and highly susceptible (Ashraf and Waheed, 1990). There were only two accessions BM 01 and BM 07 that produced greater than 90 percent RTDW (Fig. 2). In the second group (moderately tolerant), there were 4 accessions that had RTDW in the range of 70-90%. In the third (susceptible) and fourth (highly susceptible) groups, there were 21 and 23 accessions that produced relative total dry matter in the ranges of 50-70 and <50% respectively. Among the 50 accessions 9% was found tolerant, 27% moderately tolerant, 41% susceptible and 23% highly susceptible (Fig. 3).

In order to simplify data presentation and interpretation, a sub-sample of 15 accessions out of the 50 was extracted for more detailed, on the basis of their visual performance in biomass production at the vegetative stage. The 15 accessions included the 2 tolerant (BM 01 and BM 07), 4 moderately tolerant (BM 11, BM 15, BM 33 and BM 36), 4 susceptible (BM 17, BM 34, BM42 and BM 50) and 5 highly susceptible (BM 04, BM 06, BM 12, BM 18 and BM 21). The data for stem, petiole, leaf and TDM, of the sub-samples selected, are presented in Table 1. There was no significant effect of NaCl salinity on the dry matter production at different plant parts of the 2 tolerant accessions (BM 01 and BM 07). However, the dry matter production of the moderately tolerant, susceptible and highly susceptible accessions was decreased substantially at 200 mM NaCl.

Although the growth of the 15 accessions were markedly reduced at 200 mM NaCl, the tolerant accessions (BM 01 and BM 07) produced greater relative dry matter (RDM) in different plant parts than that of moderately tolerant, susceptible and highly susceptible accessions (Table 2). The 5 highly susceptible accessions (BM 04, BM 06, BM 12 BM 18 and BM 21) had very low RDW at the salt treatment and among them the accession BM 21 produced the lowest RDM (27%)

It has been argued that selection for salinity tolerance at the vegetative stage may not produce tolerant adult plants (Kingsbury and Epstein, 1984; Shannon, 1979). In contrast, the performance of seedlings under saline conditions has been considered highly predictive of the response of adult plants to salinity (Azhar and McNeilly, 1987; Blum, 1985; Greenway, 1965). Norlyn (1986), Ashraf and Rasul (19886) and Ashraf and Waheed (1990) screened seedlings of mungbean and lentil genotypes, respectively and found a considerable relationship in salt tolerance at the adult stage. The results presented in this study deal with the salt tolerance of the accessions at the vegetative stage. As the earlier reports on the relationshop of salt tolerance of genotypes at different growth stages are inconclusive, the tolerance observed in the 50 accessions of mungbean at early vegetative stage may or may not confered at adult stage.

Nevertheless tolerance observed at the early vegetative stage is of great importance. This is because, it has been emphasized by many workers that the assessment of salt tolerance at vegetative stage of a plant species is of considerable value in determing the ultimate tolerance of the species (Ashraf and McNeilly, 1987; Ashraf and McNeilly, 1988; Ashraf *et.al*., 1990; Aslam *et al.*, 1993; Ashraf, 1994). In consideration of the severe effect of salt on vegetative stage, the growth of a crop cultivar in saline area is facilitated by leaching the salt and also by other management practices. Therefore, knowing the tolerance that was observed at the vegetative stage of some accession would be of considerable economic value for crop establishment on salt affected soils.

From the data it mighy be concluded that the salt tolerant accessions found in the diverse gerplasm of mungbean, examined in this study, could be of considerable economic value in increasing yield on saline areas, provided the lines show salt tolerance till maturity. In the following study the salinity tolerance of each group as made in the present study will be judged from their performance at later stages of growth.

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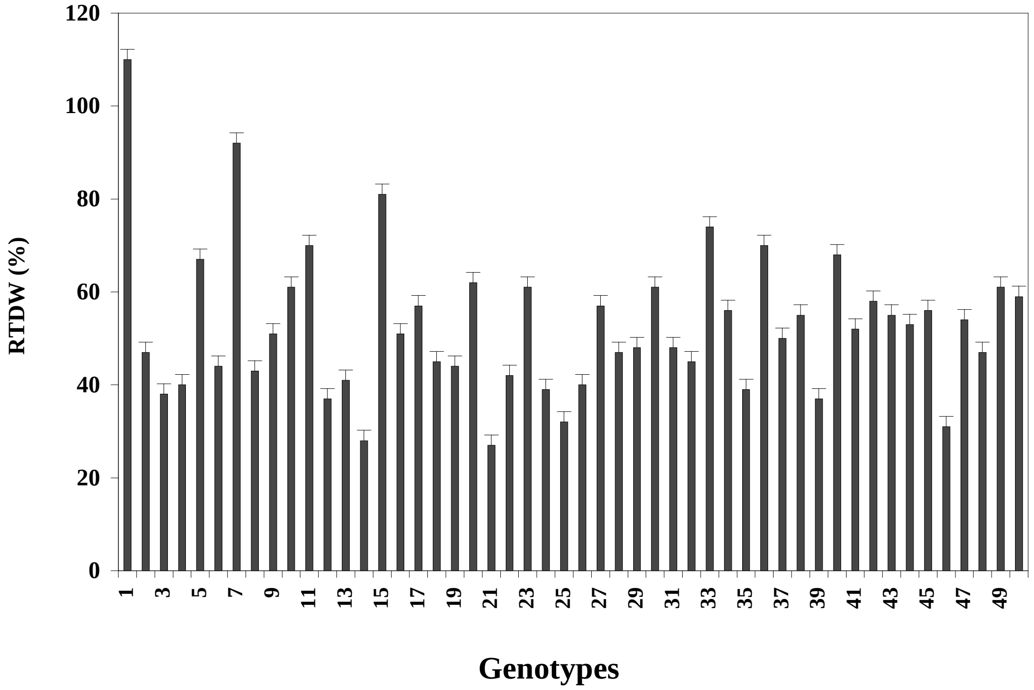

Fig. 1. Relative total dry weight (RTDW) of 50 mungbeangenotypes. Error bars represent standard error

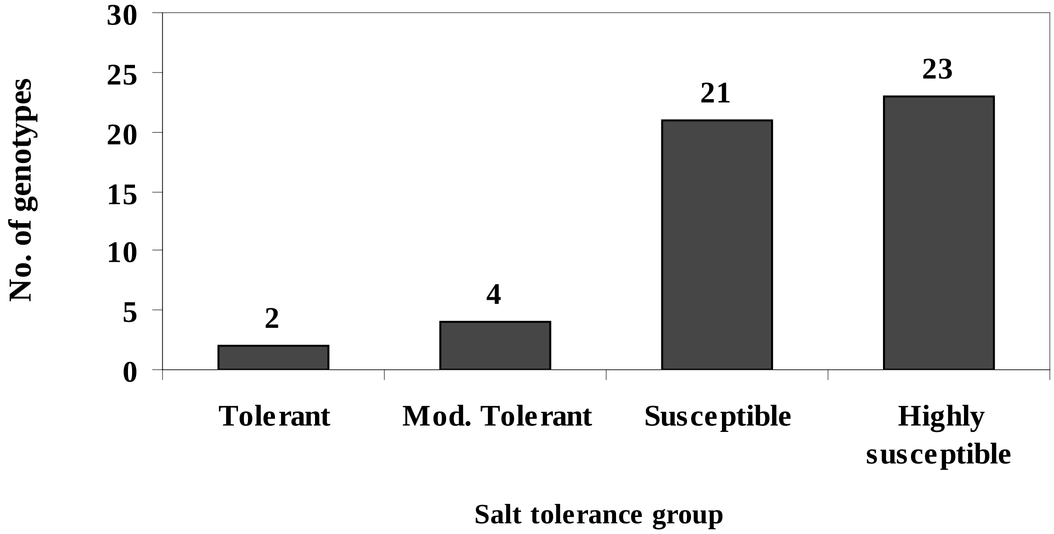

Fig. 1.5. Friquency distribution of 50 mungbean genotypes based on relative performance and salt tolerance levels

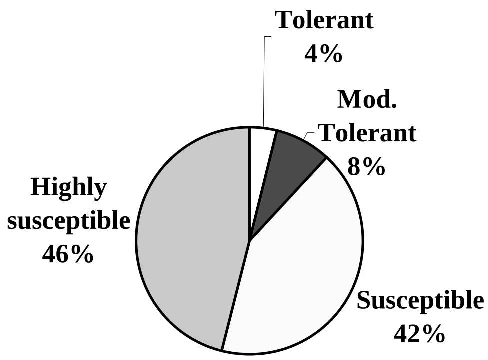

Fig. 3. Percentage of NaCl salt tolerance of 50 mungbean genotypes

Table 1. Effect of NaCl on dry matter production (g/plant) in different plant-parts of 15 selected mungbean accessions 30 days of growth

Acc. No.	Plant parts						Total dry matter	
	Stem		Petiol		Leaf			
	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM	0 mM	200 mM
BM 01	0.51	0.53	0.24	0.25	0.95	1.10	1.70	1.88
BM 04	0.73	0.24	0.35	0.12	1.08	0.50	2.16	0.86
BM 06	0.86	0.31	0.31	0.13	1.40	0.68	2.57	1.12
BM 07	0.62	0.58	0.29	0.27	1.17	1.07	2.08	1.92
BM 11	0.80	0.45	0.39	0.20	1.17	0.99	2.36	1.64
BM 12	0.99	0.22	0.41	0.06	1.22	0.61	2.42	0.89
BM 15	0.85	0.56	0.42	0.26	1.42	1.37	2.69	2.19
BM 17	0.78	0.28	0.37	0.20	1.37	0.96	2.52	1.44
BM 18	0.79	0.31	0.36	0.15	1.51	0.74	2.66	1.20
BM 21	0.95	0.22	0.38	0.08	1.39	0.43	2.72	0.73
BM 33	0.49	0.30	0.22	0.16	0.93	0.76	1.64	1.22
BM 34	0.82	0.31	0.27	0.17	1.07	0.73	2.16	1.21
BM 36	0.57	0.39	0.26	0.18	1.03	0.73	1.86	1.31
BM 42	0.70	0.29	0.31	0.17	1.35	0.92	2.36	1.38
BM 50	0.58	0.29	0.26	0.18	1.15	0.70	1.99	1.17
$LSD_{(.05)}$	0.13	0.09	0.08	0.05	0.24	0.18	0.21	0.15
CV(%)	8.31	9.26	10.25	9.81	9.36	10.52	6.59	8.23

Table 2. Effect of NaCl on relative total dry weight production (% of control) in different plant-parts of 15 selected mungbean accessions 30 days of growth

Tolerance levels	Code No.	Accession No.	Plant parts			RTDW
			Stem	**petiole**	**Leaf**	
Tolerant	1	BM 01	103	104	115	110
	2	BM 07	93	93	91	92
Mean			**98**	**96**	**103**	**101**
Moderately Tolerant	3	BM 11	56	51	85	70
	4	BM 15	66	62	96	81
	5	BM 33	61	73	82	74
	6	BM 36	68	69	71	70
Mean			**63**	**62**	**84**	**74**
Susceptible	7	BM 17	36	54	70	57
	8	BM 34	38	63	68	56
	9	BM 42	41	55	68	58
	10	BM 50	50	69	61	59
Mean			**40**	**60**	**67**	**58**
Highly susceptible	11	BM 04	33	34	46	40
	12	BM 06	36	42	49	44
	13	BM 12	22	15	50	37
	14	BM 18	39	42	49	45
	15	BM 21	23	21	31	27
Mean			**30**	**31**	**45**	**38**

GROWTH AND DRY MATTER PRODUCTION OF TWO MUNGBEAN GENOTYPES AT DIFFERENT GROWTH STAGES IN RESPONSE TO SALINITY TOLERANCE

M. A. Aziz[1] , M.A.Karim[2], A. Hamid[2], Q.A. Khaliq[2], M. Hossain[2] and A.J.M.S. Karim[2]

Abstract

The experiment was conducted to clarify the tolerance of mungbean to salinity at various growth stages. All plants of BM 21 receiving 200 mM died within 10 and 15 days of salinization at the vegetative and flowering stages, respectively, but not at pod filling stage indicating that with the advances in the growth stage the tolerance of the plants to salinity might have increased. The salt tolerance in mungbean increases with the advancement of growth stage. The relative reduction of TDM was higher at vegetative stage than that at flowering and pod-filling stage, especially in BM 21. Between the two genotypes BM 01 showed greater salt tolerance than BM 21.

Key words: *Salt tolerance, mungbean, growth stages, NaCl salinity, dry matter production*

Introduction

Identification of salt sensitive growth stages of a crop helps in designing irrigation management strategies with brackish water. As salinity tolerance of a crop varies with growth stages, e.g. greengram (Gill, 1988; 1990; Ashraf and Rasul, 1988), cowpea (Maas and Poss, 1989), it could be possible to alleviate the yield loss of a crop under saline conditions by identifying the sensitive growth stages and avoiding irrigation with water containing high concentrations of salt at those stages. Several studies have shown that exposure of a plant to salinity at early seedling stage shows a greater total dry matter loss than that exposure at later part of growth (Lunin *et al.*, 1983; Maas *et al.* 1983 and Pasternak *et al*., 1986). However, it is not well clear from those studies whether the low productivity of dry matter was due to their exposure to salt stress for a longer period of time or not. The present study was conducted to clarify the tolerance of mungbean to salinity at various growth stages in terms of growth and dry matter production.

Materials and Methods

The experiment was conducted at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. The experimental was carried out in a completely randomized design with five replications comprising two varieties mungbean viz., BM 01 (tolerant one) and BM 21(susceptible one); three salinity treatments viz., 0, 100 and 200 mM NaCl imposed at three different growth stages viz. vegetative, flowering and pod-filling stage. Seeds of mungbean genotypes BM 01 and BM 21 were sown on 8 March 2000 in earthen pots of 24 cm in diameter and 30 cm in height. Each pot was filled with 12 kg air-dried soil and kept in venyl house. Compost (1/4th of the soil volume) and 0.27, 0.28, and 0.20 g urea, TSP and MP per pot, respectively were incorporated uniformly into the soil. Before application of such high concentrations of saline water, the plants were irrigated with a 25 mM and then a 50 mM NaCl solution for 5 days in order to protect the plants from osmotic shock. Treatment solutions were applied in excess so that the extra solutions dripped out through the bottom of the pots.

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Treatments at each stage were continued for 10 days, after which the pots were flushed with tap water to leach out the accumulated salt and the plants were irrigated with tap water until plant sampling. Control plants were irrigated with tap water only.

Five plants per treatment were harvested at the end of salinity treatment at each stage to measure their dry weight. The data were analyzed by ' MSTAT' program and the treatment means were compared by LSD.

Results and Discussion

Phenological growth

Visual observations at early growth stages revealed signs of injury like chlorosis, necrosis and burning in the leaf margin in BM 21 at all salt concentrations. These injuries were severe at high salt concentration. All plants of BM 21 receiving 200 mM NaCl died within 10 and 15 days of salinization at the vegetative and flowering stages, respectively. No plants died when salinity stress of this level was imposed at pod filling stage indicating that with the advances in the growth stage the tolerance of the plants to salinity might have increased.

Plant height was significantly reduced due to salinity (Table 1). At vegetative stage the relative plant height of BM 01 (90% and 86% in 100 and 200 mM, respectively) differed significantly from BM 21 (80% and 68%). At flowering stage, the differences in height between the accessions (treated with NaCl and their control) were less than that at vegetative stage. At pod-filling stage plant height of both accessions was less affected by NaCl relative to control and at flowering stage. Relative plant heights of BM 01 were more or less similar at flowering and pod- filling stage. By contrast, the tolerance of BM 01 progressively increased from vegetative and flowering stage to pod-filling stage. It is clear from previous work that sensitivity to salinity differs between species as well as within growth stages of a species. Studies in cowpea (Maas and Poss, 1989), mungbean (Ashraf and Rasul, 1988; Gill, 1988 and 1990) and lentil (Ashraf and Waheed, 1990) suggested that vegetative growth of these species was the most sensitive to salinity compared to other growth stages.

Root dry matter per plant

As usual the absolute root dry matter accumulation increased with the increasing growing time (vegetative vs. flowering vs. pod-filling stage). The relative root weights of each of the genotypes differed significantly at each growth stage (Table 1). The adverse effect of NaCl was more pronounced at vegetative stage. The relative salt tolerance values at vegetative stage ranged from 64% to 78% compared to 76% to 88% at flowering stage. The improved relative salt tolerance of BM 01 was significant ($P<0.05$). At pod-filling stage, the overall mean relative root dry weight of the genotypes was higher than that at flowering stage, whilst that of BM 01 increased significantly ($P<0.05$) from 88% to 96%.

Roots are the most salt-sensitive organ (Sharma, 1998; Due, 1997), and thus root inhibition and poor root growth adversely affects the survival and productivity of plants. Although the data presented in Table 1 to 3 showed that there was a significant reduction in all plant characters due to NaCl, it had a particular deleterious effect on root growth. Root growth inhibition is likely to have been due to specific ion toxicity, Na^+ and Cl^- (Sharma, 1998; Due, 1997) and to osmotic imbalance (Yoshiba *et al* 1995; Yoshiba *et al*. 1997). The inhibitions of root growth have resulted due to reduction of mitotic activity as previously observed in mungbean (Ashraf and Waheed, 1990) and in cotton (Leidi and Saiz, 1997).

Shoot dry matter per plant

The shoot dry weight is defined as the sum of leaf, stem petiole and reproductive organ dry weight. Analysis of variance showed that there were significant differences in the dry weight of shoot components at different growth stages under100 mM and 200 mM NaCl salinity. No differences in growth between genotypes were observed at 0 mM NaCl. At 200 mM NaCl, leaf dry weight decreased by 38, 35 and 33% in BM 01 and 59, 44, and 40% in BM 21 at vegetative, flowering and pod-filling stages respectively (Table 1). Stem dry weight was reduced by 43, 37 and 33% in BM 01 and 61, 50, and 45% in BM 21; petiole dry weight 47, 38 and 34% in BM 01 and 64, 57 and 51% in BM 21, respectively. The reproductive organ reduced by 28 and 24% in BM 01 and 69 and 64% in BM 21 at flowering and pod- filling stages, respectively (Table 2). Similar trend of reduction was also observed at 100 mM NaCl for both the genotypes. The salinity level associated with a decrease of shoot dry weight was maximum at vegetative stage followed by flowering and pod filling stage. These results suggest that salt tolerance in mungbean increases with the advancement of growth stage (Raptan 2001; Faruquei, 2002). Stronger reductions in dry weight of leaves, stem, petiole as well as reproductive organ were observed at high salinity levels (100 and 200 mM NaCl) at the vegetative stage as compared to flowering and pod-filling stage (Table 1 and Table 2). These reductions were closely related to those in root dry weight and plant height.

Total dry matter per plant

Clearly the total dry mater (TDM) decreased more at vegetative stage than that at flowering and pod-filling stage (Table 3). Moreover, higher the salt concentration the larger was the TDM reduction. The absolute amount of TDM was higher in BM 01 than that in BM 21. In general TDM of BM 21 decreased more than that of BM 01. The relative reduction of TDM was higher at vegetative stage than that at flowering and pod-filling stage, especially in BM 21. At 200 mM NaCl, the TDM production reduced by 61, 51 and 47% in BM 21 at vegetative, flowering and pod-filling stages respectively. While it as 42, 36 and 29% in BM 01, respectively. The reduction in TDM was attributed to low dry weight of leaf, stem and petiole due to the stress. Patil *et al*. (1995) and Faruquei (2002) observed that leaf, stem, pod and total dry matter production at all growth stages in mungbean were reduced by increasing salinity.

The slope of the line in Table 4 represents the reduction in percent of relative TDM per unit increase per mM of NaCl. There were only small differences in the slope between flowering and pod filling stages for TDM production, while the change at vegetative stage exhibited a great effect on the slope for TDM yield (Table 4). An increase in each mM of NaCl reduced the relative TDM yield (%) in plants treated at the vegetative, flowering and pod filling stages by 0.41%, 0.34% and 0.30% in BM 01 and 0.93%, 0.56% and 0.42% in BM 21 respectively (Table 4). A number of investigators reported various effects of salinity applied at different growth stages (Gill, 1988 and 1990; Mass and Poss, 1989; Ashraf and Rasul, 1988; Karim *et al.*, 1993). The results indicated that the salt tolerance of mungbean was greatly enhanced at pod filling stage, whereas only slightly when treated at flowering stage in comparison to that at vegetative stage. However, genotypes responded differently to salinity. Between the two genotypes BM 01 showed greater salt tolerance than BM 21.

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Table 1. Plant height, root and leaf dry weight of BM 01 and BM 21 as affected by NaCl salinity at the vegetative (V), flowering (F) and pod-filling (P) stages of growth

NaCl (mM)	BM 01			BM 21		
	V	F	P	V	F	P
Plant height (cm)						
0	31.50(100)	57.08(100)	58.54(100)	42.76(100)	55.12(100)	56.80(100)
100	28.40(90)	53.12(93)	56.52(97)	34.08(80)	45.52(83)	49.62(87)
200	27.08(86)	51.72(91)	55.64(95)	30.16(71)	39.80(72)	47.18(83)
$LSD_{(.05)}$	1.61					
CV (%)	10.25					
Root dry weight (g/ plant)						
0	0.74(100)	0.99(100)	1.19(100)	0.80(100)	0.95(100)	1.08(100)
100	0.53(71)	0.80(77)	1.05(86)	0.39(49)	0.62(59)	0.76(67)
200	0.40(54)	0.66(61)	0.84(65)	0.28(35)	0.50(47)	0.62(51)
$LSD_{(.05)}$	0.12					
CV (%)	9.69					
Leaf dry weight (g/plant)						
0	1.25(100)	4.96(100)	6.51(100)	1.62(100)	4.45(100)	6.05(100)
100	0.92(74)	3.79(80)	5.50(88)	0.86(59)	2.49(65)	3.67(76)
200	0.72(62)	3.04(65)	4.35(67)	0.61(41)	1.90(56)	2.95(60)
$LSD_{(.05)}$	0.58					
CV (%)	10.71					

Values presented in parentheses indicate percent values to the control.

Table 2. Stem, petiole and reproductive organ dry weight of BM 01 and BM 21 as affected by NaCl salinity at the vegetative (V), flowering (F) and pod-filling (P) stages of growth

NaCl (mM)	BM 01			BM 21		
	V	F	P	V	F	P
Stem dry weight (g/plant)						
0	0.82(100)	3.39(100)	5.72(100)	0.91(100)	3.98(100)	5.63(100)
100	0.61(75)	2.70(80)	4.93(87)	0.51(53)	2.40(60)	3.70(71)
200	0.49(57)	2.15(63)	3.91(67)	0.37(39)	1.97(50)	3.00(55)
$LSD_{(.05)}$	0.23					
CV (%)	5.22					
Petiole dry weight (g/ plant)						
0	0.30(100)	0.98(100)	1.22(100)	0.36(100)	0.84(100)	1.13(100)
100	0.23(77)	0.78(80)	1.06(86)	0.21(47)	0.52(56)	0.75(58)
200	0.18(53)	0.63(62)	0.85(66)	0.15(36)	0.43(43)	0.62(49)
$LSD_{(.05)}$	0.11					
CV (%)	10.30					
Reproductive organ dry weight (g/plant)						
0	-	0.85(100)	2.67(100)	-	1.20(100)	2.46(100)
100	-	0.73(86)	2.45(92)	-	0.63(53)	1.36(55)
200	-	0.61(72)	2.02(96)	-	0.37(31)	0.88(36)
$LSD_{(.05)}$	0.10					
CV (%)	5.63					

Foot notes are similar to those in Table 1.

Table 3. Total dry weight weight of BM 01 and BM 21 as affected by NaCl salinity at the vegetative (V), flowering (F) and pod-filling (P) stages of growth

NaCl (mM)	BM 01			BM 21		
	V	F	P	V	F	P
TDM weight (g/plant)						
0	3.11(100)	11.17(100)	17.31(100)	3.69(100)	11.42(100)	16.35(100)
100	2.29(74)	8.80(80)	14.99(88)	1.97(54)	6.66(61)	10.20(70)
200	1.79(58)	7.09(64)	11.97(71)	1.41(39)	5.17(49)	8.07(53)
$LSD_{(.05)}$	0.51					
CV (%)	3.27					

Foot notes are similar to those in Table 1.

Table 4. Equation of linear regression relating salt stress (in mM NaCl) (x) to TDM production (% of control) (y), where y = a + bx

Treatment		Parameters of regression					
Growthstage	NaCl (mM)	a		b		R^2	
		BM 01	BM 21	BM 01	BM 21	BM 01	BM 21
V	0 - 200	161.25	196.14	-0.42	-0.93	98^{**}	97^{**}
F	0 - 200	154.67	157.34	-0.35	-0.55	96^{**}	98^{**}
P	0 - 200	150.81	139.33	-0.30	-0.42	98^{**}	97^{**}

** Significant at P<0.01 V, vegetative; F, Flowering; P, Pod-filling

SALT TOLERANCE OF MUNGBEAN AT DIFFERENT GROWTH STAGES: EFFECT OF NaCl SALINITY ON ION UPTAKE AND DISTRIBUTION

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Abstract

The experiment was conducted to clarify the tolerance of mungbean to salinity at various growth stages in terms of ion uptake and distribution. All plants of BM 21 receiving 200 mM died within 10 and 15 days of salinization at the vegetative and flowering stages, respectively, but not at pod filling stage indicating that with the advances in the growth stage the tolerance of the plants to salinity might have increased. The salt tolerance in mungbean increases with the advancement of growth stage. Vegetative stage is being more sensitive than flowering and pod-filling stages. Salt injury in this crop may be owing to plant Na^+ accumulation and reduction in the K^+: Na^+ ratio at early growth stage. With the advancement of growth stages, Na^+ accumulation was in order of root > stem > petiole > leaf > reproductive organ.

Key words: *Salt tolerance, mungbean, growth stages, ion uptake and distribution*

Introduction

Growth and yield of many crops may be adversly affected under saline conditions due to disturbance in the clectrobyte balance resulting in deficiency of some essential nutrient and excess of certain unwanted salts in the plant tissuee. The reduced water potential at high salt concentrations may further aggravate the effects. According to Epstein (1985) besides an engineering approach, development of crops, tolerant to salinity, is a better strategy for meetintg the challange of this peoblem. To achieve this, a better understanding of physiology of mechanism of salt tolerance at different growth stages in terms of ion uptake is highly essential. Because sensitive growth stages, however, differ among the crops, among cultivers of the same crop and even among different growth stages in a same cultivar (Blum, 1988: Ashraf and Waheed, 1990).

Mungbean is one of the important pulse crops of South and South-East Asia. In Bangladesh it is gerown mostly in southern part (about 70%). It is certain, therefore, that mingbean can be an ideal material for study to understand the mechanism of ion uptake and distribution specially Na^+ and K^+ at different growth atages and salt tilerance in plants. It was thought worthwhile, therefore, to investigate the effect of NaCl salinity on uptake and distribution on Na^+, K^+ and Na^+/K^+ in mungbean in order to understane the mechanism of salt tolerance at different geowth stafes in this legume.

Materials and Methods

The experimental was conducted in a completely randomized design consisting of three salinity treatments (0, 100 and 200 mM NaCl) imposed at three different growth stages in pot culture. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 –0.28–0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. Two genotypes BM 01(tolerant) and BM 21 (susceptible) were tankn as test material. Irrigation with 100 and 200 mM NaCl solutions (Ec = 10 and 20 dS/m respectively) was then applied at the vegetative, flowering and pod-filling stages. Treatment solutions were applied in excess so that the extra solutions dripped out through the bottom

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of the pots. Treatments at each stage were continued for 10 days, after which the pots were flushed with tap water to leach out the accumulated salt and the plants were irrigated with tap water until maturity. Control plants were irrigated with tap water only.

Five plants per treatment were harvested at the end of salinity treatment at each stage to measure their dry weight as well as Na and K concentrations in the plant parts. The plant parts were finally ground for the determination of Na and K. The ground samples were dry-ashed at 800 ^{0}C for six hours and digested with concentrated hydrochloric acid. Na and K concentrations were determined from four replicated plants in each genotype with atomic absorption spectrophotometer (Shimadzu, Atomic Absorption/ Flame Spectrophotometer, Model-AA 610 S).

Results and Discussion

Sodium ion concentration in different plant parts

The accumulation of Na^+ increased with the increasing levels of NaCl (Fig. 1.). At vegetative stage, root accumulated more Na^+ than shoot. At flowering stage more Na^+ was accumulated in root and stem than petiole, leaf and reproductive organ. At pod filling stage, Na^+ accumulation was more in root, stem, petiole and leaf but less in reproductive organ. BM 01, the tolerant genotype, accumulated less amount of Na^+ in most of the plant parts compared to BM 21, except root. Roots of BM 01 expressed higher accumulation of Na^+ than the roots of BM 21. A similar result was reported by Lauchli and Wieneke (1979) for soybean and Raptan (2001) for blackgram that tolerant cultivar maintained relatively larger Na^+ in the root and a smaller amount in the shoot compared to the salt-susceptible cultivar. Patil *et al*. (1995) reported that increasing salinity increased accumulation of salts in the root zone of greengram that created osmotic effect and a restriction of nutrient availability except Na^+. Perhaps genotype BM 21 suffered more with Na^+ toxicity by accumulating higher amount of that ion than BM 01 at 200 mM NaCl during vegetative and flowering stages of growth.

The accumulation of Na^+ ions in the shoot (stem, petiole and leaf) also increased at the vegetative stage followed by flowering and pod filling stages (Fig. 2). In contrast to shoot, Na^+ concentration was greatly reduced in reproductive organ during flowering and pod filling stages of growth. The reduction was higher in BM 01 compared to BM 21. This observation indicated that the translocation of Na^+ from shoot to the reproductive organ was regulated efficiently in BM 01 compared to that in BM 21. Probably this might be the reason for tolerance of the former genotype to salinity stress at reproductive phase. High inclusion as well as increased accumulation of Na^+ ion in the reproductive organs of BM 21 demonstrated its weak regulation of Na^+ transport to the vital reproductive organ. On the contrary, relatively higher exclusion and poor translocation of Na^+ ion in the reproductive organs of BM 01 provided the evidence for salinity tolerance at reproductive phase. Evidences for Na^+ ion exclusion exist in the cultivars of wheat (Mass and Poss, 1989), barley (Greenway and Muns, 1980) and rice (Yasmeen, 2000).

Potassium ion concentration in different plant parts

Compared to non saline condition, the K^+ ion concentration decreased by salinity in most of the plant parts in both the genotypes of mungbean, except reproductive organs at different growth stages (Fig. 3). The reduction percentage of K^+ ion in BM 21 was higher compared to BM 01 (Fig.4). In contrast to root and shoot, K^+ in reproductive organ was increased at flowering and pod-filling stages under saline condition. Increase in K^+ in reproductive organ is important for the protection of reproductive organ development against the damaging effect of Na^+. In this study, salinity increased significantly Na^+ in root and shoot. This increase was accompanied by a decline in the K^+ content, indicating an apparent antagonism between K^+ and Na^+. This antagonism may be due to the direct competition between K^+ and Na^+ at a site of ion uptake in the plasmalemma (Epstein, 1985). High levels of Na^+ may also enhance the efflux of K^+ into the growth medium and displace Ca^{+2} from root membranes, changing their integrity (Cramer et al. 1985) and, thus, affecting the selectivity for K^+ uptake (Cramer et al. 1987). Perhaps, relatively higher translocation of K^+ ion in the reproductive organ of BM 01 provided the evidence for salinity tolerance at the later stages. In fact the ability to maintain metabolically significant concentrations of K^+ may be essential for salt tolerance in glycophites (Zhu *et al*. 1998).

K^+ : Na^+ ratio in different plant-parts

The response of plants in maintaining K^+: Na^+ ratio varied among the plant parts at different growth stages under saline condition. Under saline condition, K^+: Na^+ ratio in the root was more or less similar at vegetative, flowering and pod filling stages (Fig. 5). Similarly in stem and petiole the reduction of K^+: Na^+ ratio was higher at vegetative stage than that at the later two stages. In the leaves, salinity stress was decreased the K^+: Na^+ ratio in both the genotypes. However, the reduction was much more predominant at vegetative stage - a sensitive stage than that at the later stages (Fig. 5). This observation was similar to the findings of Ashraf and Rasul (1988) and Gill (1990) who reported low K^+: Na^+ ratio at the vegetative stage of mungbean.

Unlike root and shoot, the K^+: Na^+ ratio was decreased in reproductive organ of both the genotypes at flowering and pod-filing stages under saline condition but the reduction was higher in BM 21 than that of BM 01(Fig.5). Higher K^+: Na^+ ratio in tolerant genotypes and the lower K^+: Na^+ ratio in susceptible genotype under saline condition support the findings of Maas et al. (1986) and Yasmeen (2000). Compared to Na^+ ions, relative higher accumulation of K^+ ions in the reproductive organ of tolerant genotype might nullify the adverse effects of Na^+ ions in the pod development of mungbean. K^+ ions probably antagonize the damaging effect of Na^+ ions in the reproductive organ.

In conclusion, the salt tolerance of mungbean increased with the advancement of growth stages. Vegetative stage is being more sensitive than flowering and pod-filling stages. With the advancement of growth stages, Na^+ accumulation was in order of root > stem > petiole > leaf > reproductive organ. Salt injury in this crop may be owing to Na^+ accumulation and reduction in the K^+: Na^+ ratio at early growth stage.

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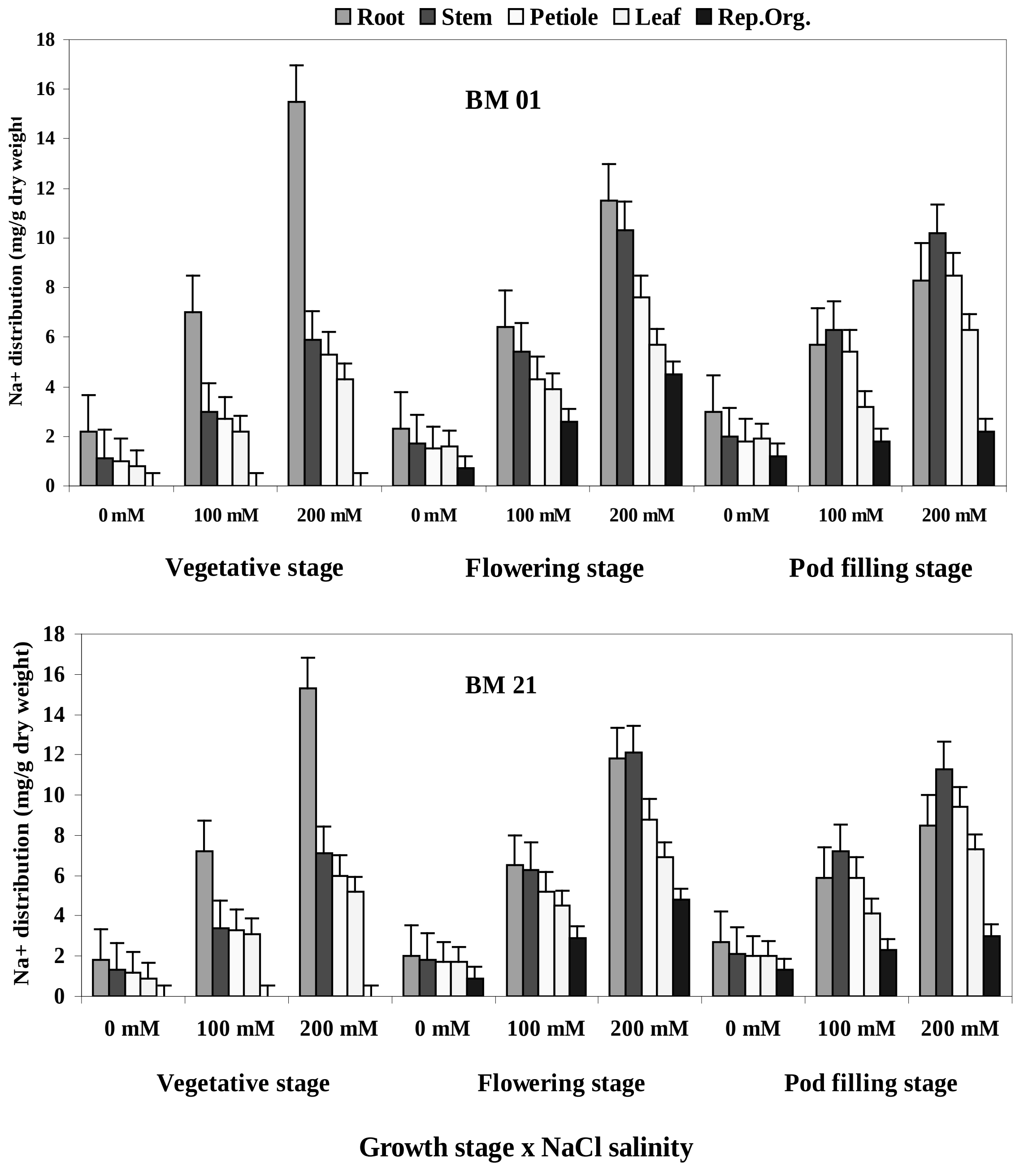

Fig. 1. Concentration of Na^+ ion in different plant parts of BM 01and BM 21 as influenced by NaCl salinity at the vegetative, flowering and pod-filling stages of growth. Error bars represent standard error

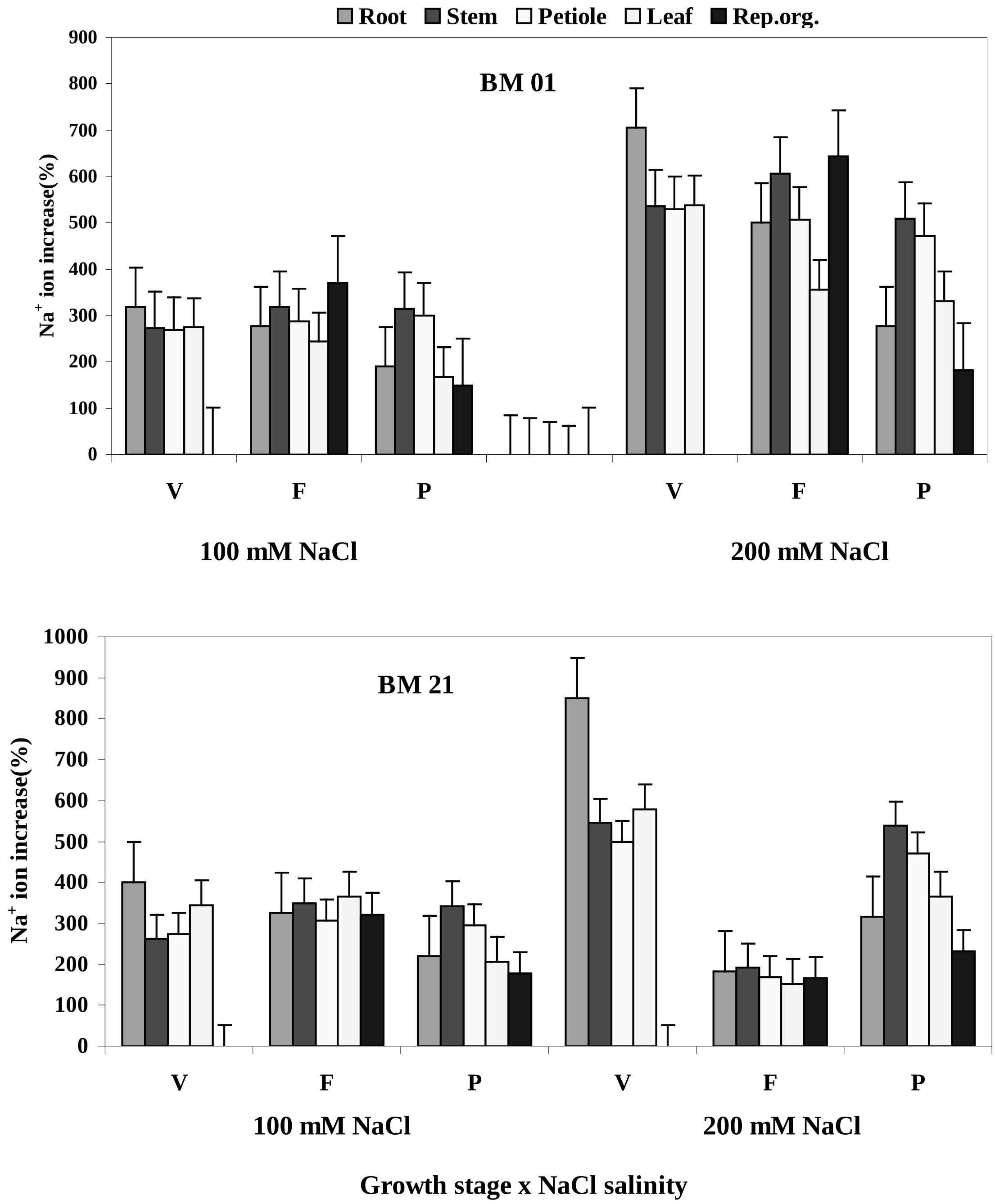

Fig. 2. Percent increase of Na^+ ion concentration in different plant parts of BM 01 and BM 21 as influenced by NaCl salinity at the vegetative (V), flowering (F) and pod-filling (P) stages of growth. Error bars represent standard error

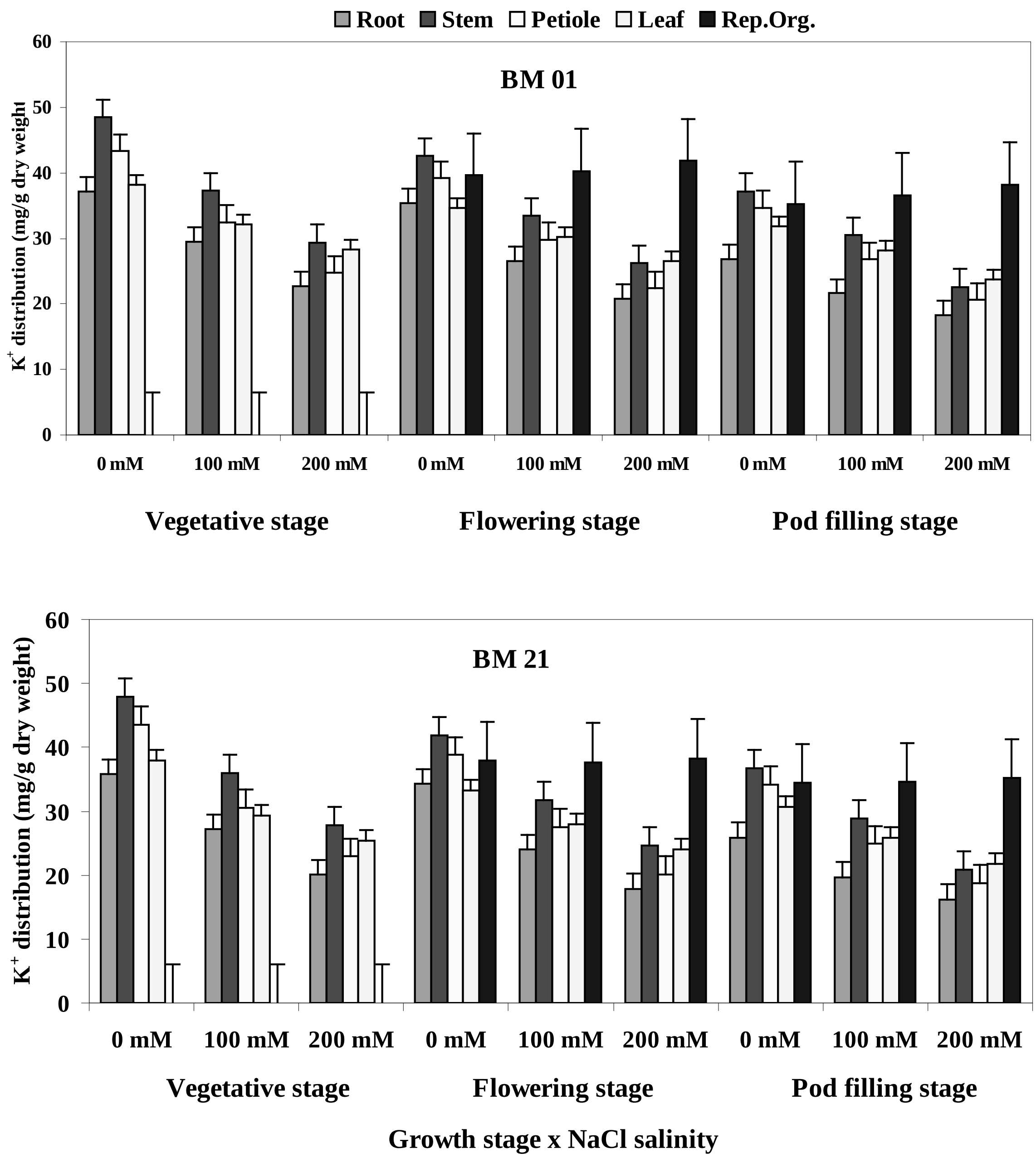

Fig. 3. Concentration of K^+ ion in different plant-parts of BM 01and BM 21 as influenced by NaCl salinity at the vegetative, flowering and pod-filling stages of growth. Error bars represent standard error

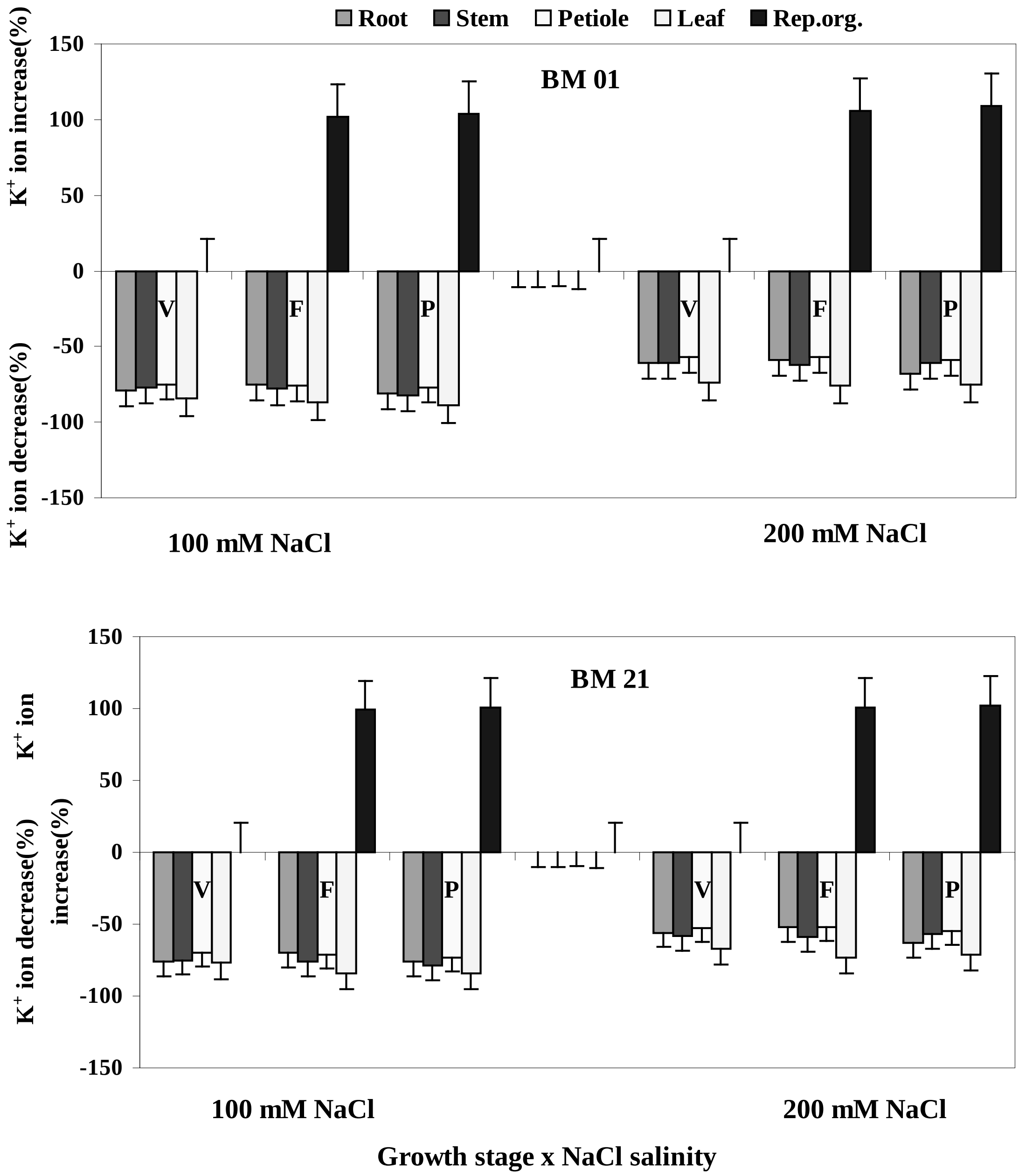

Fig. 4. Percent increase or decrease of K^+ ion concentration in different plant-parts of BM 01and BM 21 as influenced by NaCl salinity at the vegetative (V), flowering (F) and pod-filling (P) stages of growth. Error bars represent standard error

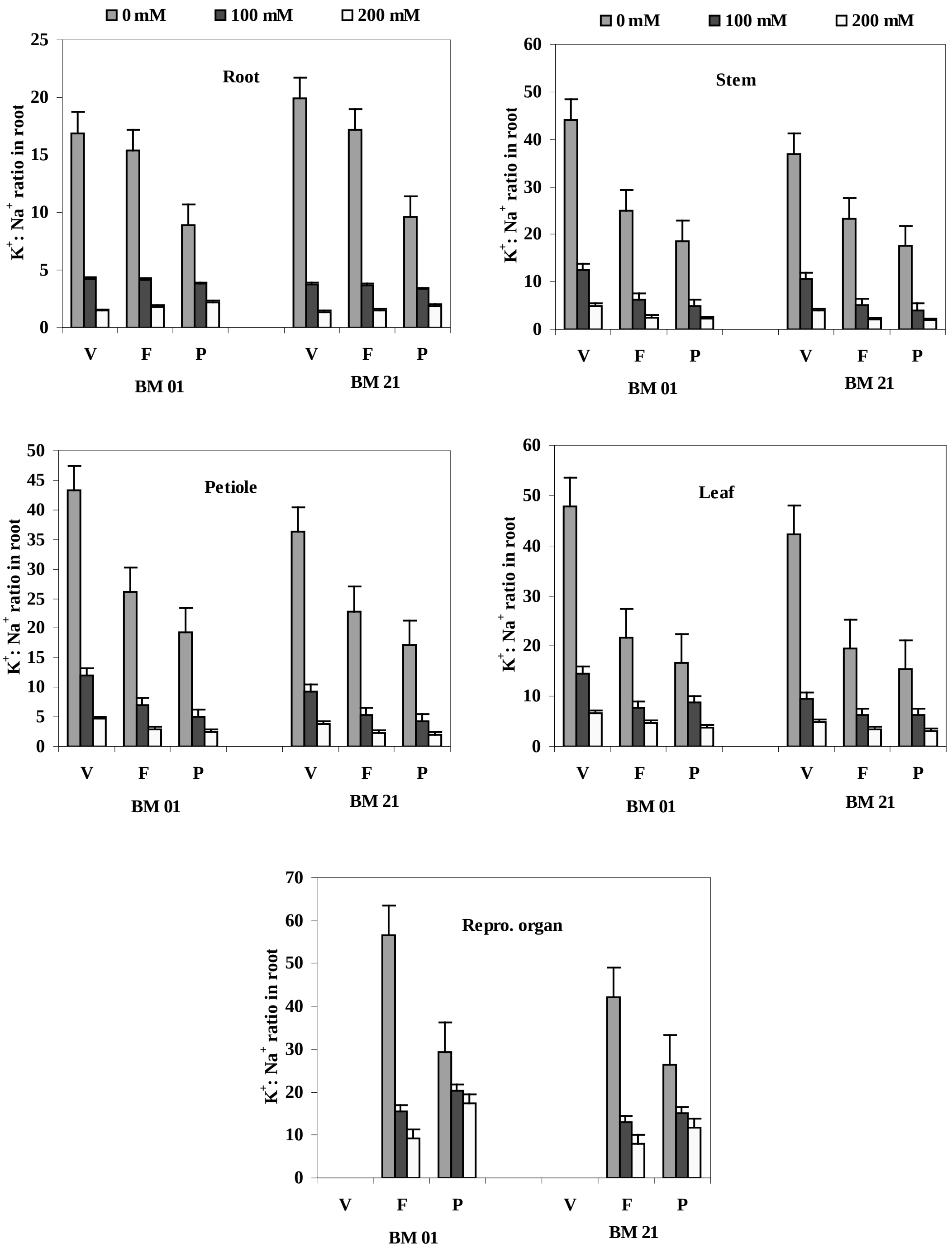

Fig.5. K^+:Na^+ ratio in root,stem, petiole, leaf and reproductive organ of BM 01 and BM 21 as influenced byNaCl salinity at the vegetative (V), flowering (F) and pod-filling (P) stages of growth. Error bars represent standard error

PHYSIOLOGICAL MECHANISMS OF SALT TOLERANCE IN MUNGBEAN: GROWTH PATTERN OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

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Abstract

The response of two mungbean genotypes differing in tolerance to NaCl salinity was studied over a period of upto maturity. In response to 0, 50, 75, and 100 mM salinity, the two genotypes showed clear differences in the changes in relative growth rate (RGR), net assimilation rate (NAR) and leaf area ratio (LAR). BM 01 expressed more salt tolerance than BM 21 in terms of growth under saline condition. The RGR of BM 01 reduced slightly by salinity, while reduced greatly in BM 21, particularly at the later stages of growth. The NAR of salt treated plants of BM 01 was little affected compares to the control plants, but the NAR of BM 21 was significantly reduced by salinity partiacularly at the later stages of growth. The reduction of LAR was higher in BM 21 than that in BM 01. The reduction of RGR appeared to be due to a decrease of LAR and NAR.

Key words: *Physiological mechanisms, salt tolerance, mungbean, RGR, NAR, L*AR

Introduction

Growth analysis is fundamental to the characterizaton of a plant response to an environmental stress. It provides useful information as to when stress effects occur, allowing for a ctitical analysis of the series of events leading to geowth inhibition of stress symptoms. In addition, growth analysis can provide useful informtion regarding the natrre of the stres effect on growth. According to He and Cramer (1993), changes in the relative growth rate (RGR) with time can be detected and correlated with two variables that influence RGR: 1) the net assimilation rate (NAR) and 2) the leaf area ratio (LAR).

Plant growth analysis has been applied to analyze the effects of salinity on plant growth (Cheeseman and Wickens, 1986; Cramer *et al*., 1990; Shennan *et al*., 1987). Some reports indicate that salinity affected LAR, but not NAR (Curtis and Lauchli, 1986; Shennan *et al*., 1987), indicating that the growth limiting factor was associated with leaf expansion. In contrast, others reported that the decrease of the RGR of salt-stressed barley was correlated with NAR, but not with LAR (Cramer et al., 1990; Cramer and Nowak, 1992), indicating that photosynthesis may be limiting the growth. Thus, the effect of salinity on growth parameters for a given species needs to be specially investigated for each genotype.

In the earlier experiments the genotypes, BM 01 and BM 21 were ranked as the most salt tolerant and salt sensitive genotypes, respectively. This study was initiated to further analyze, in details, the effects of NaCl salinity on growth pattern in terms of RGR, NAR and LAR of two mungbean genotypes differing in salt tolerance.

Materials and Methods

Seeds of two genotypes of mungbean, BM 01 (tolerant one) and BM 21 (susceptible one), were sown in earthen pots in the vinylhouse at the Environmental Stress Research Site of the

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Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. Six plants were used in each treatment for the measurement of agronomic parameters. The pots were irrigated with tap water until the seedlings were well established. NaCl solutions were applied every other day at an increment of 12.5 mM until the respective final concentrations, 50, 75, and 100 mM were attained for each treatment. The treatment solution was applied with irrigation water until maturity. Plants in the control group were irrigated with tap water. Sampling was done at a ten-day interval from 25 days after emergence (DAE) till maturity. For growth analysis, the relative growth rate (RGR), net assimilation rate (NAR) and leaf area ratio (LAR) of whole plants were determined by the method following He and Cramer (1993) as follows:

$$RGR = \frac{\text{In } W_2 - \text{In } W_1}{T_2 - T_1}$$

In W_2 and In W_1 represent In – transformed total plant dry seight (g) at two different harvest dates and T represents the time (day) at those harvests.

$$NAR = \frac{W_2 - W_1}{T_2 - T_1} \text{ x } \frac{\text{In } L_{A2} - \text{In } L_{A1}}{L_{A2} - L_{A1}}$$

Net assimilation rate (NAR) was obtained in the same way as RGR except using the following formula:

where W, L_A and T represent total plant dry weight (g), leaf area (m^2) and time (day), respectively.

Leaf area ratio (LAR) was directly calculated using the following formula :

$$LAR = \frac{L_A}{W}$$

where L_A and W represent leaf area (m^2) and total plant dry weight (g), respectively.

Results and Discussion

RGR of the two genotypes decreased with time (Fig. 1a). The RGR between the genotypes and the treatments were evaluated. There was a difference in RGR between the two genotypes. The RGR of BM 21 was strongly inhibited by salinity, particularly at the later growth stages and RGR of BM 01 was only slightly inhibited by salinity at the early growth stages. The relative reduction of RGR expressed as the percentage of control showed that BM 01 performed better than BM 21 (Fig. 1b). The relative reduction of RGR was an approximately 7-50% in BM 01 while the RGR of BM 21 decreased by 25-100% at 100 mM NaCl.

The change in NAR over time is shown in Fig. 2a and Fig. 2b. The difference in NAR between the genotypes indicated a better performance of BM 01 in this respect. At 50 mM NaCl, BM 01 showed higher NAR than control. There was comparatively little difference in their intercept or slope in analysis of covariance indicating that NAR of salt treated plants of BM 01 was little affected compared to the control plants over time. In contrast, the NAR of BM 21 was significantly reduced by salinity particularly at the later stages of growth. There was 19-97% reduction of NAR in salt treated plants (100 mM NaCl) from day 25 to harvest in BM 01 while ttht was 70 to 100% from day 25 to day 45 in BM 21, corresponding to the decrease of the RGR of this genotype during that time period. The correlation analysis showed that the reduction of NAR was significantly correlated with RGR (r = 0.99 for BM 01 and r = 0.91 for BM 21).

The differences in LAR due to salinity were clear between two genotypes. LAR of the salt treated plants was reduced significantly at the later stages of growth. The reduction was higher in BM 21 than that in BM 01 (Fig. 3a). The reduction of LAR in BM 01 was significantly correlated with the reduction of RGR (r =0.98) (Fig. 3b). The relative reduction as expressed by percent of control in BM 21 was 5-30% compared to 3-19% in BM 01 at 100 mM NaCl (r = 0.91). BM 01 had a greater LAR than BM 21.

Salinity also affected significantly carbon allocation as reflected in the change of root: shoot ratio (Fig. 4). Salt treated plants showed a higher root: shoot ratio than control plant in both genotypes, indicating a greater percentage of total carbon fixed was allocated to the roots of salt-treated plants. It appeared that BM 21 had a relatively higher root: shoot ratio than BM 01. Salinity decreased significantly the total dry weight of the two mungbean genotypes. The magnitude of dry weight reduction was greater in BM 21 than that in MB 01.

RGR, LAR and NAR of the two genotypes affected differently by NaCl salinity. RGR of BM 01 reduced slightly by salinity, whereas RGR of BM 21 showed a large reduction at the later stages of salinization (Fig. 2). A reduction in RGR due to salinity was also reported for different plant species, such as kenaf (Curtis and Lauchli, 1986), rice (Akita and Cabuslay. 1990), barley (Cramer *et al.*, 1990), and *Brassica* species (He and Cramer, 1992). However, the results of this study indicated that the decrease of RGR in susceptible genotype (BM 21) was higher than that of tolerant genotype (BM 01) which confirmed the findings of the He and Cramer (1993). With plant aging, the difference of RGR was largely reduced between the salt treated and the control plants of BM 21.

NaCl salinity decreased the LAR of BM 21 at the later stages of growth (Fig 4a) and the reduction of LAR was significantly correlated with the decrease of RGR (r = 0.98 for BM 01 and r = 0.91for BM 21). The reduced LAR under saline conditions reflects a reduction in leaf area of the plant, probably due to an inhibition of leaf expansion relative to other plant parts. Leaf expansion rate is sensitive to leaf turgor (Bradford and Hsaio, 1982), but turgor does not appear to limit the growth of salt–stressed plants (Cramer and Bowman, 1991). Salt stress can also reduce hydraulic conductivity (Munns and Passioura, 1984), decrease the extensibility and increase the yield threshold of the cell wall (Cramer, 1992). These changes in the cell growth parameters may be responsible for the decreased expansion growth of plants under salt stress.

In contrast to BM 01, the LAR of salt-treated BM 21 was reduced greatly compared to the control plants. The high correlation between the reduction of NAR and RGR of BM 21 (r = 0.98) clearly indicated that the decrease of the RGR of BM 21 was due to the inhibition of NAR. Similar to BM 21, NAR and LAR of *Brassica* species (He and Cramer, 1993), NAR but not LAR of barley (Cramer *et al.*, 1990) was decreased by salinity, whereas the opposite was true for kenaf (Curtis and Lauchli, 1986) and *Aster tripolium* (Shennan *et al.*, 1987).

A decrease of NAR reflects a decrease in the rate of photosynthesis (Cheeseman, 1988; Rawson *et al.*, 1988 Yeo *et al.*, 1985) or an increase in respiration (Nieman, 1962; Schwarz and Gale, 1981). Under low water potential conditions stomatal conductance is often reduced probably by changes in apoplastic concentrations of abscisic acid (Schulze, 1986), resulting in lower CO_2 concentrations within the leaf. In addition to the rate of photosynthesis, a plant carbon balance could also be affected by respiration. Since root/ shoot ratio was increased by salinity, root respiration of salt-treated plants is expected to consume a proportionally greater amount of carbon than that of control plants. Also, increased maintenance respiration by salinity could account for some reduction of NAR (Schwarz and Gale, 1981; He and Cramer, 1993).

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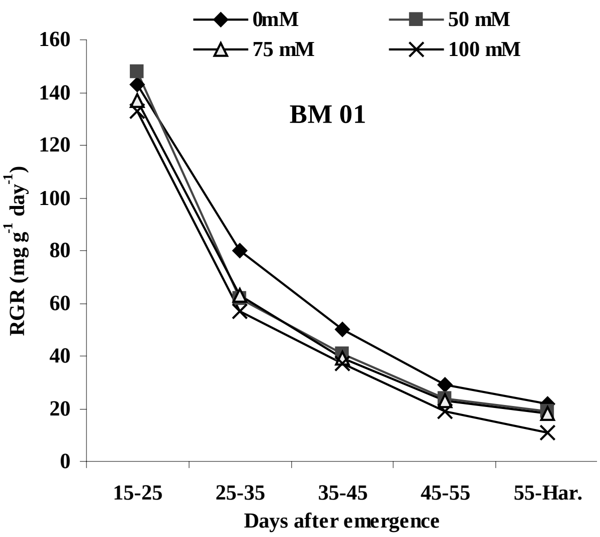

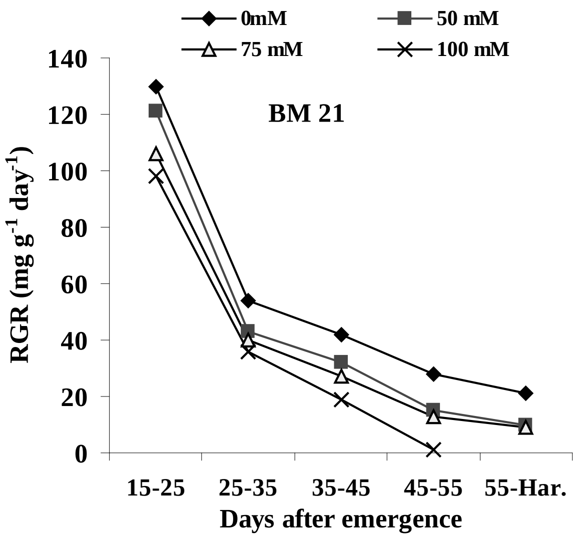

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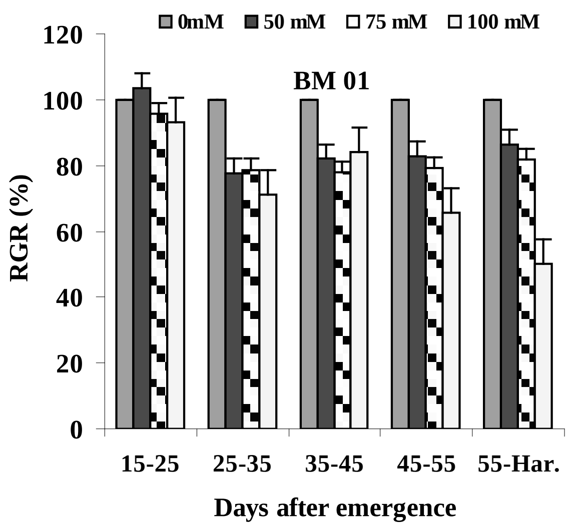

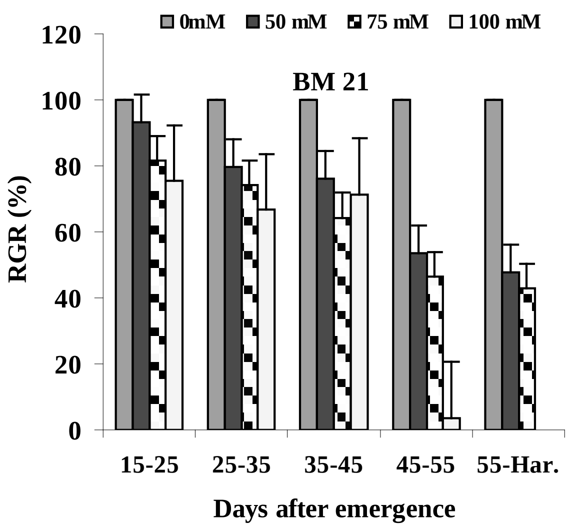

Fig. 1. Relative growth rate (a) and RGR (%) (b) of BM 01and BM 21as affected byNaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

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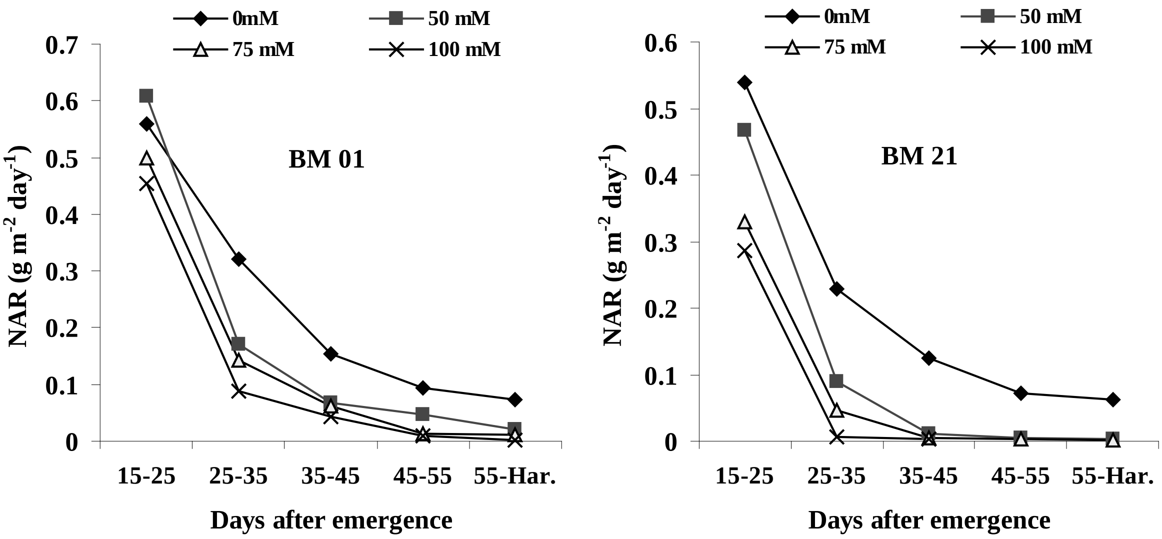

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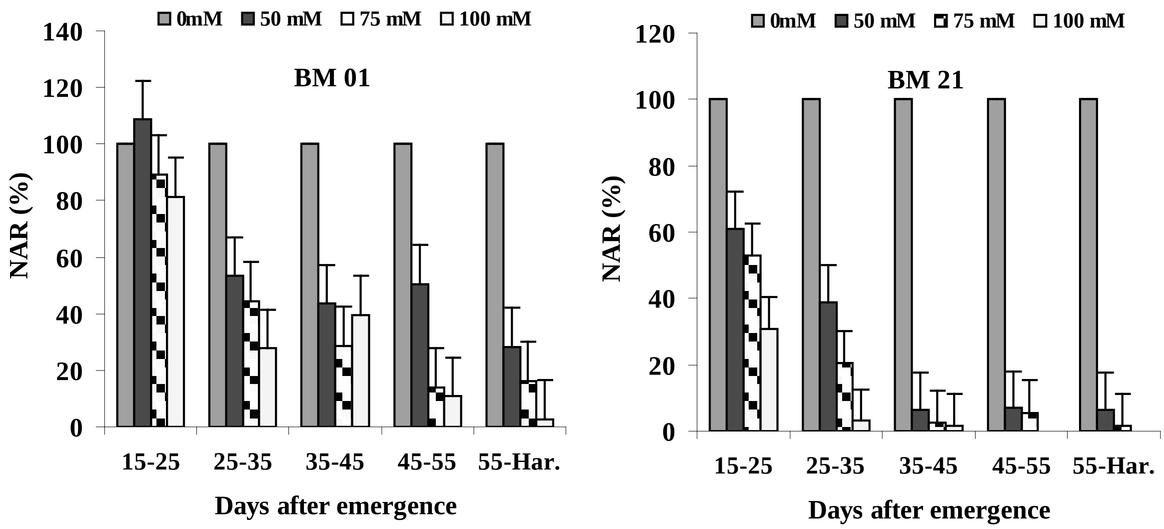

Fig. 2. Net assimilation rate (a) and NAR (%) (b) of BM 01and BM 21as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

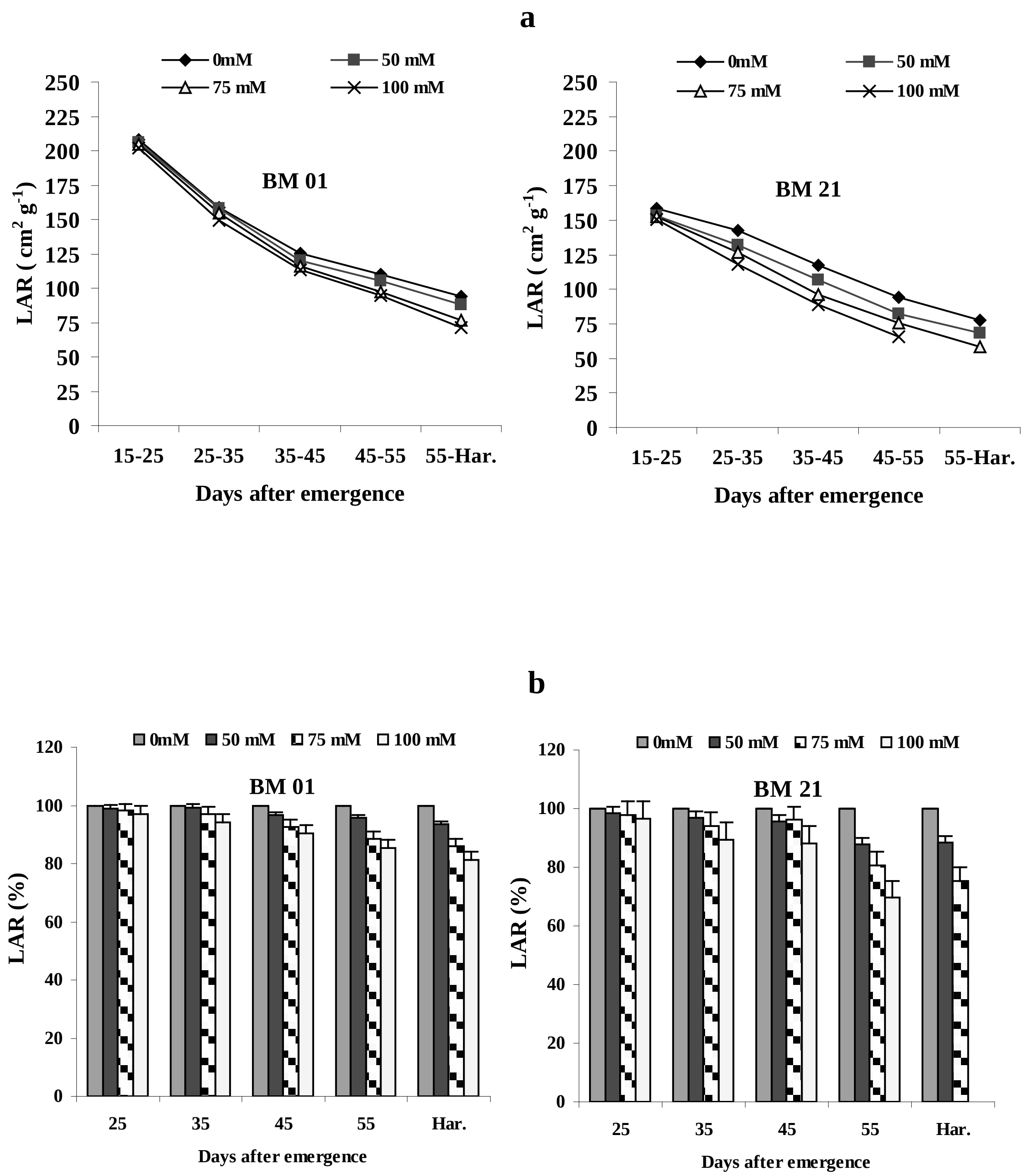

Fig. 3. Leaf area ratio (a) and LAR (%) (b) of BM 01and BM 21as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

DISTRIBUTION OF K^+ and Ca^{+2} IONS IN DIFFERENT PLANT PARTS OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

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Abstract

Salt tolerance in two mungbean genotypes BM 01 and BM 21 differing in K^+ and Ca^{+2} ion distributionin, were investigated with NaCl solutions at concentrations of 0, 50, 75 and 100 mM. BM 01 accumulated higher amount of K^+ than BM21 at all levels of salinity. A decreasing trend in Ca^{2+} accumulation was observed in roots and shoots with the increasing salinity as well as with the age of the crops. The capacity to maintain sufficient amount of K^+ and Ca^{+2} in the tissue was higher in BM 01 than that of BM 21. BM 01 expressed more salt tolerance than BM 21. Thus, it is likely that the difference in salt tolerance between the two genotypes was associated with the difference in the capacity to maintain sufficient amount of K^+ and Ca^{+2} in the tissue.

Key words : *Salt tolerance, mungbean, K^+ and Ca^{+2} ion distribution*

Introduction

One aspect of the salt tolerance of plants is related to specific-ion effects (He and Cramer 1993 Gorham *et al* 1985). Plants can 'exclude' ions, especially Na^+ or Cl^- from the leaves. Another mechanism for salt tolerance is to 'include' ions in the cells, but to exclude them from processes that are inhibited by high concentrations of ions. This is believed to be achieved by sequestering the ions in the vacuole. It is argued that these ions in the vacuole provide energetically 'cheap' solutes for osmotic adjustment (Flowers *et al* 1991). The concentration of essential elements like K^+ and Ca^{+2} may also play a role in the difference in salt tolerance among plant species. High concentrations of Na decrease like K^+ and Ca^{+2} a concentrations in the tissue of many plant species (Greenway and Munns 1980), even to a degree that symptoms of like K^+ and Ca^{+2} deficiencies appear (Maas and Grieve 1987). The capacity of plants to maintain sufficient Ca and like K^+ may be an important factor that provides a degree of salt tolerance in plants. In this paper, a more detailed analysis of the efffects of NaCl salinity on the ion accumulation of two mungbean genotypes differing in salt tolerance are provided. The hypotheses that the difference in salt tolerance between these two genotypes was related to differences of the deficiency of K^+ or Ca^{+2} in the plant tissue were tested.

Materials and Methods

Seeds of two genotypes of mungbean, BM 01 (tolerant one) and BM 21 (susceptible one), were sown in earthen pots in the vinylhouse at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. Six plants were used in each treatment for the measurement of agronomic parameters. The pots were irrigated with tap water until the seedlings were well established. NaCl solutions were applied every other day at an increment of 12.5 mM until the respective final concentrations, 0, 50, 75, and 100 mM were attained for each treatment. The treatment solution was applied with irrigation water until maturity. Plants in the control group were irrigated with tap water. Sampling was done at ten-day intervals from 25 days after emergence (DAE) till maturity. After harvesting, roots were separated from the plants and washed with tap

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water. The plant parts were segmented into leaf, stem and reproductive organ (flowers + pods). The samples were oven-dried at 70 ^{0}C to a constant weight. Potassium and calcium concentrations from these parts of the plants were determined by atomic absorption spectrophotometer (Shimadzu, Atomic Absorption /Flame Spectrophometer; Model- AA. 610s) following Hitachi Ltd. (1986).

Results and Discussion

Potassium

K^+ content decreased markedly in root and shoot with increasing salinity in both the genotypes except the reproductive organ (Fig. 1). Under control conditions the K^+ accumulation at 25 DAE was almost similar to that at other growth stages in both roots and shoots of the two genotypes. The accumulation pattern indicates that plant age did not have significant influence on K^+ accumulation in mungbean. Contrary, with the increase in salinity from 0 to 100 mM the K^+ content decreased in leaves, stem and roots in both the genotypes. Moreover, longer the exposure of plants to salinity higher was the reduction in K^+ accumulation. BM 01 accumulated higher amount of K^+ than BM 21 at all levels of salinity (Fig. 1). The relative reduction in K^+ accumulation due to salinity was more in BM 21 than that of BM 01 indicating that BM 01 maintained more balanced nutrients than BM 21. Potassium is a major nutrient that plays important roles in metabolic processes, such as protein synthesis and osmotic adjustment (Marschner 1995). Maintenance of high cytoplasmic levels of K^+ is essential for survival of plans in saline habitats (Chow *et al* 1990). Bealloch *et al* (1994) suggested that the characteristics of K^+ and Na^+ transports are determinant of the NaCl tolerance in plants. High levels of Na^+ can displace Ca^{2+} from root membranes, changing their integrity (Cramer *et al* 1985) and, thus, affecting the selectivity for K^+ uptake (Cramer *et al* 1987; He and Cramer 1993). In fact the ability to maintain metabolically significant concentrations of K^+ may be essential for salt tolerance in glycophytes (Zhu *et al* 1998). Salinity induced reduction in K^+ accumulation was also reported in other legumes such as chickpea (Due 1998; Singh and Singh 1999), blackgram and mungbean (Raptan *et al* 2001; Islam 2001) and munbgbean (Faruquei, 2002).

Calcium

Accumulation of Ca^{2+} in roots and shoots of BM 01 and BM 21 at different growth stages is shown in Figure 2. A decreasing trend in Ca^{2+} accumulation was observed in roots and shoots with the increasing salinity as well as with the age of the crops. Paliwal and Maliwal (1980) in greengram and blackgram, Nakamur *et al* (1990) in mungbean, Pati *et al* (1996) in greengram, He and Cramer (1993) and Hu (1996) in wheat found that Ca^{2+} uptake decreased with the increase in saline water irrgation. Contrary, Sudhakar *et al* (1990) in horsegram and greengram, Islam (2001) and Raptan *et al* (2001) in mungbean reported that salinity increases Ca^{2+} accumulation. Apparently, roots and shoots of BM 01 (tolerant one) accumulated higher concentrations of Ca^{2+} than BM 21 (susceptible one). He and Cramer (1993) found a higher Ca^{2+} in tolerant *Brassica* species than susceptible one. Lynch *et al* (1987), Nakamur *et al*. (1990) and Rengel (1992) reported that Na^+ reduces the binding of Ca^{2+} to plasmamembrane (by a mechanism called "exchange adsorption") inhibits influx and increases efflux of Ca^{2+}, and causes depletion of internal Ca^{2+} stores in cell compartments. Changes in Ca^{2+} levels of cells are the primary responses to salt stress, which are perceived by root cells. The supply of Ca^{2+} to leaf cells is reduced and the activity of Ca^{2+} in leaf cell is decreased, while the Na^+ activity increased.

Ion effects have been considered to be related to salt tolerance (He and Cramer 1993; Gorham *et al* 1985). The hypothesis associated with the relationship between salt tolerance and ion effects is that there is a difference between genotypes in the capacity to maintain sufficient nutrient concentrations, like K and Ca, for growth of plants under salt stress. In this experiment, the decrease in K concentration in the shoots and roots of salt treated plants of the two genotypes was different (Fig. 1 & 2), indicating that salt tolerance of BM 01 was due to a higher concentration of K and Ca in the shoot and root. This conclusion is in agreement to an earlier report where K (Zhu et al 1998; Yesmeen 2000) and Ca (He and Cramer 1992; and 1993) nutrition was highly correlated with salt tolerance.

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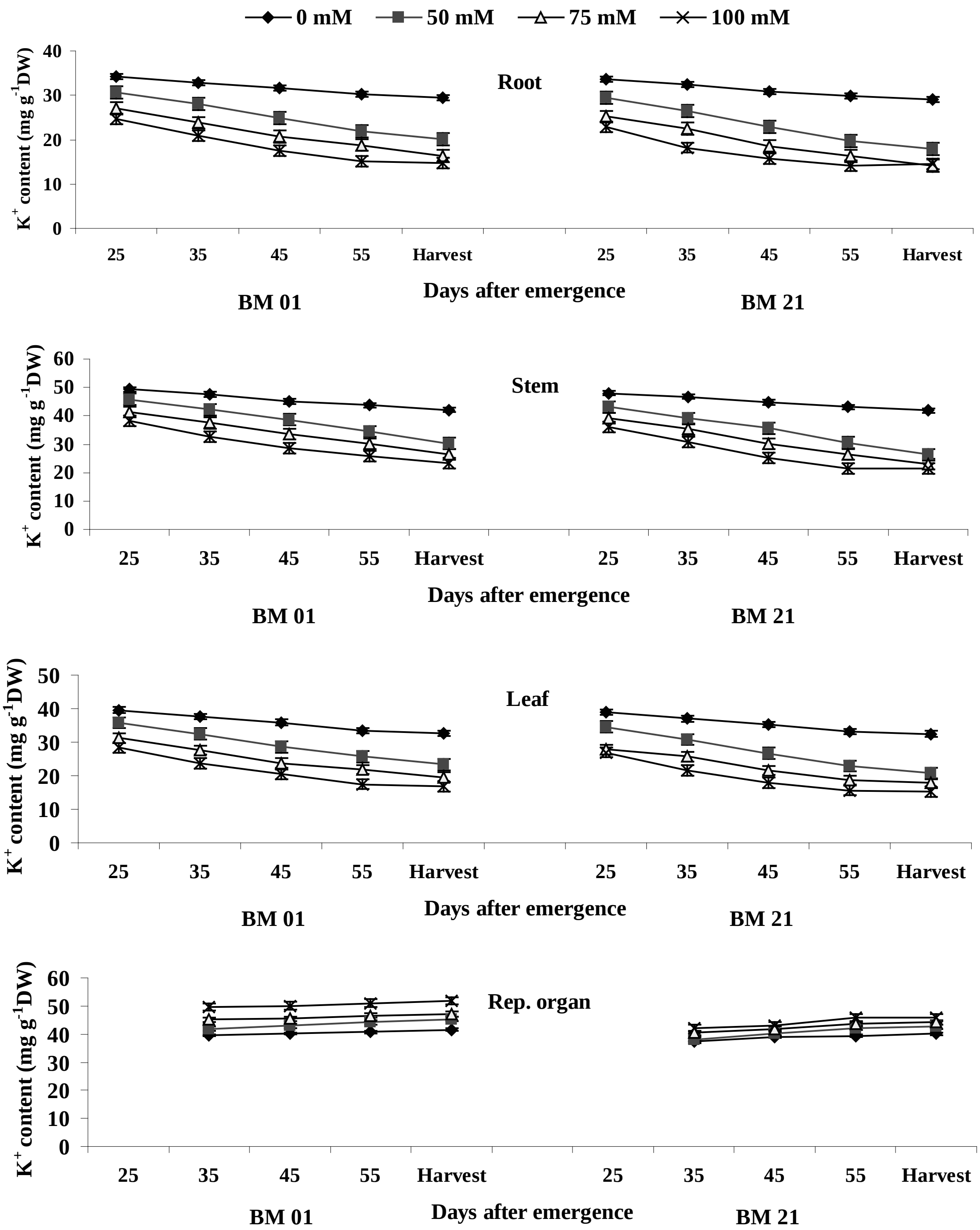

Fig.1. Potassium ion content in different plant parts of BM 01and BM 21 as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

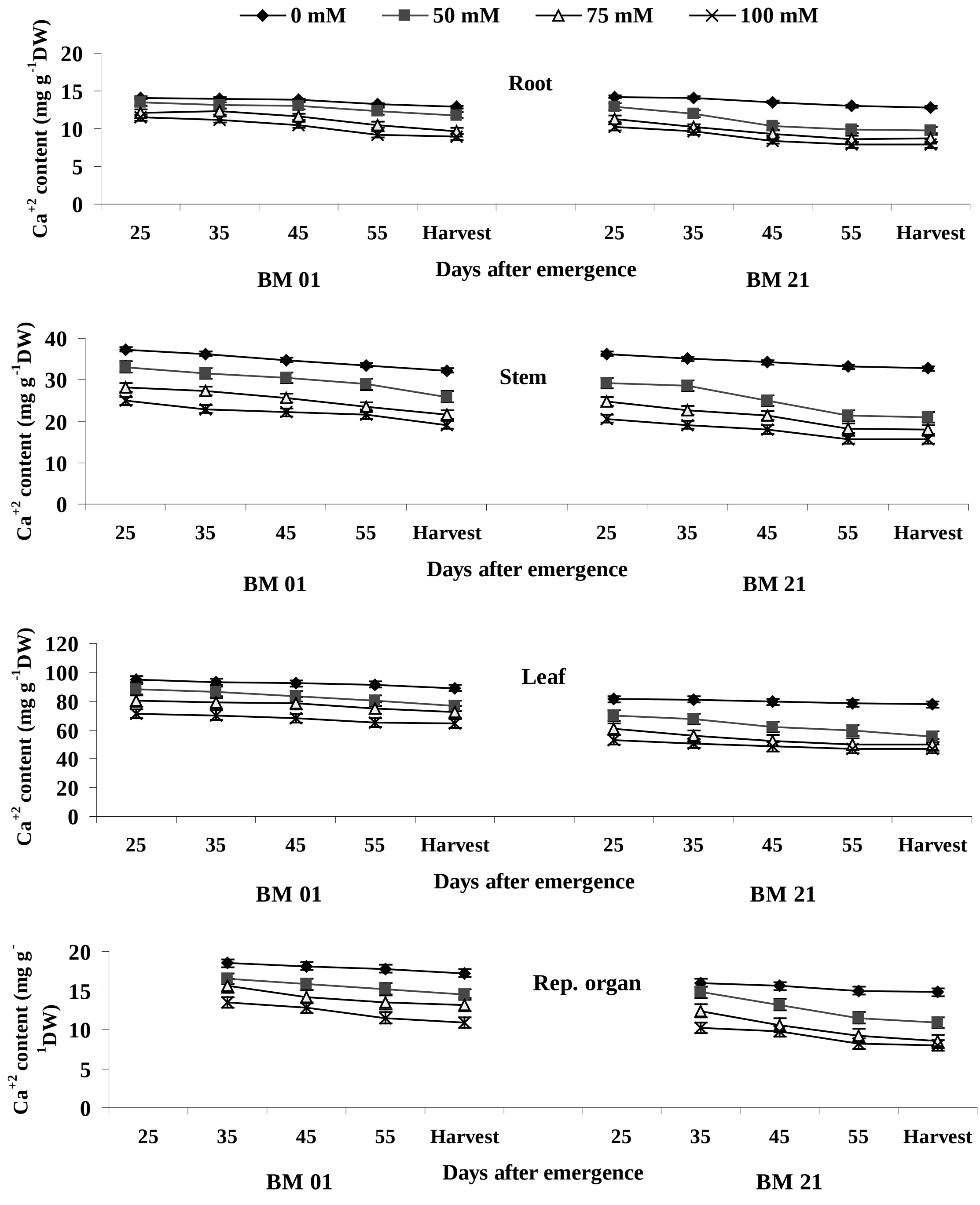

Fig.2. Calcium ion content in different plant parts of BM 01 and BM 21 as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

RESPIRATION, QUANTUM YIELD OF PHOTOSYNTHESIS AND TRANSPIRATION OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

[6]M. A. Aziz[1], M.A. karim[2], A. Hamid[2], Q. A. Khaliq[2], M. Hossain[2] and A. J. M.S. Karim[2]

Abstract

The mechanism of salt tolerance in relation to individual leaf growth, transpiration, dark respiration rates, and quantum yield was studied at 0, 50 and 100 mM NaCl solutions. At the high salt concentration all the leaves of BM 21 showed consequently higher reduction in growth than those of BM 01. The relative reduction (% of control) of Tr and dr were least in BM 01 than in BM 21. The dark respiration rates were less than 1 μmol (CO_2) m^{-2} s^{-1} and accounted for 19 and 32% increase (% of control) at the highest PFD in BM 01, while it was 31 and 44% in BM 21, respectively at 50 and 100 mM NaCl. More reduced quantum yield in BM 21 than BM 01 reflects more maintenance costs of energy in repairing injured tissue, enzyme reactions and ion movement.

Key words : *Salt tolerance, mungbean, respiration, quqntum yield, transpiration*

Introduction

The basis of the decline on plant growth under saline conditions is poorly understood. It has been suggested that decreases in growth with salinity may be due to increased respiration rates resulting from higher energy requirements (Gale 1975: Schwarz and Gale 1981; Orcutt and nilsen 2000) and reduction of quantum yield of photosynthesis (Yeo 1983; Seemann and Critchley 1985). Others have atributed the depression in growth rates to the combined effects of salinity on photosynthesis and the pattern of carbon allocation (Brugholi and Lauteri 1991; Masojidek and Hall 1992). Another possibility is that increased salinity reduces the photosynthetic surtace area available for CO_2 assimilation, i.e. that salinity may reduce the expansion of the leaf surface (Orcutt and nilsen 2000). There is increasing evidence that salinity changes photosynthetic parameters, including osmotic and leaf water potential, transpiration rate, leaf temperature (Sultana *et al* 1999; Islam 2001; Faruqui 2002 and Kabir 2002). In this study we compare the effects of NaCl salinity on the components of carbon accumulation in two mungbean genotypes BM 01 and BM 21 which differ in their salinity tolerance: dark respiration, quantum yield, transpiration rate and and the extension growth of individual leaves.

Materials and Methods

Mungbean seeds of two genotypes, BM 01 (tolerant one) and BM 21 (susceptible one), were sown in earthen pots in the vinylhouse at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil.The pots were irrigated with tap water until the seedlings were well established. After seedling establishment tap water in control group and 12.5 mM NaCl solution were applied in salt-treated groups up to three days and 25 mM for the next three days for hardening of seedlings before applying actual treatments. When the trifoliate appeared i.e. ten days after emergence (DAE) required amount of respective salt solutions (50 and 100 mM) were applied in 25 pots per treatments. The salt solutions were applied till harvest.

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Dark respiration (O μ mol m^{-2} s^{-1}) was measured using a portable photosynthesis system (LICOR-6200) assembled with an infra Red Gas Analyzer (IRGA) and data logger following the procedure described by Kubota and Hamid (1992) and the leaf chamber was covered with black cloth. The quantum yield for net CO_2 exchange was derermined at intercellulaer CO_2 concentration which were saturating for photosynthesis and over a photon flux range of 0 and 50 µmol $m^{-2}S^{-1}$ (photosynthetically active radiation). Each measurement was replicated 3 times. The light source was artificial halogen lamp (OSRAM, HQI-TS 150/NDL). Leaf area was measured with a leaf area meter (Model AAM-7 Hayashi Dehnco Co Ltd. Tokyo Japan). Specific leaf area (SLA) for individual leaf was calculated as the dry weight per unit leaf area (Leidi and Saiz 1997).

Results and Discussion

Leaf growth

Salinity reduced the growth of leaves in both genotypes (Fig.1) and the reduction was higher in BM 21 than that in BM 01. However, the genotypes exhibited a striking difference in leaf appearance rate in response to salt stress. Leaf appearance rate of BM 01was insensitive to salt stress, while the appearance rate of BM 21 decreased due to salinity. Genotype BM 21 failed to produce 8^{th} leaf under saline condition. Green leaf area followed the same trend as leaf fresh and dry weight (Fig. 1). Leaf area per plant was higher in BM 21 than in BM 01 at all the treatments but the reduction due to salinity was greater in BM 21 than that in BM 01. Green leaf area per plant was reduced by 43% and 56% over the control in BM 01 and BM 21 at 100 mM NaCl respectively. It indicated that leaves of BM 21 were more sensitive to salinity than those of BM 01. BM 01 had a higher SLA than genotype BM 21 except under control condition (Fig. 1). The reduction of SLA was 8 and 34% at 50 mM in BM 01 and BM 21, while it was 24 and 40% at 100 mM NaCl respectively. Leaf expansion was less inhibited in BM 01 as shown by higher SLA, leaf area and total leaf number at harvest. Beadle (1993) and Leidi and Saiz (1997) found higher relative growth rate in genotypes with leaves of higher SLA (less carbon invested per unit of area) under saline condition. This seemed for the case of BM 01 under salt stress, as plants of this genotype showed expanding L6, L7 and L8. Genotype BM 21 showed a delay in the generation of the new leaves with only half of the plants reaching the 7^{th} leaf stage. Sharma (1998) concluded from his study that salinity led to increased leaf diffusive resistance, consequently a decrease in transpiration and increase in leaf temperature. The shift in temperature may play a vital role for tissue desiccation. In addition, increased ionic concentrations in the leaves further aggravated the leaf growth along with tissue dehydration (Mangal and Lal 1988; Leidi and Saiz 1997).

Transpiration rate and diffusive resistance

In general, the transpiration rate (Tr) was decreased and diffusive resistance (dr) of both the genotypes was increased with the increasing levels of salinity (Fig. 2). A weak negative linear relationship ($y = -0.2627x + 3.2283$, $R^2 = 0.4112$) was observed between Tr and dr. The genotype BM 01 showed higher Tr rate and lower dr than that of BM 21 under salt stress condition. The relative reduction (% of control) of Tr and dr was lower in BM 01 than that in BM 21. Higher transpiration rates in BM 01 than BM 21 indicates that BM 01 plants maintained a better water relation than BM 21 under salt stress condotions (Hagemeyer 1997; Orcutt and Nilsen 2000). Subbarao *et al* (1990) observed higher Tr rate in tolerant pigeonpea genotype than salt sensitive one. He reported that the tolerant genotype was able to maintain high transpiration rates, possibly because of the high ability of root system to uptake soil moisture to meet the demands of water required for transpiration under salinity stress. Reduced transpiration rates under salt stress were also observed by Waisel 1991; Munns 1993; Flowers 1995.

Dark respiration rate

The dark respiration rate measured at 0 PFD increased with increasing salinity levels in both the genotypes (Table 1). This increased respiration is generally refered to as salt respiration (Schwarz and Gale 1981; Datta *et al* 1990; Islam 2001). The respiratory energy may be consumed in repairing the injured tissues and in conducting the active transport processes. Therefore, it has been proposed (Ahmed *et al* 1989) that growth inhibition under saline conditions as compared with non-saline condition is partly due to shortage of energy since a considerable amount of energy is consumed in osmotic adjustments. BM 21 showed higher relative respiration than BM 01. The dark respiration rate was less than 1 μmol (CO_2) m^{-2} s^{-1} and accounted for 19 and 32% increase (% of control) in BM 01, while it was 31 and 44% in BM 21, respectively at 50 and 100 mM NaCl. Higher relative respiration in BM21 under salt stress indicated more consumption of respiratory energy in repairing the injured tissues and in conducting the active transport processes. Earlier reports indicated that salinity has little effect on dark respiration of salt tolerant plant (Ahmed *et al* 1989 Schwarz and Gale 1981).

Quantum yield

Quantum yields were estimated from the slope of the PFD response curves in the linear regression between 0 and 50 μmol m^{-2} s^{-1} PFD. A reduction in photosynthetic efficiency with salt stress was observed in the quantum yield for CO_2 fixation (μmol CO_2 fixed mol^{-1} absorbed quanta, photosynthetically active radiation) for BM 01 and BM 21 (Table 1). The quantum yield of leaves from BM 01 grown at 100 mM NaCl was approximately 50% below that of control plants, while it was 74% in BM 21. Determination of quantum yields at high CO_2 concentration precluded interference from stomatal closure resulting from salinity stress (Yeo 1983; Seemann and Critchley 1985). The reduction of the quantum yield of photosynthesis with salt stress may constitute at least a partial basis for the reduction in the rate of photosynthesis over the CO_2 saturtion portion of the Pn curve. Salt might have a direct effect upon processed involved in light harvesting, electron transport and/or photophosphorylation and result in a decrease in the quantum efficiency of photosynthesis (Seemann and Critchley 1985). Another possibility is that the reduced quantum yield reflects energy utilization associated with ion movement. Energy costs of ion movement have been estimated by Yeo (1983), and in some cases it is calculated that ion transport in glycophyte, is in fact, more costly than that in halophyte (Gale et al 1967). Therefore, more reduced quantum yield in BM 21 than BM 01 reflects more maintenance costs of energy in repairing injured tissue, enzyme reactions and ion movement (Cheeseman 1988).

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Table 1. Quantum yields (μmol CO_2 fixed mol^{-1} absorbed quanta, photosynthetically active radiation (PAR)) and dark respiration of BM 01 and BM 21 under saline conditions

NaCl salinity (mM)	Quantum yield*		Dark respiration	
	BM 01	BM 21	BM 01	BM 21
0	0.0972(100)	0.1160(100)	-2.82(100)	-3.02(100)
50	0.0646(66)	0.0510(55)	-2.28(119)	-2.06(131)
100	0.0532(50)	0.0298(26)	-1.97(133)	-1.69(144)

* Quantum yields were determined between 0 and 50 μmol m^{-2} s^{-1} at 30^{0c} and saturating CO_2 (Seemann and Critchley, 1985)

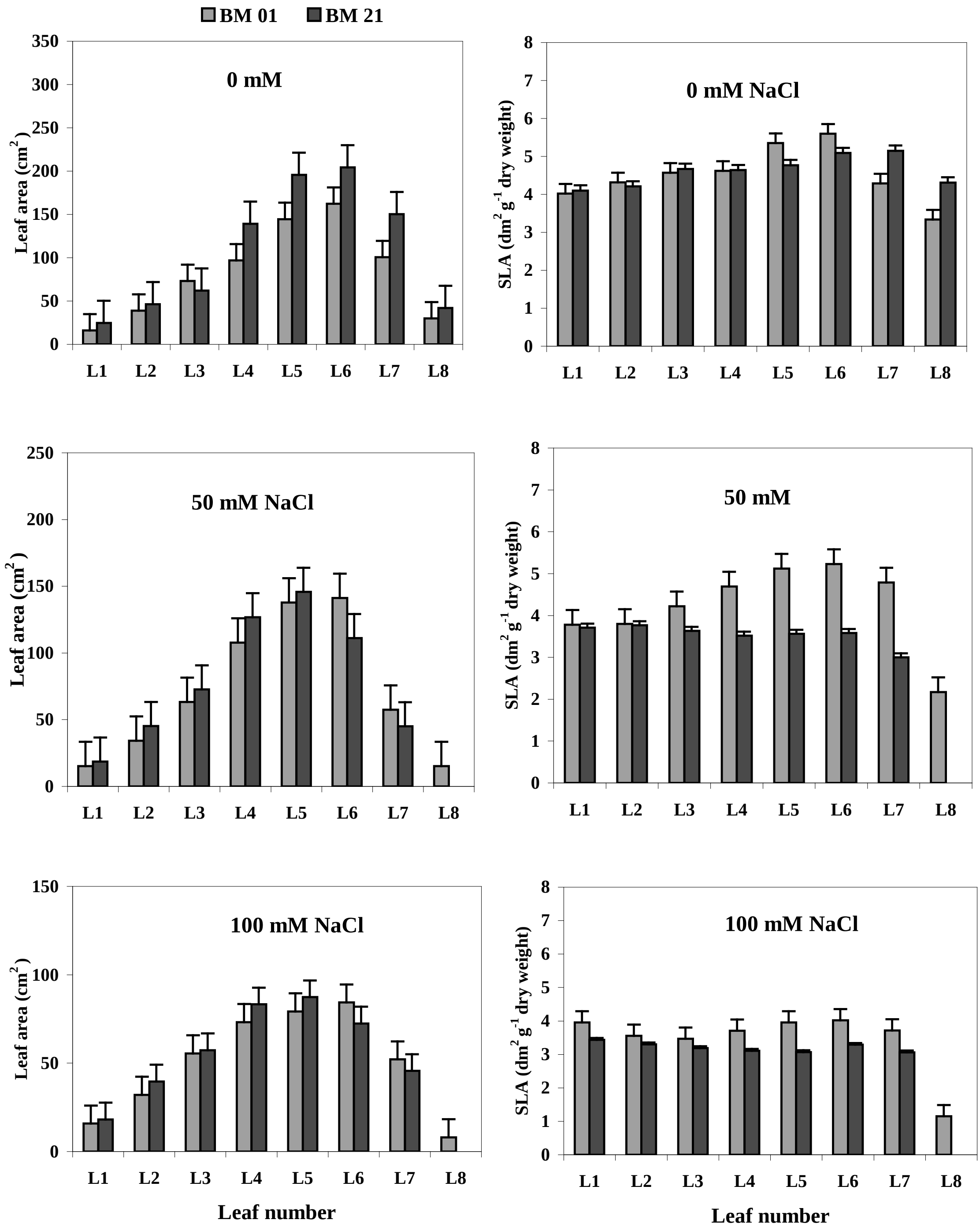

Fig.1. Leaf area and specific leaf area of individual leaf of BM 01 an BM 21 as affected by salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

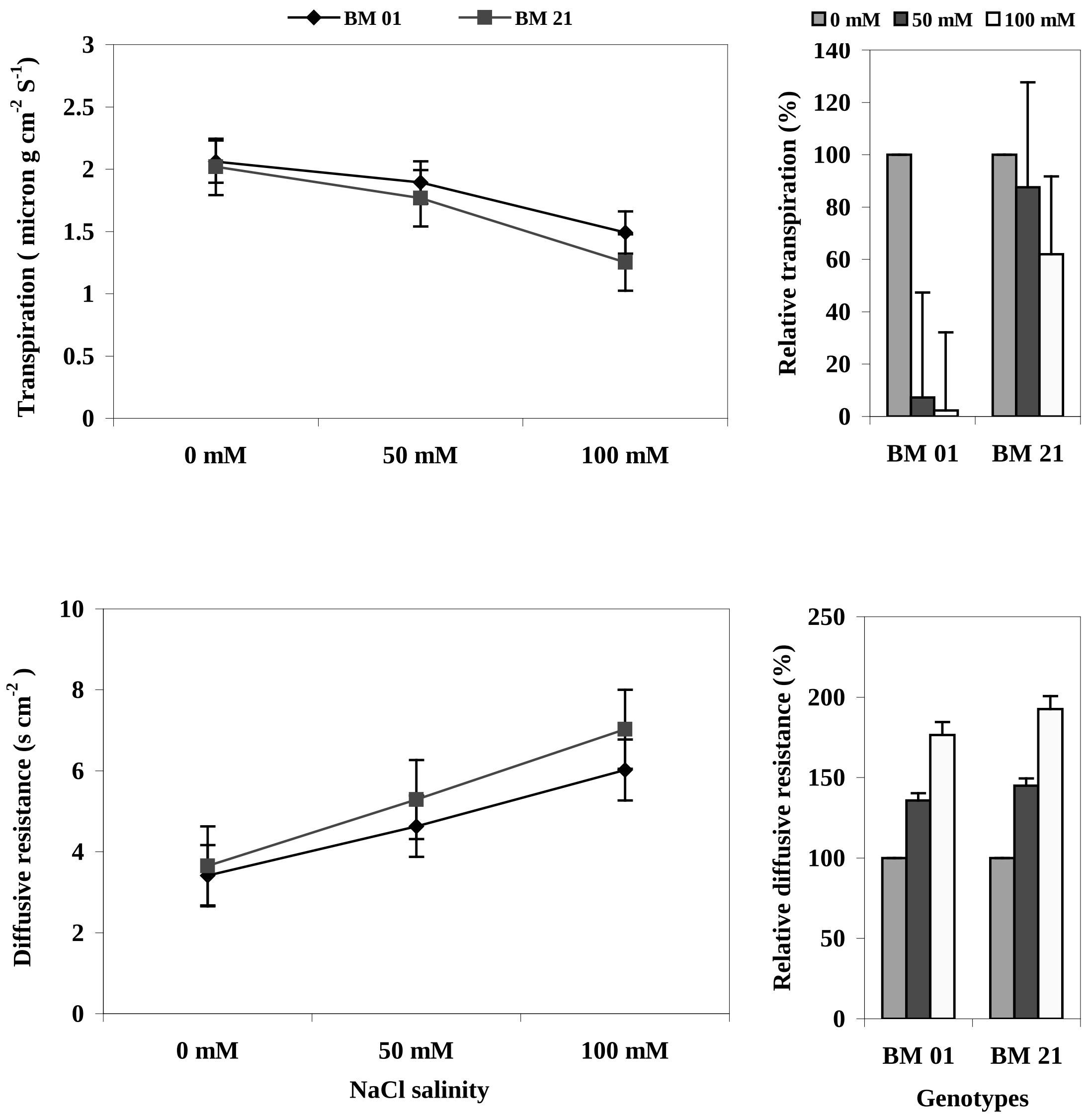

Fig. 2. Transpiration rate, diffusive resistance and their relative values of BM 01 and BM 21 as affected by salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

OSMOREGULATION AND MEMBRANE THERMOSTABILITY OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

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Abstract

The experiment was aimed at assessing the effect of NaCl on some biochemical components and to find out the relationship between those components and membrane thermostability (MT) and salt tolerance in mungbean. At all levels of salinity the genotype BM 01 showed less reduction in LWP than that of BM 21. BM 01 accumulated higher proline content under-stress condition than that of BM 21. The injury index also showed significant negative association with leaf calcium content of BM 01and BM 21. Better osmotic adjustment with lower injury index and maintaining higher membrane stability in BM 01 than that of BM 21 contributed to higher salt tolerance of the former genotype.

Key words: *Salt tolerance, mungbean, osmoregulation and membrane thermostability*

Introduction

Salt tolerance is dependent on pattern of change in several biochemical components, viz. protein content (Orcutt and Nilsen 2000; Durgaprasad *et al* 1996) and free amino acids (Durgaprasad *et al* 1996) especially proline (Sultana *et al* 1999). Some basic structural components of membranes are affected by salinity. Vesicularization of the plasmamembrane is reported to be associated with salt tolerance in halopytes (Flowers *et al* 1977). There can also be a significant increase in endoplasmic reticulum. The increase in vesicules and endoplasmic reticulum may be a mechanism of compartmentalizing or exporting Na^+ ions (Hagemeyer 1997). Under saline conditions plasma membrane leakage increases in glycophytes (Orcutt and Nilsen 2000). In fact, there is a liner relationship between external silinity and membrane leakage (Leopols and Willing 1984). It is clear that Na^+ replaces Ca^{2+} in membranes, and this ionic change distrupts the differential permeability of membrane (Renegal 1992; Orcutt and Nilsen 2000). To elucidate fully the mechanisms of salinity tolerance of mungbean genotypes differing in their tolerance levels, it is also necessary to analyze in details the changes of basic physiological parameters that are associated with salinity tolerance. In the present study attempt was undertaken to clarify further the reasons for high salt tolerance of BM 01 compared to BM 21.

Materials and Methods

The experiment was conducted at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Seeds of two mungbean genotypes, BM 01 (tolerant one) and BM 21 (susceptible one), were sown on 7th May 2004 in earthen pots in the vinylhouse. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. The pots were irrigated with tap water until the seedlings were well established. The trial was carried out in a completely randomized design with five replications. NaCl solutions were applied every other day at an increment of 12.5 mM until the respective final concentrations, 50, 75 and 100 mM were attained for each treatment. The treatment solution was applied with irrigation

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water until harvest. Plants in the control group were irrigated with tap water. Proline was extracted and estimated following Bates et al. (1973). Plant material (0.5g leaf sample) was homogenized in 10 ml of 3% aqueous sulfosalicylic acid and the homogenate filtered through whatman # 2 filter paper. Two ml of filtrate was reacted with 2 ml acid ninhdrin and 2 ml of glacial acetic acid in a test tube for 1 hour at 100 ^{0}C, and the reaction terminated in an ice bath. The reaction mixture was extracted with 4 ml toluene, mixed vigorously with a test tube stirrer for 15-20 second. The chromophore containing toluene was aspirated from the aqueous phase, warmed to room temperature and the absorbance read at 520 nm using toluene for a blank. The proline concentration was determined from a standard curve and calculated on a fresh weight basis as follows:

$$\text{Proline content } (\mu\text{mole/g}) = \frac{[(\mu\text{g proline/ml x ml toluene})/115.5\mu\text{g/mole}]}{[\text{gsample}]/5}$$

Membrane thermostability (MT) was estimated following Sarkar (1993):

% Injury index = $[1-(1-T_1/T_2)/(1- C_1/ C_2)]$ x 100

Where, C_1 and C_2 represent EC values of control samples before and after autoclaving and T_1 and T_2 represent values of slat-stressed samples before and after autoclaving, respectively.

Results and Discussion

Proline accumulation

Marked variation in accumulation of proline was found between the two genotypes differing in salt tolerance (Fig. 1A). Although statistically identical, under control condition BM 01 accumulated higher proline content (0.53 µ mole/g FW) than BM 21 (0.49µ mole/g FW). Proline accumulation increased with increasing salinity levels in both the genotypes. BM 01 accumulated higher proline content under stress condition than BM 21. The proline accumulation was 66, 157 and 201% higher in BM 01 when subjected to 50, 75 and 100 mM NaCl, respectively and 51, 130 and 183% higher in BM 21 over control (Fig. 1B). Durgaprasad *et al (*1996) concluded that cotton genotype CO –1 (tolerant one) had higher amino acids and proline content in leaf under saline conditions than ADT-1(susceptible one). Higher free amino acids and proline content are associated with salt tolerance mechanism. Orcutt and Nilsen (2000) reported that increasing proline concentration increases osmotic protection. A mutation in *E. coli* (ProB74) had overproduction of proline and endows that increased resistance to osmotic stresses (Csonka *et al* 1988). It has been suggested by Hare and Cress (1997) that a small increase in proline concentration can alter the redox balance of NADP/NADPH (increases at high proline) which may have a large effect (stumulation) on the oxidative pentose phosphate pathway. There is strong evidence to suggest that proline metabolism has a significant effect on cellular redox potential, which may be important for signaling processes associated with salinity tolerance as well as general stress tolerance traits (Hare and Gress 1997). Perhaps the higher accumulation of proline in BM 01 contributed better for osmoregulation in genotype than BM 21.

Membrane thermostability

Membrane thermostability was determined to estimate the percentage of injury of mungbean (Sarkar 1993) under salt stress condition. According to Blum and Ebercon (1981), injury index signifies the degree of membrane damage due to stress. Increasing the levels of salinity significantly increased the injury index in both the genotypes (Fig. 2A). Increased injury index was also observed due to water stress in soybean (Sarkar 1993) and temperature stress in wheat (Saadalla *et. Al* 1990a: Saadall *et. Al* 1990b). Under control condition BM 01 (52.01%) and BM 21 (52.35%) showed identical injury index. The difference of injury index became wider with the increasing salinity levels. BM 01 showed 64, 70 and 74% injury index while BM 21 showed 68, 73 and 85% and 50, 75 and 100 mM NaCl, respectively. The injury index was 42% higher in BM 01 at 100 mM NaCl whereas it was 61% higher in BM 21 (Fig. 2B). The results indicated that the degree of membrane damage was higher in BM 21 than in BM 01 due to salt stress. Lester (1985) demonstrated that electrolyte leakage was related to stress sensitivity of *Cucumis melo.* Under saline conditions plasma membrane leakage increases in glycophytes which are related with the damage in some basic structural components in membrane (Orcult and Nilsen 2000). In this study BM 21 was found to be more injured than BM 01. Thus, the relative tolerance of BM 01 to salt-stress, in terms of membrane stability, is greater than that of BM 21 (Blum and Ebercon 1981).

A linear relationship existed between injury index and proline content in both the genotypes and was expressed by the equation y = 18.839x + 83.363 (R^2 = 0.947) and y = 29.450x + 42.201 (R^2 = 0.975), respectively, where R is highly significant (Fig. 2C). Higher R value as found in BM 21 that in BM 01 indicated a stronger relationship between injury index and proline content in the former genotype than the letter. The positive association thus observed, suggests parallelism between proline accumulation and memberane injury, and higher proline accumulation in BM 01 indicated less extent of damage in this genotype than BM 21. The benefit of proline accumulation towards tolerance as emphasized by other workers (Greenway amd Munns, 1980; Sarkar, 1993; Durgaprasad *et al*., 1996; Hare and Gress, 1997; Orcutt and Nilsen, 2000) was observed in this study.

Increasing salinity significantly reduced the Ca^{2+} content in leaf and the reduction was higher in BM 21 than in BM 01 (Fig. 3). The injury index showed significant negative association with leaf calcium content of BM 01 and BM 21, and expressed by the equation y = -0.8403x + 134.88 (R^2 = 0.9425) and y = 1.3396x + 179.59 (R^2=9878), respectively, where R is highly significant. Higher R value as estimated in BM 21 than in BM 01 indicated a stronger relationship between injury index and calcium content in the former genotype than the latter. Calcium is an essential plant nutrient, which is associated with may functions of metabolism like stabilization of membranes, signal transduction, and control of enzyme activity (Hagemeyer 1997: Greenway and Munns 1980). It is known that Na^+ replaces Ca^{2+} in membranes under salt stress conditions, and this ionic change disrupts the differential permeability of membranes (Renegal 1992; Orcutt and Nilsen 2000) . The less reduction in Ca^{2+} accumulation in BM 01 leaf than BM 21 by salinity was presumably contributed for maintaining higher membrane stability in the former genotype than the latter, (Shanahan *et al* 1990; Hagemeyer 1997; Orcutt and Nilsen 2000). Based on the results of this study it was concluded that better osmotic adjustment with lower injury index in BM 01 than BM 21 contributed to the high salt tolerance of the former genotype than BM 21.

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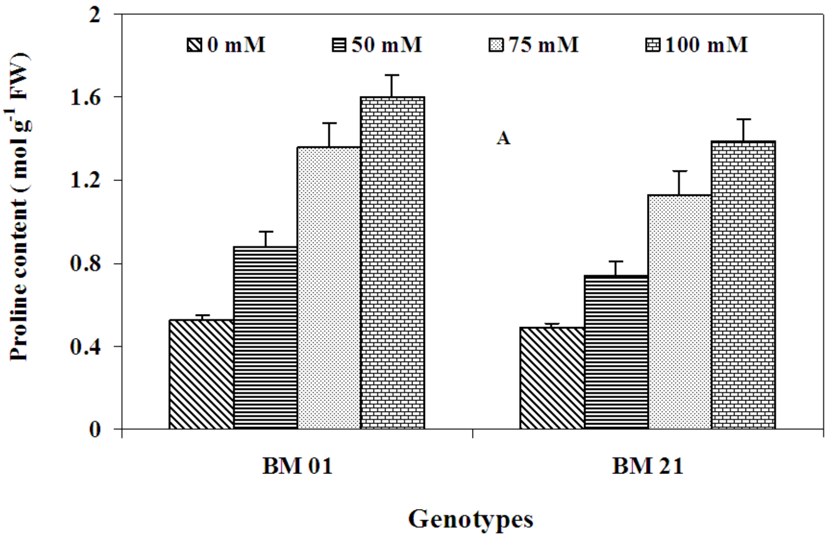

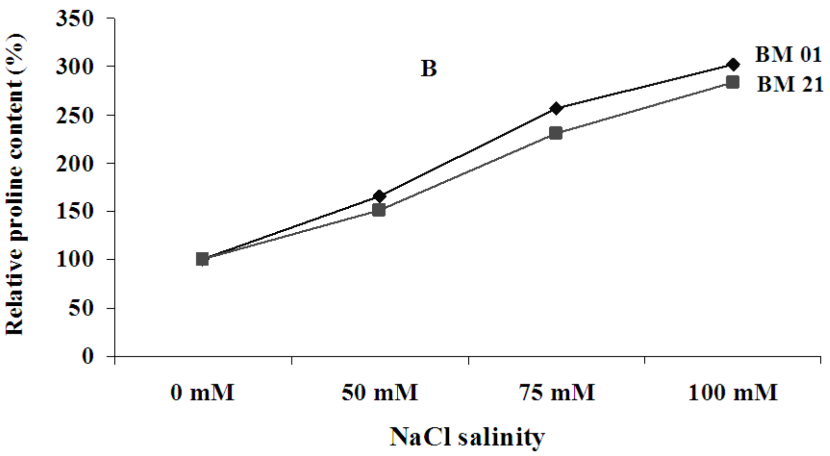

Fig. 1. Proline content in leaves (A:absolute and B: relative) of BM 01 (salt-tolerant) and BM 21 (salt-susceptible) as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown.

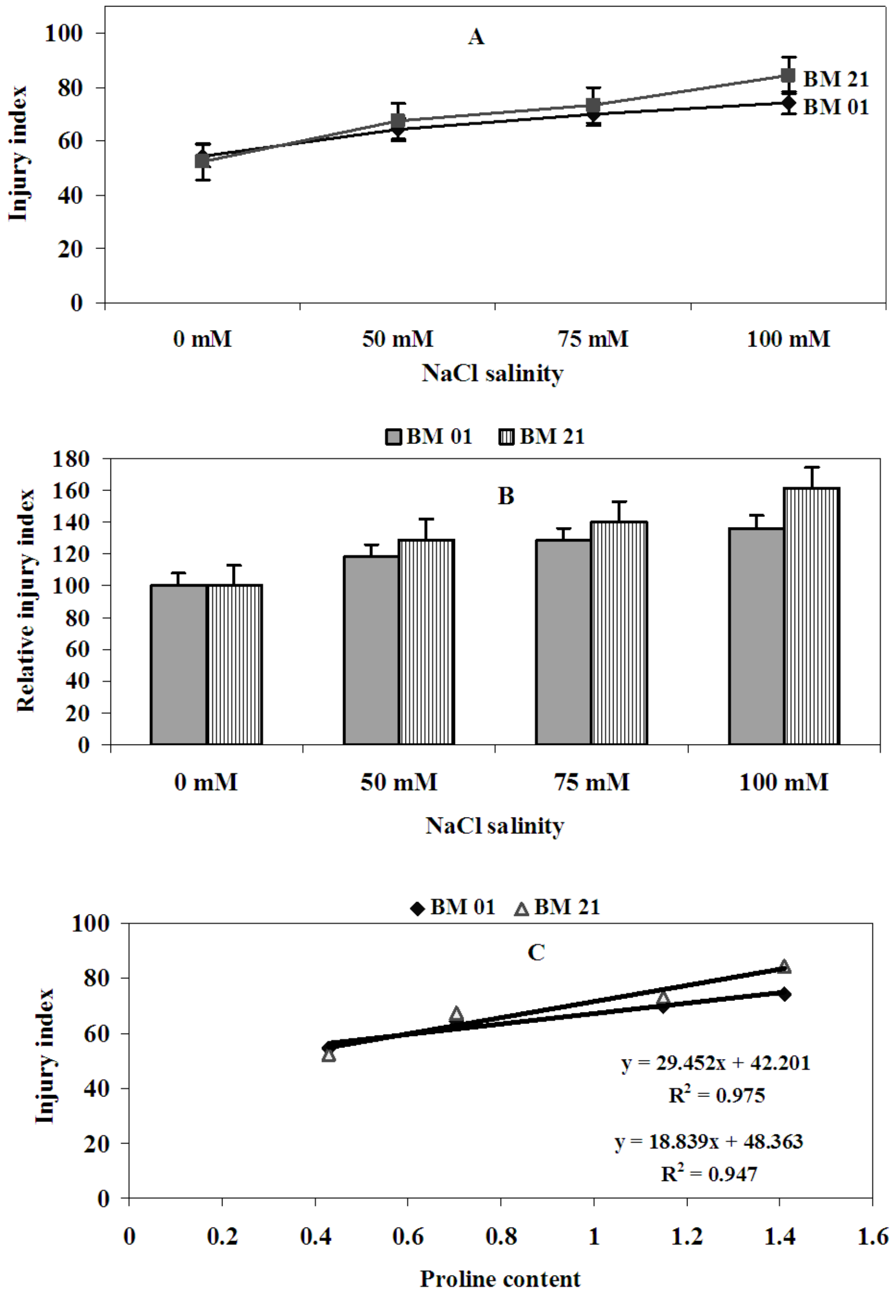

Fig. 2. Percent relative injury in leaves (A:absolute, B: relative and C: functional relationship) of BM 01 (salt-tolerant) and BM 21 (salt-susceptible) as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

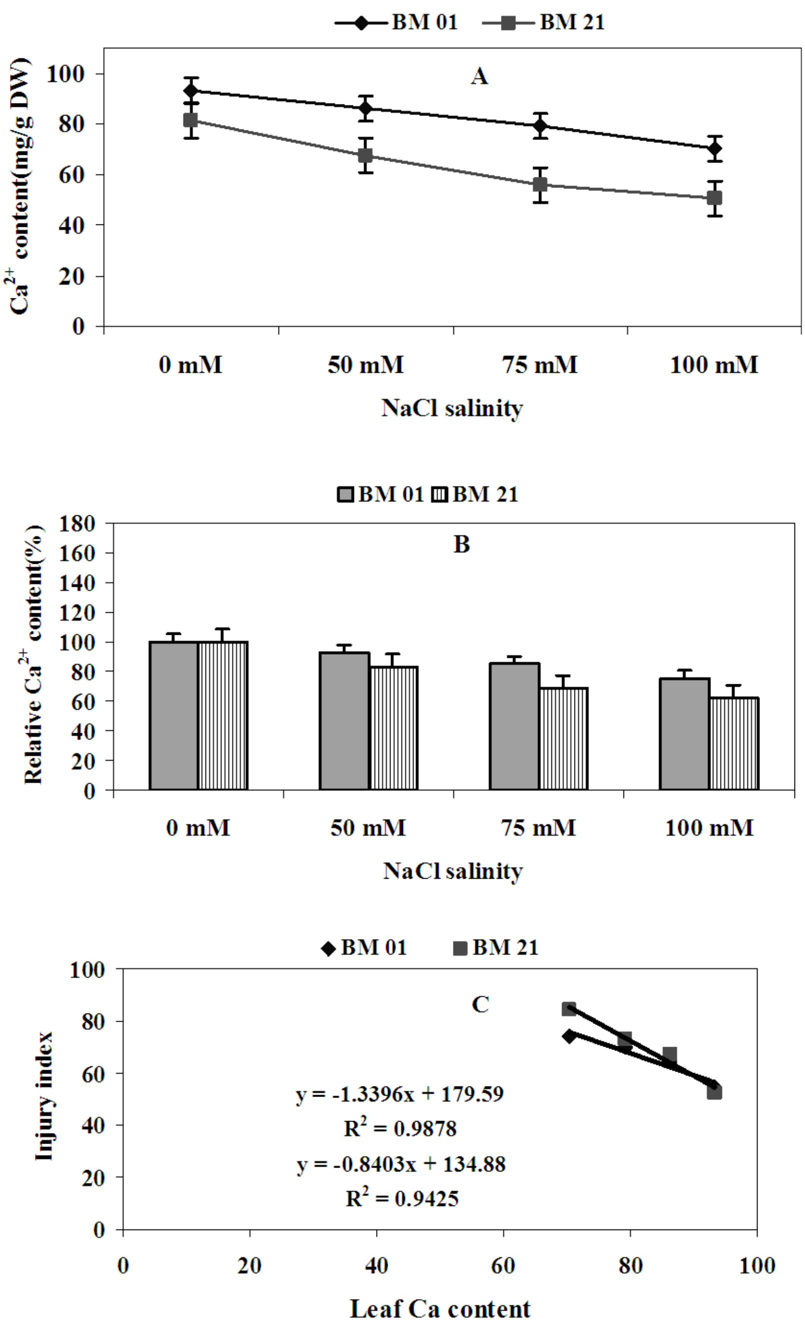

Fig.3. Calcium content in leaves (A:absolute, B: relative and C: functional relationship) of BM 01 (salt-tolerant) and BM 21(salt-susceptible) affected NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

GROWTH, DRY MATTER PARTITIONING AND YIELD OF TWO MUNGBEAN GENOTYPES IN RESPONSE TO SALINITY TOLERANCE

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Abstract

The effect of NaCl salinity on growth, dry matter partitioning and yield of two mungbean genotypes was determined in pot culture experiment. TDM of BM 21 decreased more remarkably compared to that of BM 01. The reduction in TDM was attributed to low dry weight of root, leaf, stem and reproductive organ due to the stress. Higher the salinity levels lower was the grain yield per plant. Average grain yield in BM 01 decreased slowly with the increasing salinity levels, till 50 mM NaCl. The grain yield in BM 21 showed a drastic reduction even at 50 mM NaCl and reached from 18.07 g/plant in control to only 2.38 g/plant at 100 mM NaCl. Although most of the yield contributing characters contributed for the yield reduction per plant under saline conditions, the contribution of the seriously affected number of pods per plant was the highest. BM 01 was more salt tolerant than BM 21, in terms of growth and grain yield production.

Introduction

Presence of salt contents in soil or irrigation water affects almost all the metabolic processes and thereby depresses growth and grain yield of plants (Orcutt and Nilsen, 2000). Salinity problem is continuously increasing in the arid and semi-arid regions. Several techniques for either alleviating the salts effects or inducing tolerance by manipulating soil amendments, resistance breeding, method of sowing and management practices have been tried but not much success has been achieved so far and the problem continues to be a serious one, limiting growth and productivity of the crops. Salinity decreases growth and yield of almost all glycophytes. All glycophytes, however, do not respond equally to salinity (Maas and Hoffman, 1977). Moreover, variations in salt tolerance exist among the cultivars of a species, e.g. mungbean (Aziz *et al.,* 2002; Faruquei, 2002), mungbean and blackgram (Raptan *et al.,* 2001; Islam, 2001), chickpea (Due, 1997), cotton (Leidi and Saiz, 1997). The variation in salt tolerance among the cultivars may be related to multiple physiological processes (Orcutt and Nilsen, 2000). Thus, the effect of salinity on growth parameters for a given species needs to be specially investigated for each genotype. This study was initiated to analyze, in details, the effects of NaCl salinity on growth pattern, dry matter partitioning and yield of two mungbean genotypes differing in salt tolerance.

Materials and Methods

The experiment was conducted at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Seeds of two mungbean genotypes, BM 01 (tolerant one) and BM 21 (susceptible one) selected by screening in previous experiment, were sown on 5th September 2004 in earthen pots in the vinylhouse. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. The pots were irrigated with tap water until the seedlings were well established. The trial was carried out in a factorial completely randomized design with six replications. NaCl solutions were applied every alternate day at an increment of 12.5 mM until the respective final concentrations, 50, 75, and 100 mM were attained for each treatment. The treatment solution was applied with irrigation water until maturity. Plants in the control group were irrigated with tap water. Six plants were used in each treatment for the measurement of agronomic parameters. Sampling was done at a ten-days interval from 25 days after emergence (DAE) till maturity. After harvesting, roots were separated from the plants and washed with tap water. The plant parts were segmented into leaf, stem and reproductive organ (flowers + pods). The samples were oven-dried at 70 ^{0}C to a constant weight. Yield

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components and grain yields were determined at maturity. Each treatment consisted of 6 replicated plants. The data was analyzed by ' MSTAT ' program and the treatment means were compared by LSD.

Results and Discussion

Growth and dry matter accumulation

Production of economic yield is determined by the proportion of assimilates partitioned to respective organ (Singh and Yadav, 1989). Thus it is important to understand the dry mater accumulation pattern and its partitioning to different plant organs for the improvement of yield level in saline soils. The effect of salinity on the pattern of dry matter accumulation in tolerant (BM 01) and susceptible (BM 21) mungbean genotypes and the partitioning of assimilates in leaves, stem, reproductive organ and root are described hereunder.

Leaf dry matter

Dry matter production of crop is mostly dependent on the magnitude of assimilatory system. Assimilatory system composes of all green area of plants. However, leaf is the largest component of the system (Nanda and Saini, 1989). Salinity affected partitioning of leaf dry weight markedly in both BM 01 and BM 21 at all growth stages. The leaf dry matter per plant decreased significantly with the increasing salinity level (Fig.1). Under control and mild stress conditions (50 mM) leaf dry weight increased up to harvest in BM 21 while in BM 01 it increased at all levels of salinity. The reduction of leaf dry weight per plant due to salinity was higher in BM 21 than that in BM 01. The decrease in leaf dry weight at later part of growth may be due to leaf senescence and remobilization of stored materials to the reproductive organs (Aziz *et al*., 2002; Khan, 2000; Islam, 2001 and Faruquei, 2002).

Stem dry matter

Stem dry matter was significantly reduced by salinity in both BM 01 and BM 21 (Fig. 1). The reduction was higher in BM 21 than in BM 01 from 25 DAE till harvest. .Pattern of stem dry matter production was almost similar to that of leaf dry matter at all salinity levels. Stem dry matter weight in BM 01 increased up to harvest at control as well as under stress conditions. In BM 21 the stem dry matter at control and 50 mM increased up to harvest while that at 75 and 100 mM NaCl was up to 45 DAE. BM 01 was comparatively more salt tolerant than BM 21 in terms of both absolute and relative stem biomass production. The result is in agreement with Ashraf and Rasul (1987), Patil *et al*., (1996) and Faruquei (2002) who noticed that increasing salt concentration significantly reduced the dry matter weight of stem in mungbean.

Reproductive organs dry matter

Dry weight of reproductive organs (flowers + pods) were started to increase from 35 DAE, increased slowly up to 45 DAE and continued to increase sharply till harvest in all the treatments except in BM 21 under stress conditions (Fig. 1). It increased slowly in BM 21 under stress conditions and decreased after 55 DAE at 100mM NaCl. The reduction may be due to dropping of reproductive organs as the plants died. However, the reduction was much higher in BM 21 than in BM 01. The findings reconfirmed the reports of Due (1997) and Yasmeen (2000) that there is a great difference between genotypes in production of reproductive organs due to salinity.

Root dry matter

The longer the exposure to NaCl salinity higher was the damage of root (Fig.1) This was clearly expressed in the higher root damage at harvest than that at other growth stages. Root dry matter of BM 01 increased up to harvest at all levels of salt stress including control. In BM 21, root dry weight increased up to 55 DAE at 50 mM and 45 DAE at 75 and 100 mM salinity, respectively and thereafter it decreased till maturity. The roots of BM 21, in general, damaged more than that of BM 01. The higher root growth of BM 01 than BM 21 presumably contributed to higher shoot growth under saline condition. Salinity induced damage in root mass was also reported earlier by Gill (1990) and Faruquei (2002) in mungbean, Raptan *et al.*, (2001) and Islam (2001) in blackgram and mungbean.

Total dry matter

Accumulation of total dry matter (TDM) per plant increased progressively over time and reached the highest at final harvest (Fig. 1). Dry matter production at stress condition resembled to that of reproductive organ development up to harvest. The strong relationship (r = 0.97 and r = 0.91) between dry matter of reproductive organ and TDM of BM 01 and BM 21 indicated the high influence of reproductive organ dry matter on TDM production. In general, TDM of BM 21 decreased more remarkably compared to that of BM 01. This result is consistent with the findings of Fruquei (2002) that BM 21 is relatively salt sensitive than BM 01 in TDM production. The reduction in TDM was attributed to low dry weight of leaf, stem and reproductive organ due to the stress. Reduction in growth and total dry matter production under saline condition was also reported earlier in different legumes e.g. in mungbean (Singh *et al.,* 1994), in mungbean, cowpea and soybean (Egeh and Zamora, 1992), in cowpea and mungbean (Hug and Lather, 1983), and in blackgram and mungbean (Raptan *et al*., 2001; Islam, 2001).

Yield components and grain yield

Yield is the result of cumulative and interactive effects of many complex physiological processes (Bingham, 1969). Generally, under stress conditions, crop yield is related with dry matter production. Thus, for a given genotype, the higher the dry matter accumulation the greater is the yield under stressful condition. Table 1 provide all important details about yield and yield contributing characters viz. pods/plant, seeds/pod, 1000-grain weight and grain yield per plant as affected by NaCl salinity.

Pods per plant

Pods per plant in between genotypes were significantly influenced by salinity. Increasing salinity led to a significant reduction in number of pods per plant (Table 1). The reduction of pods/plant at 50 mM NaCl ranged from 14% in BM 01 to 54% in BM 21. The production of pods/plant at 100 mM NaCl reduced to a great extent and ranged from 66% in BM 01 to 82% in BM 21. Singh *et al.,* (1994) and Faruquei (2002) in mungbean; Raptan (2001) in mungbean and blackgram observed that increasing salinity significantly reduced pods per plant. Although pollen viability or fertilization of flower did not counted but these factors could be responsible for reduction in pod-set/plant.

Seeds per pod

The number of seeds/pod was affected a little by salinity (Table 1). In BM 01, the relative seed production/pod was 100 percent at 50 mM and even 98 and 94 percent at 75 mM and 100 mM NaCl respectively. In BM 21 it was 92 percent at 100 mM NaCl. The result is in agreement with the earlier work in mungbean (Hafeez *et al*., 1988; Aziz *et al*., 2002), blackgram (Asharf and Karim, 1990) and mungbean and blackgram (Islam, 2001) that salinity reduced seeds per pod at higher salt concentration. In BM 01 it was, however, evident that salinity did not disturb the fertilization to form seeds.

1000-grain weight

The 1000-grain weight under nonsaline condition was the highest in BM 21 (36.70g) while it was 22.29g in BM 01 (Table 1). The seed weight reduction was insignificant at all levels of salinity in

BM 01 but was significant in BM 21. At 100 mM NaCl the seed weight reduction was 25 percent. A reduction of 1000-grain weight clearly indicated that salinity slowed down the mobilization of assimilates to the seeds. Siddiqui and Kumar (1985), however, reported that more dry matter was partitioned into the seeds at higher level of salinity while the least at low level of salinity. Although a remarkable reduction in seed size was observed at 100 mM NaCl in BM 21, BM 01 partitioned more dry matter into the seeds than in other plant organs. Hye (2000) in chickpea and Faruquei (2002) in mungbean noticed that the number and size of the seeds reduced due to salinity.

Grain yield per plant

Grain yield is the function of pods per plant, seeds per pod and 1000-grain weight. Changes in any of the characters due to salinity would provide a detailed appraisal for the reasons for lower grain yield in salinized mungbean plants. An inverse relationship was expressed between salinity levels and grain yield. Higher the salinity levels lower was the yield. However, it was clear from data (Table 1) that BM 01 was more salt tolerant than BM 21, in terms of grain yield production. Average grain yield in BM 01 decreased slowly with the increasing salinity levels, till 50 mM NaCl. By contrast, the grain yield in BM 21 showed a drastic reduction even at 50 mM NaCl and reached from 18.07 g/plant in control to only 2.38 g/plant at 100 mM NaCl (Table 1). Although most of the yield contributing characters contributed for the yield reduction per plant under saline conditions, the contribution of the seriously affected number of pods per plant was the highest. The negative relationship between yield and salinity levels was also reported earlier in mungbean (Haffez, *et al.*, 1988; Salim and Pitam, 1993; Singh *et al.*, 1994; and Aziz *et al*., 2002), blackgram (Ashraf and Karim, 1990) and Chickpea (Hye, 2000). However, between the two genotypes BM 01 showed greater salt tolerance than BM 21.

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Table 1. Yield and yield components of mungbean genotypes BM 01 and BM 21 as affected by NaCl salinity

NaCl (mM)	No. of pods/ plant		No. of Seed/ pod		1000-seed weight (g)		Yield (g/plant)	
	BM 01	BM 21	BM 01	BM 21	BM 01	BM 21	BM 01	BM 21
0 mM	63.80 (100)	46.20 (100)	12.35 (100)	11.25 (100)	22.29 (100)	36.70 (100)	17.11 (100)	18.07 (100)
50 mM	53.40 (83.7)	21.00 (45.5)	12.29 (99.5)	11.15 (99.1)	21.85 (98.0)	34.84 (94.9)	13.48 (77.0)	7.58 (41.9)
75 mM	39.80 (62.4)	13.20 (28.6)	12.09 (97.9)	10.86 (96.5)	21.62 (97.0)	33.04 (90.0)	8.33 (48.7)	5.04 (27.9)
100 mM	21.80 (34.2)	8.20 (17.8)	11.62 (94.1)	10.45 (92.9)	21.26 (95.4)	27.48 (74.9)	5.83 (34.1)	2.38 (13.2)
$LSD_{(.01)}$	3.57		NS		1.89		1.50	
CV%	8.30		5.56		3.99		8.87	

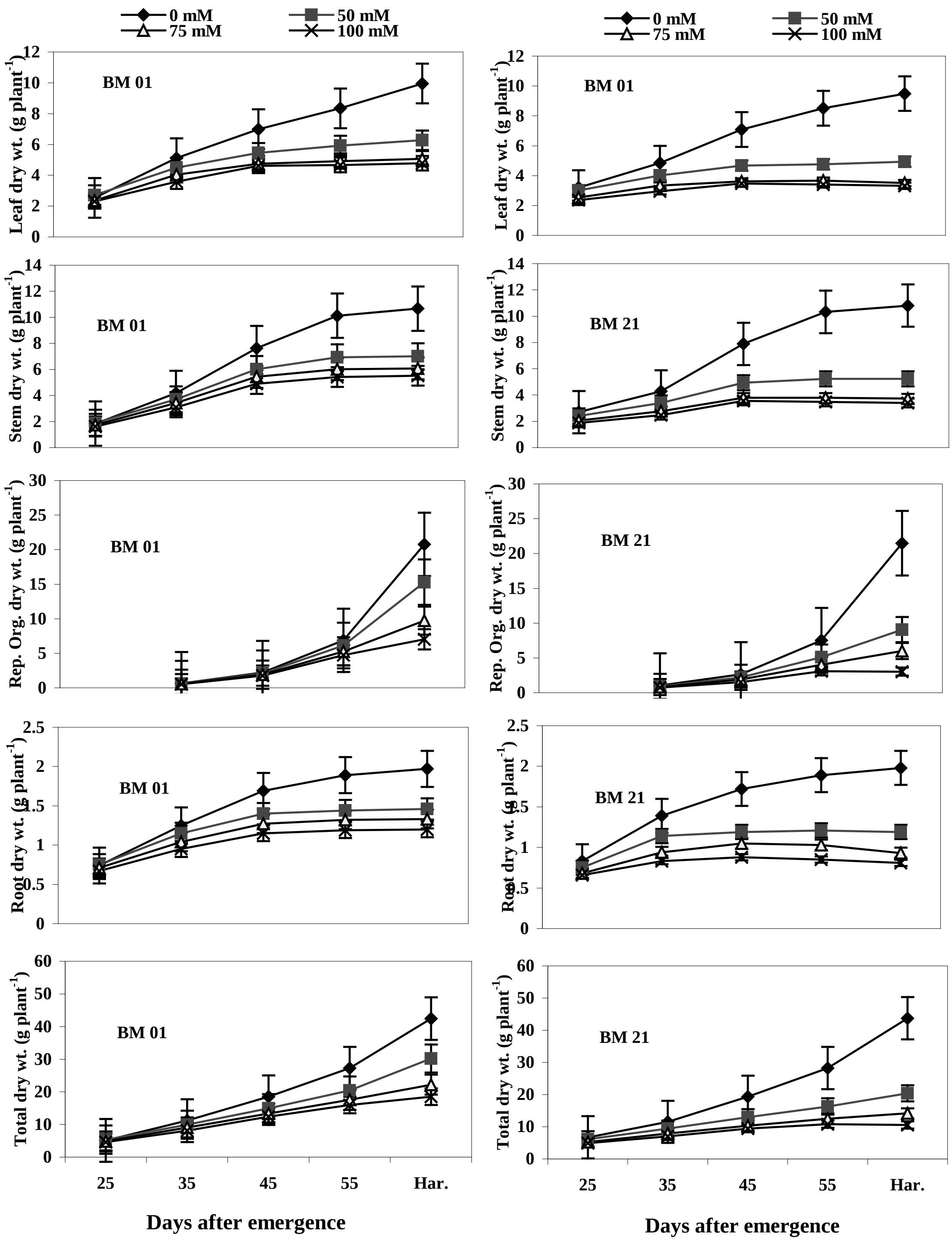

Fig. 1. Dry matter production and its partitioning to different plant parts of mungbean genotypes BM 01 and BM 21as affected by NaCl salinity. Error bars represent standard errors. Error bars fit within the plot symbol if not shown

SUCCULENCE AND ION COMPARTMENTATION IN INDIVIDUAL LEAVES OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

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Abstract

Physiological response of salt stress was studied in two mungbean genotypes grown at 0, 50, and 100 mM NaCl solutions. The increase in succulence was higher in BM 01 than in BM 21 due to salt stress. The main feature of the tolerant genotype BM 01 was a lower accumulation of Na^+ in leaves and an apparent capacity for K^+ redistribution to younger leaves. The genotype BM 01, with low K^+ concentration in older leaves, showed adequate K^+ concentration in younger leaves suggesting an efficient retranslocating system. The K^+: Na^+ ratio was also higher in BM 01 than that of BM 21.

Introduction

Better understanding of the mechanism that enables plant to adapt to salinity stress and maintain growth will ultimately help in the development of stress-tolerant cultivars. Breeding for salt tolerance to salinity in crops has usually been limited by lack of reliable traits for selection (Noble and Rogers, 1994). Studies on adaptation to saline environments frequently point to limited ion accumulation, dilution by succulence and compartmentation as basic adaptation leading to salt resistance in glycophytes (Greenway and Munns, 1980; Leidi and Saiz, 1997). Limited sodium uptake and maintenance of higher K^+: Na^+ is a trait related to salinity tolerance in several crop plants (Subbarao *et al*., 2000; Orcutt and Nilsen, 2000). In previous experiment mungbean genotype BM 01 showed more salt tolerance than BM 21. BM 01 maintained less Na^+ and higher K^+:Na^+ ratio in the leaf than BM 21. In the present study ion dilution by succulence and their compartmentation in individual leaves were investigated for better clarification of the salt tolerance mechanism in mungbean gebotypes BM 01 and BM 21, which differ in their salinity tolerance.

Materials and Methods

Seeds of two Mungbean genotypes, BM 01 (tolerant one) and BM 21 (susceptible one), were sown in earthen pots in the vinylhouse. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. The pots were irrigated with tap water until the seedlings were well established. After seedling establishment tap water in control group and 12.5 mM NaCl solution were applied in salt-treated groups up to three days and 25 mM for the next three days for hardening of seedlings before applying actual treatments. When the trifoliate appeared i.e. ten days after emergence (DAE) required amount of respective salt solutions (50 and 100 mM) were applied in 25 pots per treatments. The salt solutions were applied till harvest. Leaf area measurements were performed with a leaf area meter (Delta-T Devices Ltd., Cambridge, England). From fresh and dry weight measurements, water contents (in g H_2O g dry weight^{-1}) were obtained. Succulence was calculated as the ratio between water content per leaf and leaf area (Longstreth and Nobel, 1979). Xylem water potential was measured using the pressure chamber technique (Turner, 1988).

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At harvest the plants were separated into individual leaves, stems and roots and weighed. Roots were washed thoroughly in tap water and blotted dry before weighing. All plant parts were dried at 70^0C to a constant weight. Oven dried leaves, stems and root were ground with a Willey grinding machine (cap/small 1029-8, Yoshida Seisakusho Co. Ltd.). Na^+ and K^+ were extracted from samples with hot water and determined using a flame photometer (EEL, Essex, England). All the data were taken at 33 days after sowing i.e., before flower initiation of the crop.

Results and Discussion

Succulence

Succulence is the ratio of water content to surface area for a tissue at equilibrium with water saturated atmosphere (Luttge and Smith, 1984). This was observed only in dicotyledons, but not in monocotyledons (Lied and Saiz, 1997). It is well known that certain plants develop thick, fleshy, succulent organs under salt stress (Waisel, 1991; Poop *et al.*, 1993). Salinity increased the succulence of all leaves in both the genotypes (Fig. 1). Normally the leaves of BM 01 were more succulent than that of BM 21 under control condition. The increase in succulence was higher in BM 01 than that of BM 21 due to salt stress. This indicated that increased thickness of succulent leaves in BM 01 is mainly due to large mesophyll cell, which absorbed water and increased the size of their vacuoles (Munns *et al.*, 1983; Waisel, 1991). Succulence results, therefore, from increased water uptake of the tissue. It has been suggested that this may help to dilute absorbed salt ions (Munns *et al.*, 1983; Leidi and Saiz, 1997; Adams, 1998). Consequently, succulence may be a mechanism to avoid high salt concentrations in plant organs (Hagemayer, 1997, Orcutt and Nilsen, 2000). Leidi and Saiz (1997) and Subbarao *et al*., (2000) reported that salt tolerance was correlated with succulence and high potassium/sodium ratios in leaves. Greenway and Munns (1980) suggested that plants that have no salt glands might regulate shoot ion concentrations either by limited uptake or by the diluting effects of an increased tissue volume, which is succulence.

Mineral ions accumulation and compartmentation

Under salt stress condition leaves of BM 01 exhibited low Na^+ and K^+ concentrations than that of BM 21 (Fig. 2); the concentrations varied with age of plant. While, BM 21 accumulated more Na^+ and less K^+ in stem than BM 01. However, the root of BM 01 accumulated more Na^+ and more K^+ than that of BM 21. The differences in leaf K^+ and Na^+ concentrations resulted in variation in K^+: Na^+ ratios between genotypes (Fig. 3). The genotype BM 21 showed lower K^+:Na^+ ratios, increasing towards the uppermost leaf. In BM 01 a similar trend of increase of K^+:Na^+ ratio from lower to upper leaves was observed. Thus, upward Na^+ transport seemed to be restricted in BM 21 mainly by retaining in stem and older leaves as found in other glycophytes (Lauchli, 1984; Ledi and Saiz, 1997). Upward transport of Na^+ in BM 01 appeared less restricted than in BM 21 as shown by the Na^+ distribution throughout the sampled leaves. The preferential K^+ accumulation in uppermost leaves might be related to the high K^+ requirement for growth (protein synthesis, cell expansion) (Leigh and Wyn Jones, 1984) and K^+: Na^+ exchange in old leaves.

The relationship between succulence (salt dilution) and more or less uniform Na^+ concentration in leaf would be related with the ions accumulation in vacuoles and lowering the water potential that increased water uptake for increasing turgor (Flowers *et al*., 1991; Leidi and Saiz, 1997). One mechanism of salt adaptation is the accumulation of Na^+ and Cl^- process coordinated with vacuolar compartmentation (Greenway *et al*., 1983. The distribution of Na^+ in different leaves of BM 01 resembled the behavior of dicotyledonous halophytes (Flowers and Yeo, 1986; Leidi and

Saiz, 1997) with almost constant levels from lower to upper leaves (Fig. 2). Results obtained in this experiment relating to Na^+ accumulation and salt tolerance agree with early work by Lauchli and Stelter (1982) and Leidi and Saiz (1997). The lack of agreement of these results with those obtained with different *Gossypium* species (Gorham and Young, 1996; Rathert, 1982) is not surprising because of the diverse mechanisms (and the resulting complexity) involved in adaptation of different species to salinity (Yeo, 1983). Thus Na^+ accumulation provides an efficient method of osmotic adjustment under saline conditions when combined with compartmentation within the cell (Yeo, 1983).

The higher accumulation of Na^+ in roots and lower accumulation in stem of BM 01 than that of BM 21 (Fig. 1) is a remarkable feature possibly related to selective transport (Jeschke, 1984) which could determine the differential leaf distribution of Na^+ between genotypes. The differential ion uptake and distribution indicates several regulation mechanisms acting at different levels (Jeschke, 1984; Yeo, 1983). Selectivity in uptake and transport, vacuolar compartmentation and even more integrated (and complex) responses such as succulence may determine the differential genotypic response to salinity.

Also of interest was the slightly high K^+ concentration recorded in expanding leaves of the sensitive genotype (BM 21) and the negative correlation (r = -0.342) found between growth and K^+ concentration. Jeschke (1984) sugested that K^+ could be limiting cell expansion at high salinity. The result further showed that the highest concentration of K^+ was recorded in expanding leaf (L7) which was in the range of sufficiency (Leidi and Saiz, 1997; Wyn Jones, 1984). But the negative correlation of growth with K^+ could indicate a lower adaptation to salt due to inefficient K^+: Na^+ selectivity.

The genotype BM 01, with low K^+ concentration in older leaves, showed adequate K^+ concentration in younger leaves suggesting an efficient retranslocating system (Jeschke, 1984; Leidi and Saiz, 1997). In fact the low K^+ concentration together with constant Na^+ concentration in older leaves of BM 01 could indicate vacuolar Na^+ accumulation and active Na^+: K^+ exchange leading to K^+ retranslocation (Jeschke, 1984; Leidi and Saiz, 1997).

Evidences for strong relationship between K^+: Na^+ ratio and salinity tolerance in plants under saline soil has been provided by several workers (Leigh and Wyn Jones, 1984: Leidi and Saiz, 1997) and also in earlier experiment. In the present experiment, the response of genotypes with respect to K^+: Na^+ ratio varied between the genotypes under salt stress condition. The K^+: Na^+ ratio was higher in BM 01 than that of BM 21 (Fig. 3). Higher K^+: Na^+ ratio in tolerant genotype under salt stress condition is in agreement with the findings of Maas (1986), Sharma (1998), Varsheny *et al*. (1998) and Yasmeen (2000).

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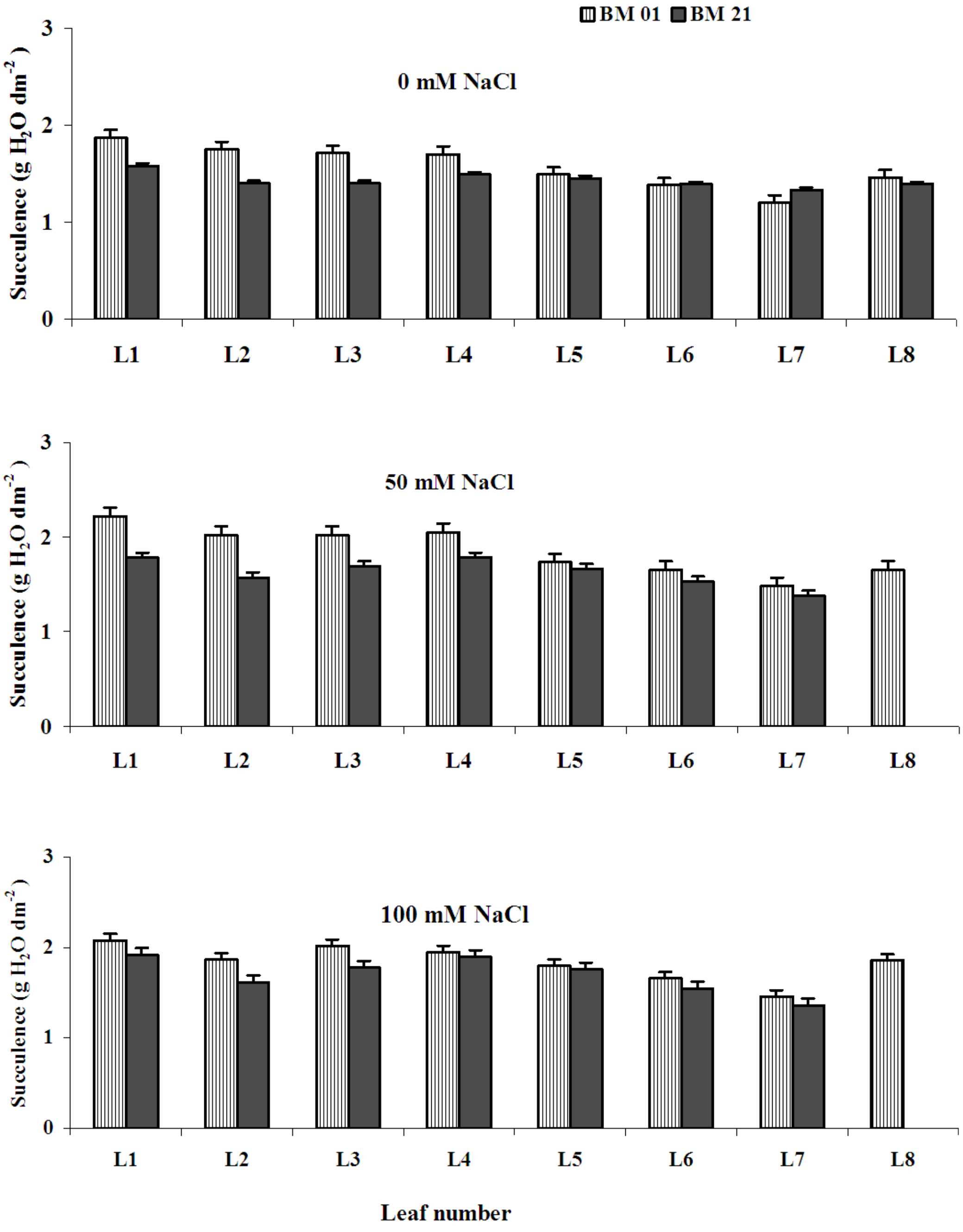

Fig.1. Succulence of individual leaf of BM 01 an BM 21 as affected by salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

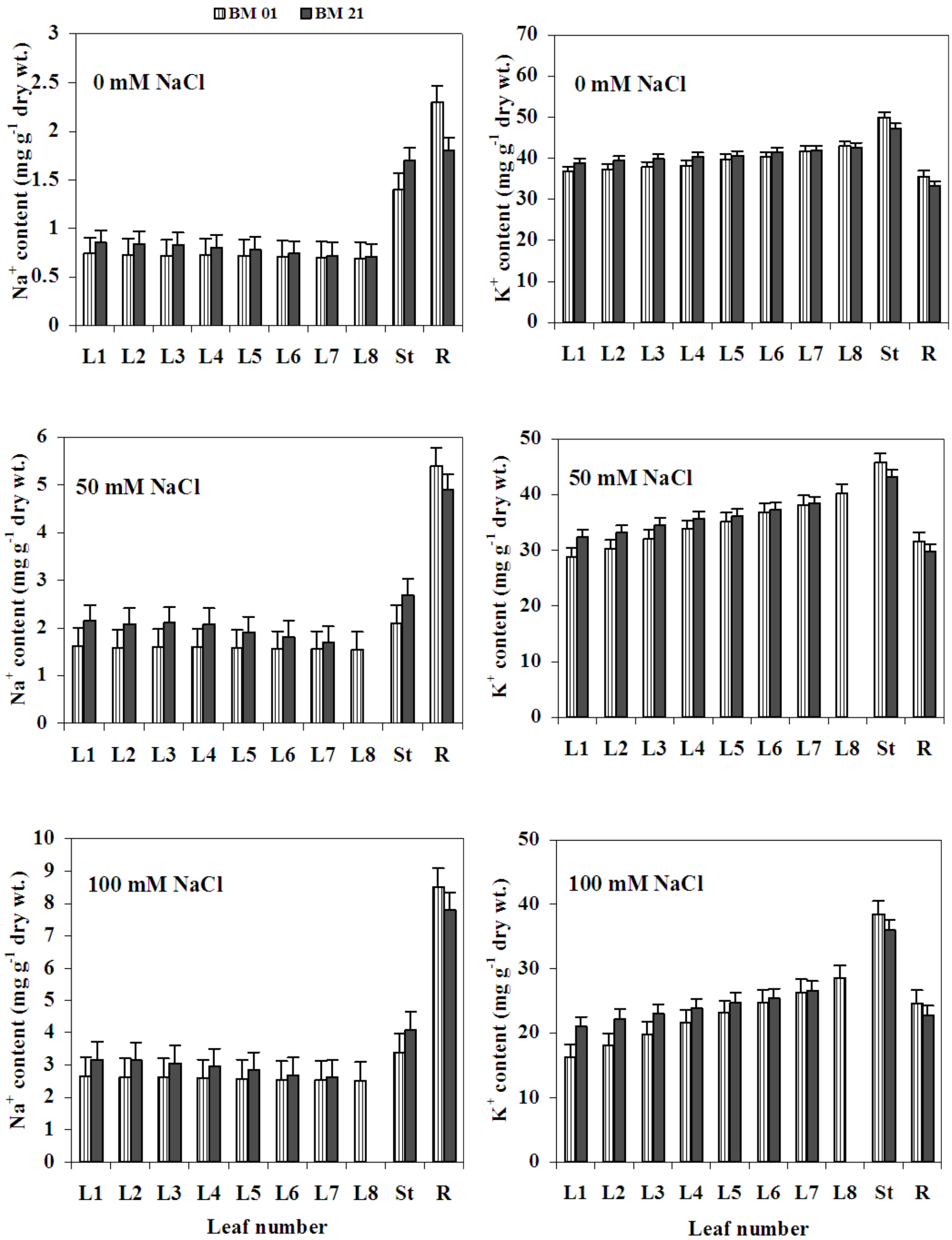

Fig. 2. Sodium and potassium content of BM 01 and BM 21as affected by salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown. (St, stem; R, root)

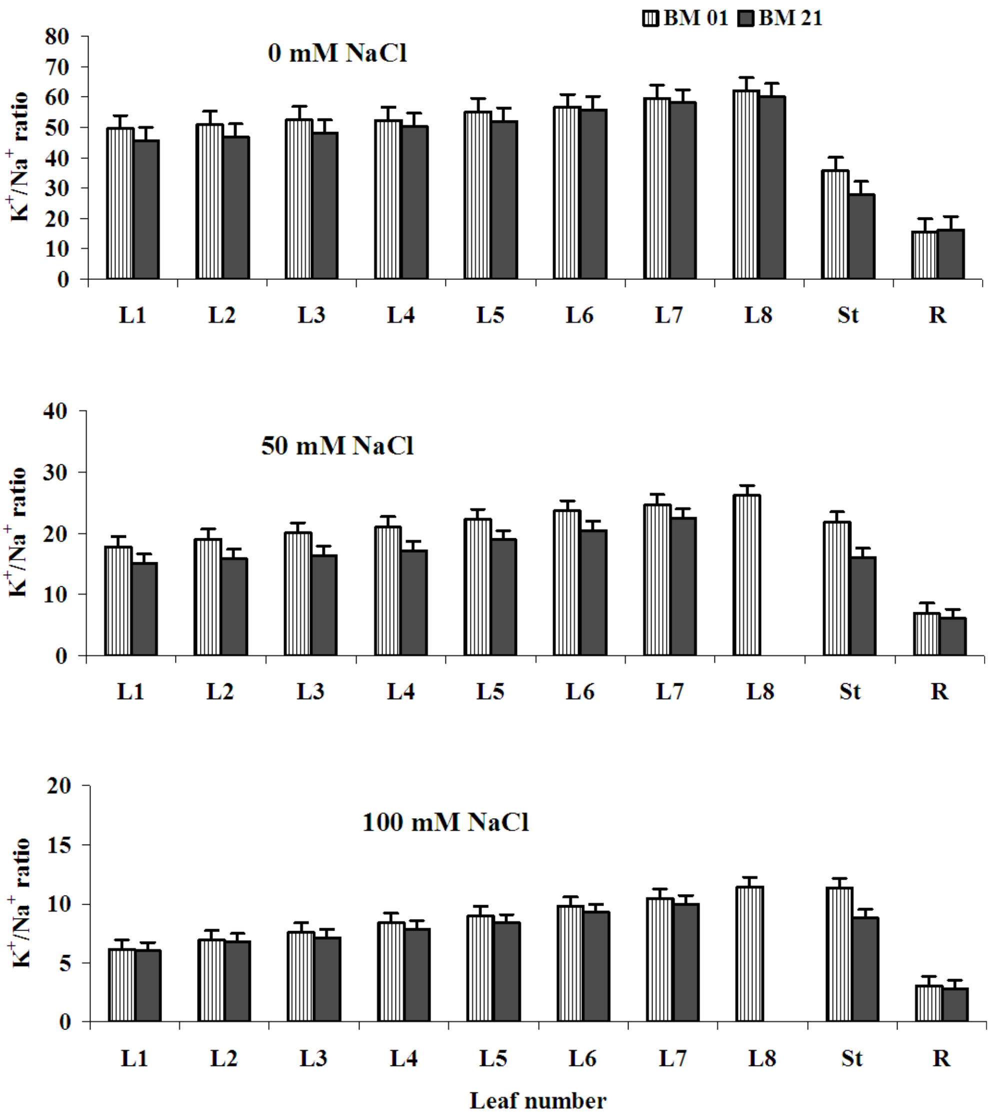

Fig. 3. K^+/Na^+ **ratio of BM 01 and BM 21 as affected by salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown.** (St, stem: R, root)

XYLEM WATER POTENTIAL AND LEAF CHLOROPHYLL CONTENT OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

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Abstract

Xylem water potential and leaf chlorophyll conetnt of two mungbean genotypes BM 01 and BM 21 were estimated at 0, 50 and 100 mM NaCl solution to clarify differences in salt tolerance. Salt stress decreased the xylem water potential (XWP) in both the genotypes BM 01 and BM 21. At all levels of salinity the genotype BM 01 showed less reduction in XWP than that of BM 21. A linerar, negative relationship observed between salinty levels and relative chlorophyll a, chlorophyll b and chlorophyll (a + b) but posotive relationship existed between salinity levels and cholorophyll a/b and total cholorophyll stabilty. The higher xylem water potential, better osmotic adjustment, less damaged chlorophylls and higher total chlorophyll stability percentage in BM 01 than BM 21 contributed to the higher salt tolerance of the former genotype than BM 21.

Introduction

Changes in biochemical components, viz. chlorophylls (Lakshmi *et al.*, 1996; Misra *et al*., 1997), carotenoids (Dubey, 1994), sugars (Sultana *et al.*, 1999), free amino acids (Durgaprasad *et al*., 1996) especially proline (Sultana *et al*., 1999) are responsible for salt tolerance in many crop plants. The growth inhibition of crop plants due to salinity may be caused primarily by the osmotic and/ or ionic components of salinity, acting on biophysical and/or metabolic components of expansive growth (Thiel *et al.,* 1988). Accumulation of Na^+ and Cl^- in the leaves, through the transpiration flow, is generally a long-term process occurring in salt-affected plants (Munns and Termaat, 1986). High internal concertrations of Na^+ and Cl^- may cause toxic ionic effect in the cellular compartment (Greenway and Munns, 1980). Ion accumulation in leaves also adversely affected cholorophyll concentation (Yeo and Flowers, 1983). Decrease in chlorophyll concentration in salinized plants could be attributed to increased activity of the chlorophyll-degrading enzyme chlorophyllase (Reddy and Vora, 1986). Strogonov *et al.* (1970) reported that the specific enzyme which was responsible for the synthesis of green pigments was suppressed by the effect of salinity. In the present study attempt was undertaken to clarify further the reasons for high salt tolerance of BM 01 compared to BM 21 in response to xylem water potential and leaf chlorophyll content.

Materials and Methods

The experiment was conducted at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. The trial was carried out in a completely randomized design with five replications. Seeds of two mungbean genotypes, BM 01 (tolerant one) and BM 21 (susceptible one), were sown 3rd March 2004 in earthen pots in the vinylhouse. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. The pots were irrigated with tap water until the seedlings were well established. NaCl solutions were applied every other day at an increment of 12.5 mM until the respective final concentrations, 0, 50, 75 and 100 mM were attained for each treatment. Xylem water potential was measured using the pressure chamber technique (Turner, 1988). Chlorophylls were measured on fresh weight basis extracting the leaf samples with 80 % acetone by using Double Beam Spectrophotometer (Model 200-20). Different chlorophylls were estimated using the following equations (Witham *et al.*, 1986):

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mg Chlorophyll a/g tissue = [12.7 (D_{663}) –2.69 (D_{645})] × [V/1000 × W]
mg Chlorophyll b/g tissue = [22.9 (D_{645}) – 4.68 (D_{663})] × [V/1000 × W]
mg Chlorophyll a+b/g tissue = [20.2 (D_{663}) – 8.02 (D_{645})] × [V/1000 × W]

Chlorophyll stability was calculated as the ratio of chlorophyll under stress to normal and expressed in percentage followed by Sarker (1993).

Results and Discussion

Xylem Water Potential

Salt stress decreased the leaf water potential (LWP) in both the genotypes BM 01 and BM 21 (Fig. 1). Decreased LWP due to salinity were also observed elsewhere, in mungbean (Nandwal *et al.,* 2000; Faruquei, 2002; Kabir, 2002), in faba bean (Ullah *et al.,* 1993), in cotton (Abd-Ella and Shalaby, 1993; Leidi and Saiz, 1997), in triticale (Karim et *al.*, 1993), and in tomato (Carvajal *et al.,* 1999; Pasternak *et al*., 1995). At all levels of salinity the genotype BM 01 showed less reduction in LWP than that of BM 21. Therefore, BM 21 suffered from maintenance of water relation more than that of BM 01 as observed in other parameters such as relative water content (RWC), water saturation deficit (WSD), water retention capacity (WRC) and succulence. Oertli (1994) proposed that extracellular accumulation of salt ions in cell walls may produce a lower water potential in the leaf apoplast under saline environment in legume. Plants suffer from osmotic shock due to lower osmotic potential in the soil solution due to salinity (Greenway and Munns, 1980; Orcutt and Nilsen, 2000) which decreases the LWP. Plant synthesizes different metabolites across the tonoplast to maintain turgor. However, the plants need to spend substantial energy to maintain turgor under water deficit conditions (Munns and Termaat, 1986). Higher LWP in BM 01 might suggest a mechanism of osmotic adjustment or an increase in cell wall elasticity (Leidi and Saiz, 1997; Faruquei, 2002).

Leaf chlorophylls

Salinity affected seriously biosynthesis of leaf chlorophylls viz. chlorophyll a, chlorophy b and total chlorophyll a+b as well as chlorophyll a/b ratio of both BM 01 and BM 21 (Fig. 2). Leaf chlorophylls decreased significantly with the increasing salinity in both the genotypes.

Chlorophyll a

Chlorphyll a was higher in BM 01 than in BM 21 at all levels of salinity (Fig. 2). However, the relative reduction in chl. a due to salinity was more in BM 21 (14, 26 and 35% at 50, 75 and 100 mM NaCl, respectively) than in BM 01 (3, 10 and 21%). The highest chl.a content (0.93 mg/g in BM 01 and 0.85 mg/g in BM 21) was recorded at control while the lowest (0.73 mg/g in BM 01 and 0.55 mg/g in BM 21) was at 100 mM NaCl. A linear but negative relationship existed between salinity levels and relative chlorophyll a (% of control) of BM 01 and BM 21, and expressed by the quation $y = -0.2015x + 102.73$ ($R^2 = 0.821$) and $y = -0.355 x + 101.14$ ($R^2 = 0.9878$), where R is highly significant (Fig. 2). Higher R value as found in BM 21 than in BM 01 indicated a stronger relationship between salinity levels and chlorophyll a in the former genotype than BM 01.

Chlorophyll b

Chlorophyll b also followed a decreasing pattern with the increasing salinity levels in both the crops (Fig. 2). BM 01 showed higher chl. b than BM 21 at all salinity levels. The relative reduction of the content was higher in BM 21 than that in BM 01. A linear (negative) relationship existed between salinity levels and relative chlorophyll b (% of control) of BM 01 and BM 21, and expressed by the quation $y = -0.4029x + 100.79$ ($R^2 = 0.9548$) and $y = - 0.4901x + 100.87$ ($R^2 = 0.9838$), respectively, where R is highly significant. Higher R value as found in BM 21 than BM 01 indicated a stronger relationship between salinity levels and chlorophyll b in the former genotype than the later.

Total chlorophyll (a+b)

Total chlorophyll (a+b) also decreased with the increasing salinity levels in both the genotypes. (Fig. 2). Higher amount of total chlorophyll (a+b) was recorded in BM 01 than BM 21. The relative reduction was also more at all levels of salinity in BM 21 than BM 01. A linear (negative) relationship existed between salinity levels and relative (% of control) total chlorophyll of BM 01 and BM 21, and expressed by the equation y = -0.148x + 101.15 (R^2 = 0.9276) and y = -0.2987x + 100.62 (R^2 = 0.9944), respectively, where R is highly significant. Higher R value as found in BM 21 than BM 01 indicated a stronger relationship between salinity levels and total chlorophyll (a+b) in the former genotype than the later. In general, all the chlorophyll contents were reduced significantly at high salt concentrations in both the genotypes, although variation between genotypes was evident. Ashraf and Rasul (1988) found greater chlorophyll a. chlorophyll b and total chlorophyll in tolerant cv. Mg 6601 than in susceptible cv-Au Mg 588. It has been suggested by Strogonov *et al*., (1970) that the specific enzyme which is responsible for the synthesis of green pigments was suppressed by the effect of salinity. Reddy and Vora (1986) reported that a decrease in chlorophyll concentration in salinized plants could be attributed to increased activity of the chlorophyll-degrading enzyme chlorophyllase. Ion accumulation in leaves also adversely affected chlorophyll concentration (Yeo and Flowers, 1983). Salinily decreased chl.a, chl . b and total chl. (a+b) were also observed in mungbean (Ashraf and Rasul, 1988; Singh *et al*., 1994), in blackgram (Maas and Hoffman, 1977; Ashraf, 1989), in *Vicia faba* (Hamada and EI- Enany, 1994), and in blackgram and mungbean (Islam, 2001).

Chlorophyll a/b ratio

The ratio of chlorophyll a/b increased due to salinity (Fig. 3). Salinity decreased chl. b more than Chl. a and thus increased the ratio. A linear relationship existed between salinity levels and relative chl. a/b (% of control) ratio of BM 01 and BM 21, and expressed by the equation y = 0.2484x + 99.408 (R^2 = 0.915) and y = 0.3291x + 100.89 (R^2 = 0.9635), respectively where R is highly significant (Fig. 3). Higher R value as found in BM 21 than in BM 01 indicated a stronger relationship between salinity levels and chl. a/b ratio in the former genotype than the later. In a study of Mishra *et al*. (1997) chlorophyll synthesis and accumulation was stimulated by mild level of NaCl salinity. The result of this experiment is partially in line with that of Singh et al. (1994) for *Vigna radiata* and Islam (2001) for blackgram and mungbean that chlorophyll a/b ratio increased with the increasing salinity levels. The less damaged chlorophylls in BM 01 than BM 21 by salinity was presumably contributed for maintaining higher Pn efficiency in the former genotype than the later (Seemann and Critchley, 1985; Ashraf and Rasul, 1988; Datta *et al.*, 1990; Islam, 2001).

Total chlorophyll stability

The total chlorophyll stability (%) also decreased with the increasing salinity levels in both the genotypes (Fig. 3). Higher percentage of total chlorophyll stability was recorded in BM 01 than BM 21. Sarker (1993) found higher chlorophyll stability for salt tolerance in soybean. A linear but positive relationship existed between salinity levels and relative (% of control) total chlorophyll stability of BM 01 and BM 21, and expressed by the equation y = 0.248x + 99.048 (R^2 = 0.915) and y = 0.3291x + 100.89 (R^2 = 0.9635), respectively, where R is highly significant. Higher R value as found in BM 21 than BM 01 indicated a stronger relationship between salinity levels and total chlorophyll stability percentage in the former genotype than the latter.

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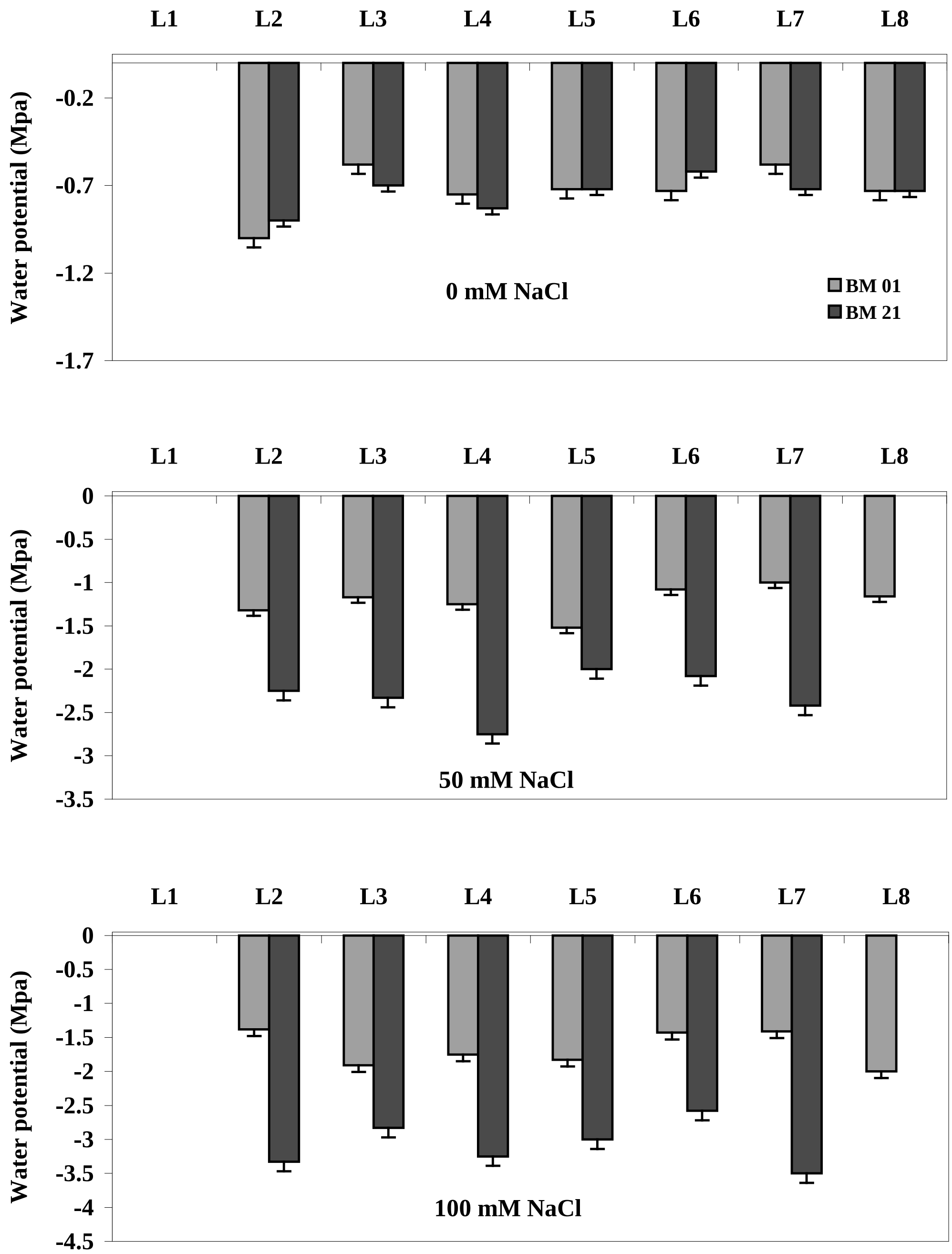

Fig.1. Xylem water potential of individual leaf of BM 01 an BM 21 as affected by salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

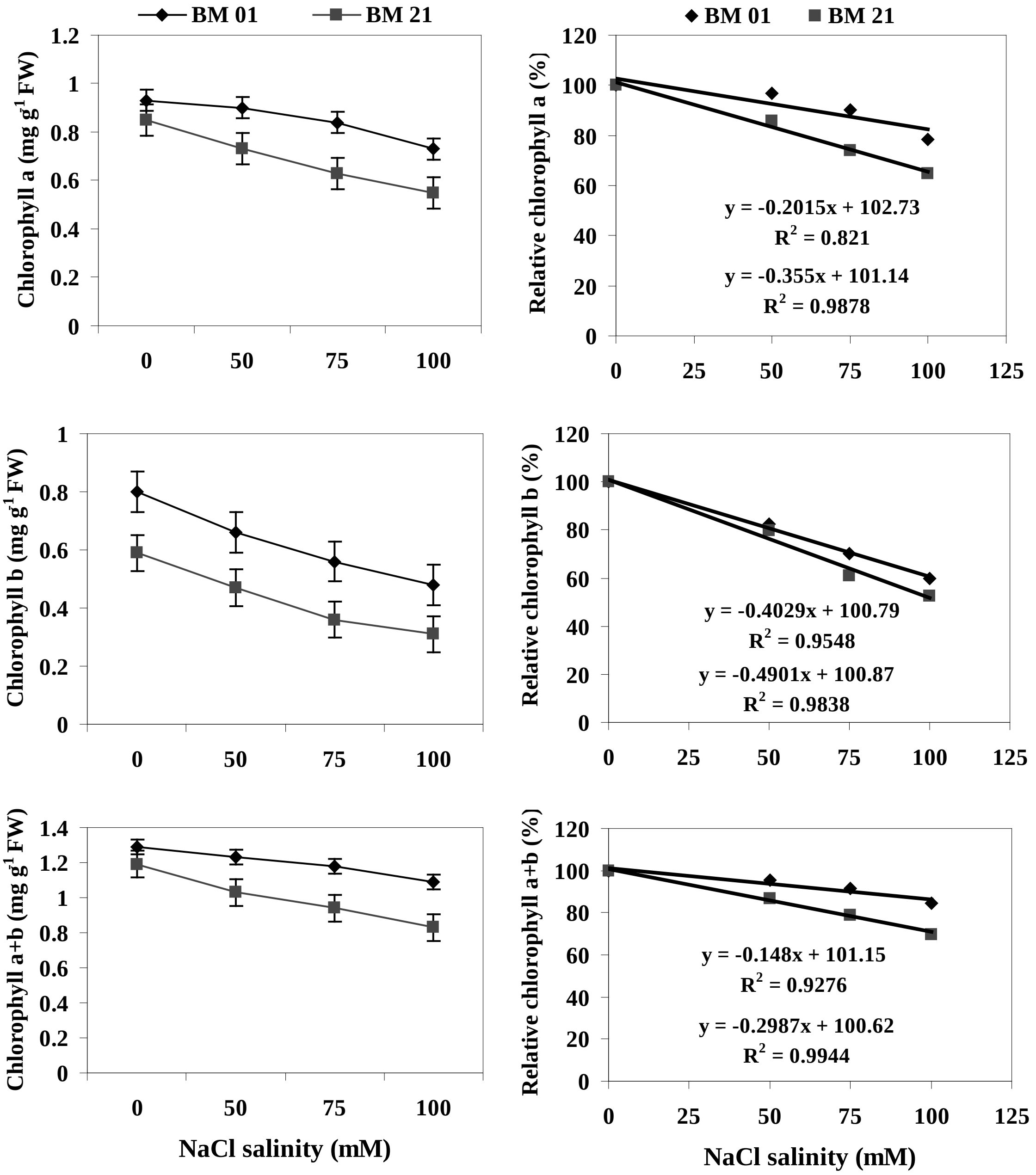

Fig. 2. Leaf chlorophyll of BM 01 (salt-tolerant) and BM 21 (salt-susceptible) as affected NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

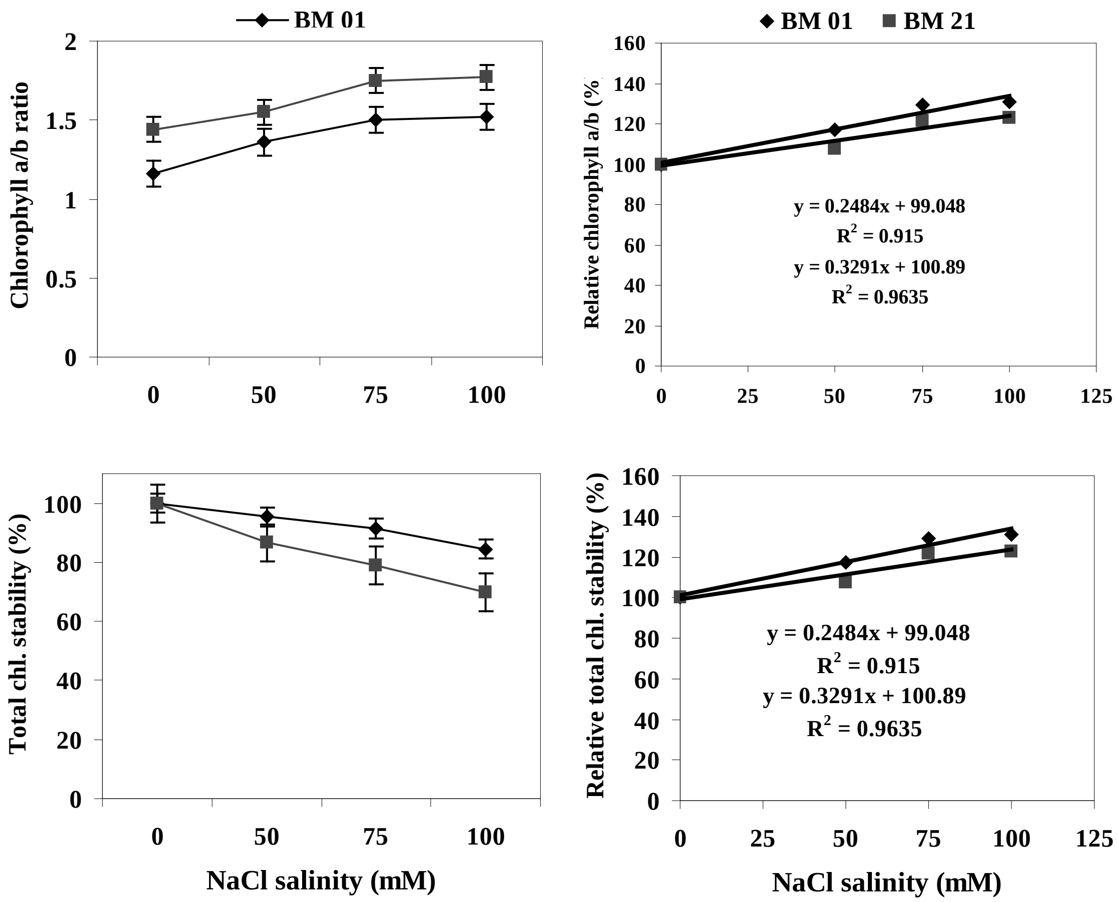

Fig. 3. Leaf chlorophyll of BM 01 (salt-tolerant) and BM 21 (salt-susceptible) as affected NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

PHYSIOLOGICAL MECHANISMS OF SALT TOLERANCE IN MUNGBEAN: NODULATION, NITROGEN FIXATION AND NITROGENASE ACTIVITY OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

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Abstract

Salt tolerance of mungbean gewnotypes BM 01 and BM 21 was assessed for nodulation, nitrogen fixation and nitrogenase activity at 0, 50, 75 and 100 mM NaCl solutionin in pot culture. Salt stress lead to a significant reduction in number of nodules per plant but the reduction in BM 21 was higher than that in BM 01. Nitrogenase activity significantly decreased with increasing salinity levels and it was 38% in BM 01 while that was 59% in BM 21 at 100 mM NaCl. The nodule dry matter reduction occurred across a wider range (58% in BM 01 and 83 % BM 21) while the range of variations in nitrogenase activity was rather narrow (38% in BM 01 and 59 % BM 21). It mignt be concluded that higher nodulation and nitrogen fixation in BM 01 than BM 21 contributed to the high salt tolerance of the former genotype than BM 21.

Key words: *Physiological mechanisms, salt tolerance, mungbean, nodulation, nitrogen fixation, nitrogenase activity*

Introduction

Nodulation in mungbean under field condition is very poor (Ashraf, 1994). It may be due to absence of Rhizobium in such soils. Alternatively other environmntal factors such as salinity (Ashraf *et al*., 1990), high temperature (Marshall, 1964) and drought (Vincent *et al*., 1962) may affect the nodulation and nitrogn fixation of leguminous plants. The adverse effects of salinity on legume-rhizobium symbiosis result in decreased nodulation, nodule dry weight, and N_2 fixation (Abd-Alla, 1992; Delgado *et al.,* 1993; Cordovilla *et al.,* 1995). Moreover nodulation and N fixation properties of legumes are also related with salinity tolerance (Subbarao *et al.*, 1990; Hye, 2000). In the earlier study the high salt tolerance of BM 01 was found to be related with osmoregulation, menbrane thermostability and chlorophyll stability compared to salt susceptible genotype BM 21. In the present study attempt was undertaken to clarify further the reasons for high salt tolerance of BM 01 compared to BM 21 in terms of nodulation, nitroen fixation and nitrogenase activity.

Materials and Methods

Two mungbean genotypes, BM 01 (tolerant one) and BM 21 (susceptible one), were sown in earthen pots in the vinylhouse. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. The pots were irrigated with tap water until the seedlings were well established. NaCl solutions were applied every other day at an increment of 12.5 mM until the respective final concentrations, 50, 75 and 100 mM were attained for each treatment. The treatment solution was applied with irrigation water until harvest. Plants in the control group were irrigated with tap water. Plant samples were collected from the pot at flowering stage. Three pots were randomly selected from each salinity levels of each genotype. Lastly six plants were selected randomly from three pots. Plants were carefully uprooted under flow of tap water so that no nodules were left in

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the soil. Nitrogenase activity of the plants was assessed by gas chromatography. The nodules from the roots of each plant were separately collected and weighed. The root, stem, leaves and nodules were oven–dried at 70 ^{o}C to a constant weight.

Nitrogenase activity

Measuring acetylene-reducing activity (ARA) in a gas chromatograph (Hardy *et al.,* 1968) assessed nitrogenase activity. Mungbean plants were harvested at flowering stage and brought immediately to the laboratory. Soil was removed from the root very carefully so that the nodules remained intact. Then the roots were individually placed in a conical flask and the flask was sealed with air tight rubber septum. Ten percent of the air in the flask was replaced with acetylene gas. One ml of gas sample was collected from each flask with a disposable 1 ml syringe at 5 and 45 minutes after incubation and immediately injected in the gas chromatograph (Shimadzu, GC – 8A) fitted with a flame ionization detector and a stainless steel column (3 mm dia, 1.5 m length). The column was fitted Porapak –R, 100-200 mesh. The column and injector temperature was 60 ^{o}C. All gases used from cylinder were of purity grade in which the following flow were maintained; H_2 20 ml/min, air 45 ml/min, N_2 30 ml/min. Ethylene and acetylene gases were separated in the column, detected in flame ionization detector and finally the peaks were recorded (model Shimadzu, R-111). The amount of ethylene was measured using the following formula :

$$\frac{(b-a)\text{ X vol. of conical flask x }60}{40} = \text{C mol } C_2H_4\text{/Plant/hr}$$

Here,

b = amount of n mol C_2 H_4/mol was produced after 45 minutes

a = amount of n mol C_2 H_4 / mol was produced after 5 minutes

C = amount of n mol C_2 H_4/ plant

Vol. of conical flask = Volume determined by subtracting root from total water weight in the flask.

Results and Discussion

Nodules per plant

BM 01 produced significantly higher number of nodules per plant at control as well as at all levels of salinity (Fig. 1). Salt stress lead to a significant reduction in number of nodules per plant compared to the control. Reduction of nodules per plant under saline condition also reported earlier in mungbean (Hafeez *et al*., 1988; Idris *et al*., 1990), in soybean (Tu, 1981; Cordovilla *et al*., 1995) and in chickpea (Sharma, 1997; Hye, 2000). However, the reduction in BM 21 was higher than that in BM 01. In BM 01 the reduction was 50% at 75 mM NaCl while it was 76% in BM.21 at 75 mM NaCl. The result confirms the findings of Sharma (1997) that salinity affected nodule formation more in susceptible chickpea genotype than that in tolerant one. Tu (1981) observed reduced nodulation under saline conditions in soybean, which was associated with poor rhizobial growth. The result was also supported by the findings of Siddiqui *et al*., (1985). Salinity reduced nodulation by effecting the survival, growth and infection ability of even the efficient Rhaizobia (Sharma, 1997).

Wight of nodules per plant

Maximum nodule dry weight was obtained in BM 01 under both control and stress condition (Fig. 1). Increasing salinity significantly decreased the nodule dry weight in both the genotypes. The percent reduction of nodule dry weight was lower in BM 01 (58%) than in BM 21 (83%) at 100 mM NaCl. Cordovilla *et al*., (1995) found that nodule dry weight of sensitive cultivars of soybean decreased more by salinity than that of tolerant cultivars. The amount of nodule dry matter in a plant indicates its capacity to remobilize nitrogen to the seed (Hafeez *et al*., 1988). Direct nitrogen uptake by a plant is related with the supply of seed nitrogen in absence of nodule nitrogen. Poor nodule dry matter in BM 21 than BM 01 might be attributed to poor nitrogenase activity in BM 21 due to salinity or to the poor supply of carbohydrates from the salt affected leaves or combine effect of both of the factors (Cordovilla *et al.,* 1995). The adverse effect of salinity on nodule dry weight was also observed by Subbarao *et al.* (1990); Abd-Alla (1992); Delgado *et al.* (1993) and Hye (2000).

Wight of individual nodules

Increasing salinity from 0 to 100 mM increased the weight of individual nodule (Fig. 2). Under control condition the nodule dry weight was 2.65 mg per nodule in BM 01 while it was 2.51 per nodule in BM 21. The increase in nodule dry weight was 9, 20 and 43% in BM 01 and 2, 15 and 35% in BM 21 at 50, 75 and 100 mM NaCl respectively. The results are in agreement with the findings of Hafeez *et al.,* (1988); and Delgado *et al.,* (1993) who reported that increasing salinity increased the individual nodule dry weight. Balasubranian and Sinha (1976) pointed out that the nodules in salt-stressed plants of cowpea and mungbean were bigger than those in the control plants, probably because relatively fewer nodules were competing for photosynthates. A similar effect was also observed in pigeonpea by Sabbarao *et al.,* (1990).

Nitrogenase activity

The activity of the nitrogenase enzyme indicates the biological activity of the nodules. Nitrogenase activity was highest under non-saline condition and the genotypes differ significantly in the response (Fig. 2). Increasing salinity significantly decreased the nitrogenase activity in both the genotypes and the reduction was higher in BM 21 than in BM 01. The adverse effects of salinity on the legume-rhizobium symbiosis decreased nitrogen fixation as observed by Hafeez *et al*. (1988); Subbarao *et al*. (1990); Delgado *et al*. (1993); Cordovilla *et al*. (1995); Hye (2000). The reduction of nitrogenase activity was 38% in BM 01 while that was 59% in BM 21 at 100 mM NaCl. The nodule dry matter reduction occurred across a wider range (58% in BM 01 and 83 % BM 21) while the range of variations in nitrogenase activity was rather narrow (38% in BM 01 and 59 % BM 21). So the nitrogen fixation activity of nodules varied between genotypes and the enzyme activity under salt-stress becomes less apparent. Cordovilla *et al.* (1995) reported that nitrogenase activity was severely depressed in salt-sensitive soybean cultivars, whereas salt tolerant cultivars continued to grow and fix N_2, although their shoot growth, nodulation, and nodule dry weights were marginally reduced. The nitrogen-fixing efficiency of salt-stressed plants declined probably because the demand for N was less due to the poorer growth rate of these plants (Balasubranian and Sinha, 1976). Therefore, the higher nodulation, nitrogen fixation and better nitrogenase activity in BM 01 than BM 21 contributed to the high salt tolerance of the former genotype than BM 21.

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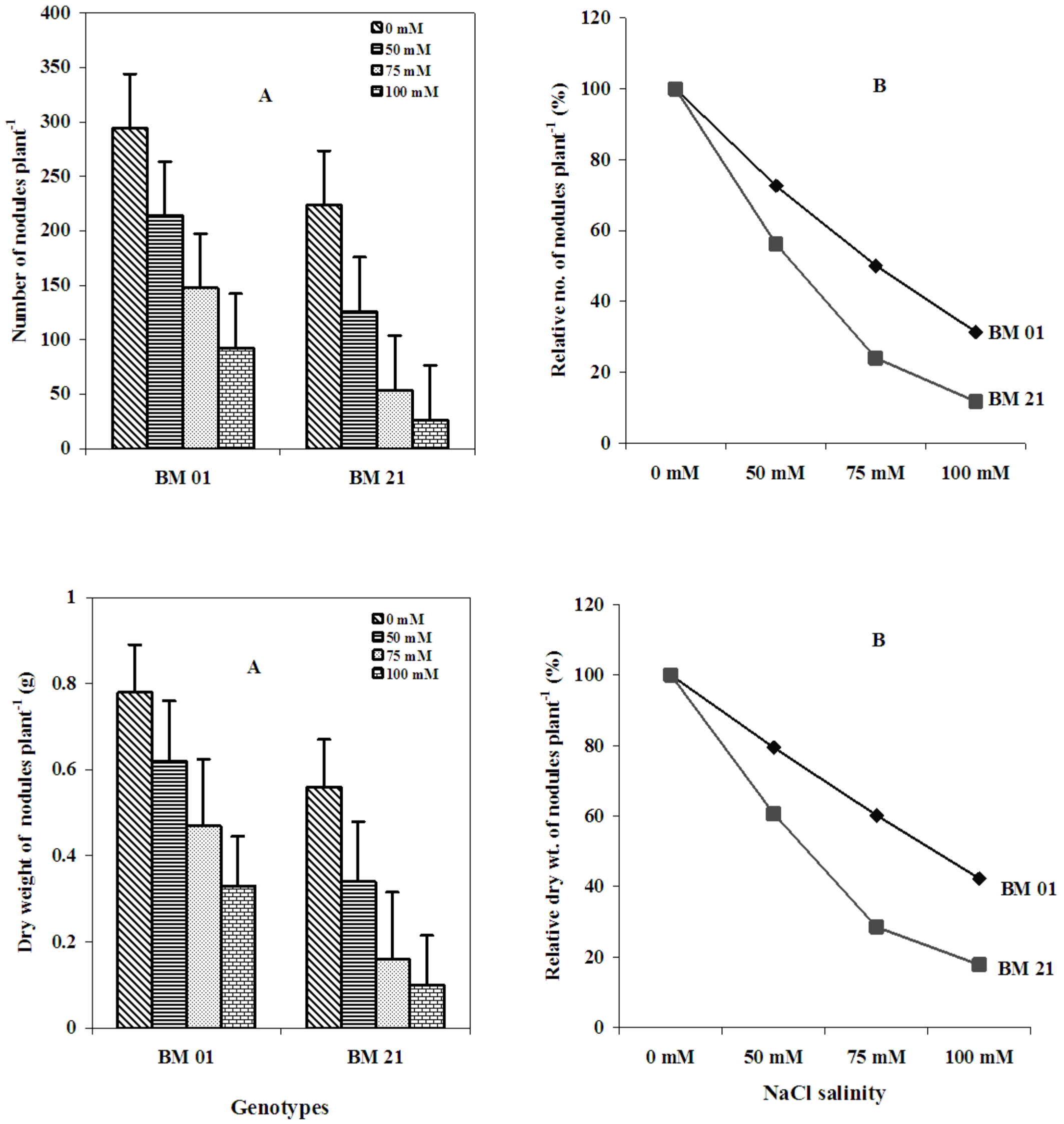

Fig.1. Number and weight of nodules per plant (A:absolute and B: relative) of BM 01(salt-tolerant) and BM 21 (salt-susceptible) as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

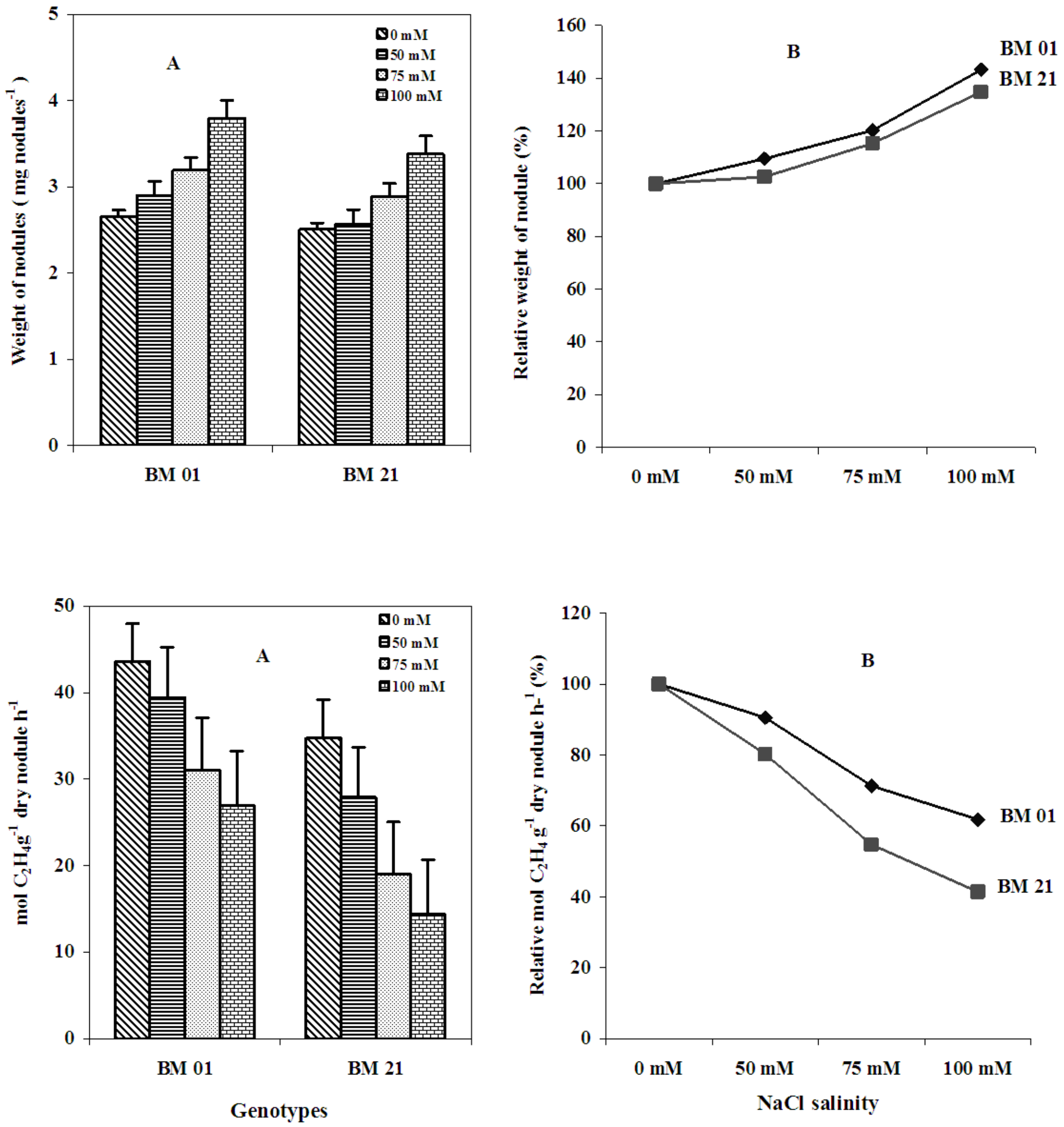

Fig. 2. Dry weight of individual nodules and Nitrogen fixation per g dry nodules (A:absolute and B: relative) of BM 01(salt-tolerant) and BM 21 (salt-susceptible) as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

DISTRIBUTION OF Na^{+}, Mg^{+2} AND Cl^{-} IONS IN DIFFERENT PLANT PARTS OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

M. A. Aziz[1], M.A. Karim[2], A. Hamid[2], Q.A. Khaliq[2], M. Hossain[2] and A.J.M.S. Karim[2]

Abstract

Under saline condition roots contained higher amount of Na^{+} than shoot in both the genotypes but the two genotypes showed a different response. The Mg^{+2} accumulation was a little lower in BM 01 than that in BM 21. Chloride ion increased dramatically with the increasing levels of salinity in both the genotypes. BM 21 accumulated relatively higher content of Cl^{-} in most of the plant parts. BM 01 expressed more salt tolerance than BM 21in terms of toxic ion accumulation. The difference in salt tolerance between the two genotypes was associated with the difference in the degree of toxicity of excess accumulation of Na^{+}, Mg^{+2} and Cl^{-} to the plant tissue.

Key words: *Physiological mechanisms, salt tolerance, mungbean,* Na^{+}, Mg^{+2} *and* Cl^{-} *ion distribution*

Introduction

The variation in salt tolerance among the cultivars may be related to multiple physilogical processes including differential patterns of uptake and transport of ions (Hagemeyer 1997; Due 1997). Orcutt and Nilsen (2000) suggested that variation in Na^{+}, Cl^{-} and Mg^{+2} ion transport from root to shoot might be responsible for the varietal differences in salt tolerance. In general, the salt tolerant cultivars have a greater ability to exclude Na^{+} and Cl^{-} ions in the foliage or greater compartmentation capability of the toxic ions within the cells and organelles (Steveninck *et al.* 1982; Leidi and Saiz 1997). Accumulation of Na^{+} and Cl^{-} in leaves, through the transpiration flow, is a general, long-term process occurring in salt-stressed plants (Munns and Termaat 1986; Hu 1996). High internal concentrations of Na^{+} and Cl^{-} may provide a means of low energy osmotic adjustment for salt tolerant plants, which at the same time must be capable of cellular compartmentation of toxic ions (Greenway and Munns, 1980). Plant growth is likely to be affected by the interactions of Na^{+} and Cl^{-} and by many mineral nutrients, causing imbalance in nutrient availability, uptake or distribution within plants, and also increasing the plant requirements for essential elements (Grattan and Grieve 1992). In this paper, we provide a more detailed analysis of the efffects of NaCl salinity on the ion accumulation of two mungbean genotypes differing in salt tolerance. We tested the hypotheses that the difference in salt tolerance between these two genotypes was related to differences of the toxic accumulation of Na, Cl or Mg in different plant parts.

Materials and Methods

Seeds of two genotypes of mungbean, BM 01 (tolerant one) and BM 21 (susceptible one), were sown in earthen pots in the vinylhouse at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. Six plants were used in each treatment for the measurement of agronomic parameters. The pots were irrigated with tap water until the seedlings were well established. NaCl solutions were applied every other day at an increment of 12.5 mM until the respective final concentrations, 50, 75, and 100 mM were attained for each treatment. The treatment solution was applied with irrigation water until maturity. Plants in the

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control group were irrigated with tap water. Sampling was done at a ten-day interval from 25 days after emergence (DAE) till maturity. After harvesting, roots were separated from the plants and washed with tap water. The plant parts were segmented into leaf, stem and reproductive organ (flowers + pods). The samples were oven-dried at 70 ^{0}C to a constant weight. Sodium and magnesium concentrations from these parts of the plants were determined by atomic absorption spectrophotometer (Shimadzu, Atomic Absorption /Flame Spectrophometer; Model- AA. 610s) following Hitachi Ltd., (1986). Chloride concentration was estimated following the method described by Jackson (1955). The ground plant materials were dry-ashed in porcelain evaporating dish with calcium oxide in a muffle furnace at 600 ^{O}C for eight hours. Then the ash sample was extracted with hot water and the chloride was analyzed by titration with standard silver nitrate.

Results and Discussion

Sodium

Compared to non-saline conditions Na^+ concentration increased with the increasing salinity in roots and shoots (leaf, stem and reproductive organ) of both the genotypes (Fig. 1). Moreover, Na^+ accumulation increased with the plant age. Perhaps higher Na^+ accumulation at later stages was due to longer exposure of the crops to salinity. Under saline condition roots contained higher amount of Na^+ than shoot in both the genotypes but the two genotypes showed a different response. Higher amount of Na^+ in root than shoot in legumes is the result of the process of reabsorption (Yeo *et al.*, 1977; Orcutt and Nilsen 2000) and retranslocation mechanisms (Lessani and Marschner 1978). In legumes, some parenchyma cells differentiate into transfer cells and reabsorb Na^+ from the transpiration stream (Matsushita and Matoh 1992). Reabsorption of Na^+ and translocation back to the roots is found only in species with relatively moderate salt tolerance (Lessani and Marschner 1978). BM 01 accumulated higher amount of Na^+ in roots and lower amount of Na^+ in shoot than that of BM 21. High Na^+ retention in root than shoot was also observed by Sharma and Kumar (1990) in chickpea. Blum (1988) indicated that tolerant crop accumulated less amount of Na^+ in shoot than susceptible one. However, the findings of Lauchli and Wieneke (1979) in soybean, Due (1998) in Chickpea and Raptan *et al*. (2001) in blackgram revealed that tolerant cultivar maintained relatively larger amount of Na^+ in the roots and a smaller amount in the shoot compared to those in salt susceptible cultivar. The excessive amount of Na^+ in the shoot under saline condition, as found in the present study, presumably caused harmful effect on plant growth, and BM21 was suffered more from Na^+ toxicity than BM 01 (Blum 1988; He and Cramer 1993; Mamo *et al*. 1996).

Magnesium

Salinity increased the Mg^{2+} accumulation, and higher the NaCl concentration as well as the plant age, greater was the accumulation (Fig. 2). Similar results were also reported by Faruquei (2002) in mungbean. Islam (2001) and Raptan *et al*., (2001) reported that magnesium accumulation increased by salinity in blackgram and mungbean. A decreased accumulation of Mg^{2+} was noticed by Lal and Bhardwaj (1984) in fieldpea, and Paliwal and Maliwal (1980) in greengram and blckgram. Contrary, Patil *et al*. (1996) did not find any influence of salinity on Mg^{2+} accumulation in greengram. The Mg^{2+} accumulation was a little lower in BM 01 than that in BM 21 a relatively salt sensitive genotype. He and Cramer (1993) found higher Mg^{2+} content in tolerant *Brassica napus* than susceptible *Brassica carinata*. It is reported that accumulated Mg^{2+} in the source (leaf) of the plant was probably helpful to maintain osmoregulation to protect the plant cells from osmotic shook caused by salinity (Greenway and Munns 1980).

Chloride

Chloride ion increased dramatically with the increasing levels of salinity in both the genotypes (Fig. 3). However, there were varietal differences in Cl^- accumulation. BM 21 accumulated relatively higher content of Cl^- in most of the plant parts (Fig. 4.10). In treated plants, leaf accumulated the greater quantity of Cl^- followed in decreasing order by stem, reproductive organ and root irrespective of the genotypes. The greater uptake of Cl^- with the increased concentration of salinity (Agastian and Vivekanandan 1997) eventually led to the specific ion effect or to osmotic effect on plant cell. Moreover, huge accumulation of Cl^- under NaCl salinity disturbed the accumulation of major nutrients as found in soybean (Wieneke and Lauchli 1979), in field pea (Lal and Bhardwaj 1984), in mungbean, cowpea and soybean (Egeh and Zamora 1992; Salim and Pitman 1983; Salim and Pitman 1987), and in horsegram (Sudhakar *et al*. 1990). Chloride is a more sensitive indicator of salt damage than Na^+, since, generally, more Cl^- than Na^+ is stored in plants (Alam 1994; Hu 1996). Chloride content was higher in BM 21 than that in BM 01. This increase may result from the more reduction in the availability of Ca^{2+} causing an increase in root permeability (Grattan and Grieve 1992; Hu 1996). However, the report of Abel and Mackenzie (1984) revealed that tolerant soybean variety had higher Cl^- exclusion ability from the shoot was pertinent completely for mungbean genotypes.

Ion effects have been considered to be related to salt tolerance (He and Cramer 1993; Cheeseman 1988; Gorham *et al*., 1985; Greenway and Munns 1980). One hypothesis associated with the relationship between salt tolerance and ion effects is that there is a difference between plant species in the degree of toxicity of Na^+ and Cl^- to growth. In our results, the concentration of Na^+, Cl^- and Mg^{2+} in the shoot and root of BM 01 appeared to be lower than that of BM 21. This is a valid argument, certainly ions could be preferentially accumulated in certain cells or cellular compartments. However, the fact that concentrated nutrient solutions inhibit plant growth to about the same extent as isosmotic NaCl solutions (Munns and Termaat 1986) and that these BM 01 and BM 21 showed the different relative tolerance, support the argument that ion effects are responsible for the differences in salt tolerance between BM 01 and BM 21. He and Cramer (1993) reported that the difference in salt tolerance between the two *Brassica* species was due to the difference in the degree of toxicity of Na^+, Mg^{2+} and Cl^-.

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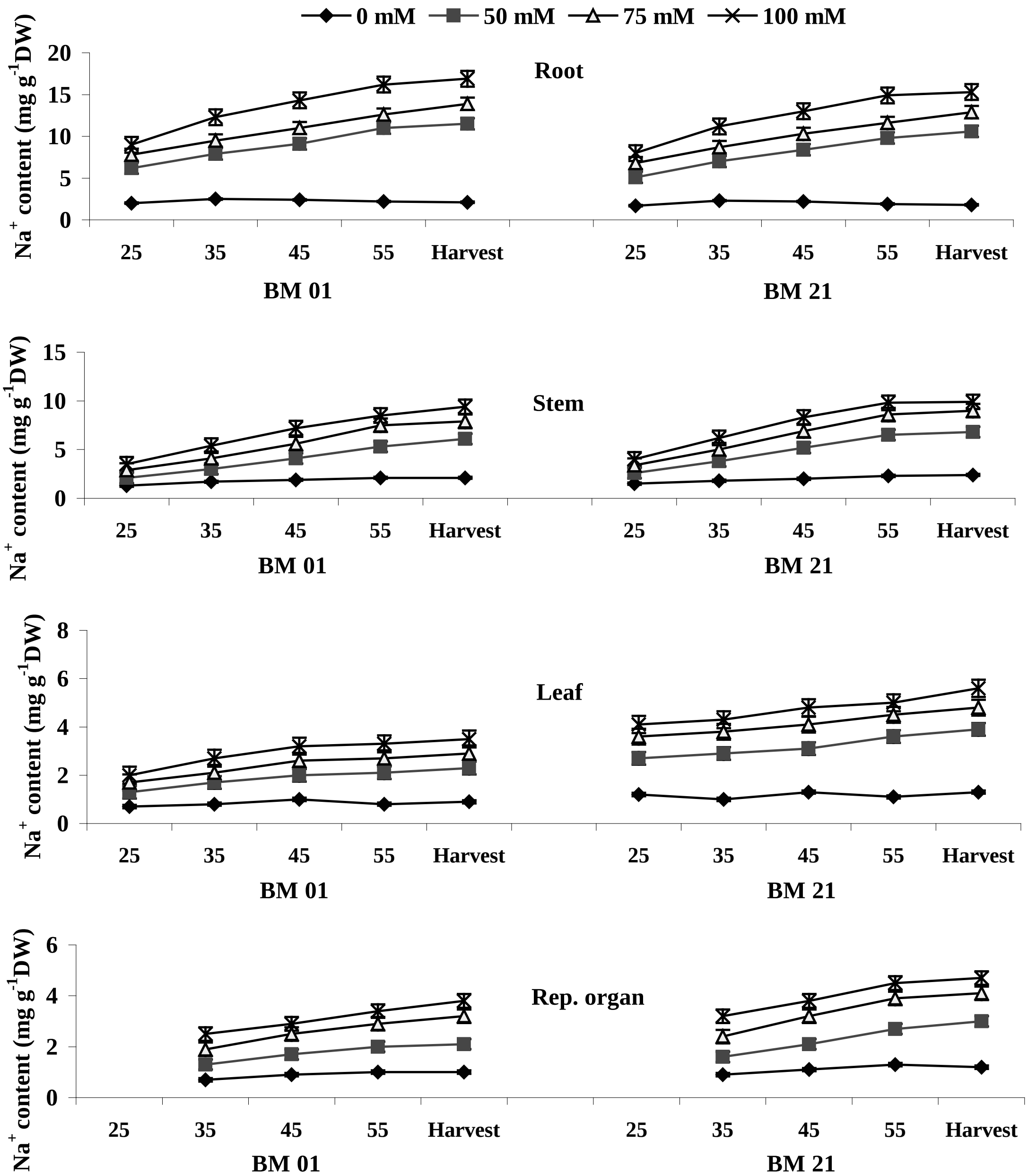

Fig.1. Sodium ion content in different plant parts of BM 01 and BM 21 as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

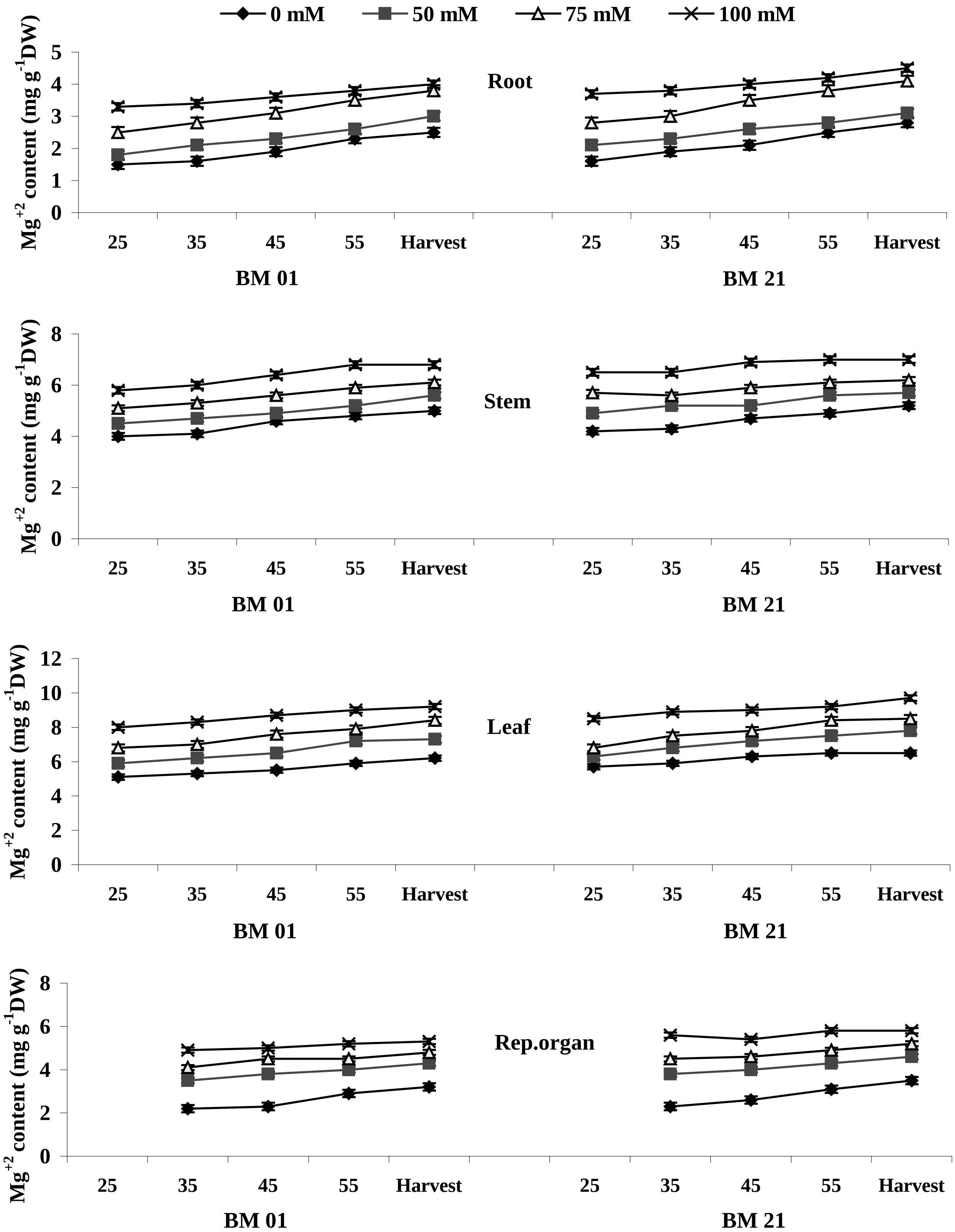

Fig.2. Magnesium ion content in different plant parts of BM 01 and BM 21 as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

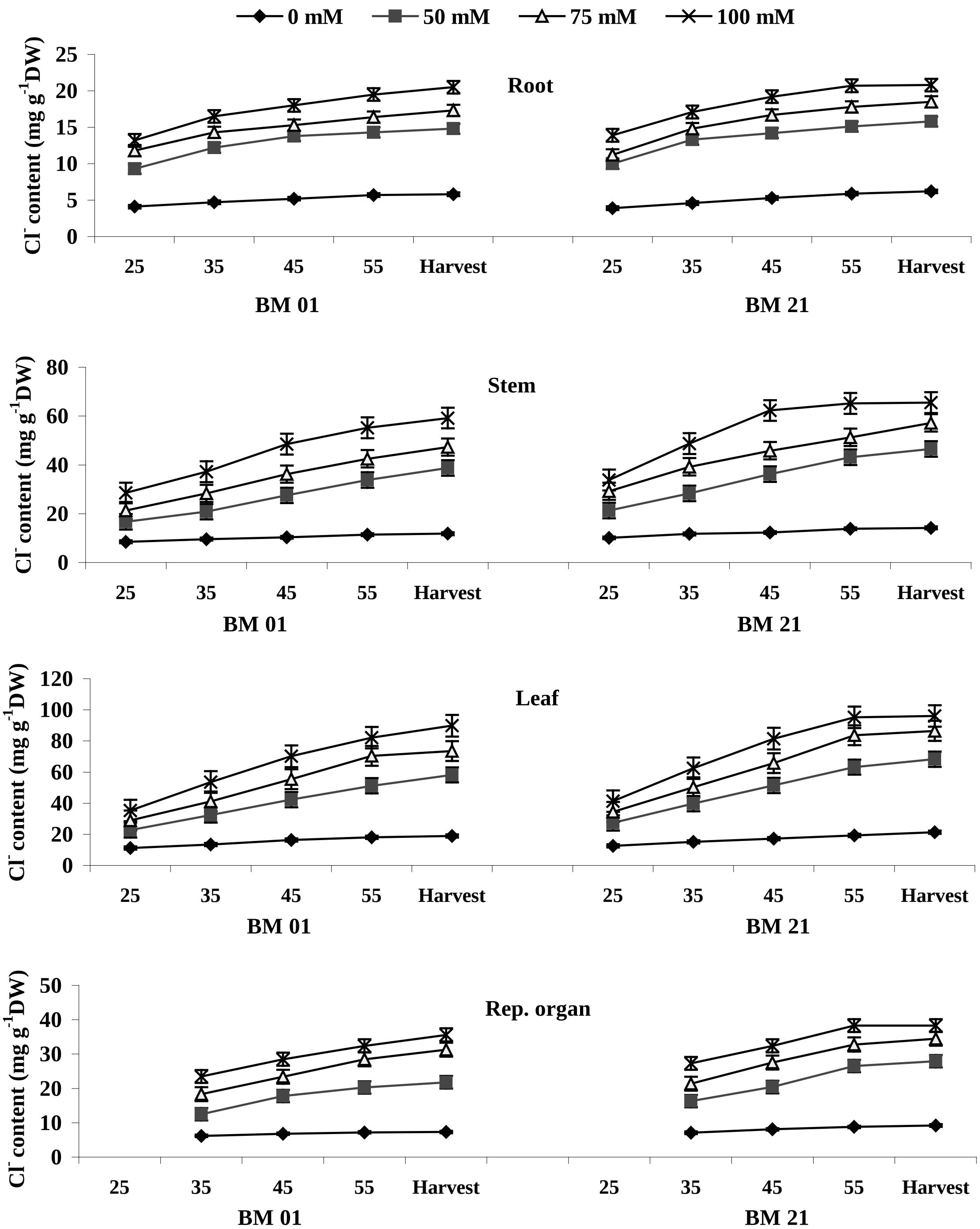

Fig. 3. Cloride ion content in different plant parts of BM 01 and BM 21 as affected by NaCl salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

WATER RELATIONS OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

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Abstract

The mechanism of salt tolerance in relation to water relations was studied in two mungbean genotypes at 0, 50 and 100 mM NaCl solutuons. At the high salt concerntration all the leaves of BM 21 showed consequently higher reduction in relative water content (RWC) (% of the control) that those of BM 01. Water saturation deficit (WSD) showed an inverse trend of RWC. BM 01 showed a little higher absolute water uptake capacity (WUC) than BM 21, the relative increase in WUC (% to the control) was greater in BM 21 than in BM 01. The exudation rate in salt treated BM 21 plants was much lower that that in BM 01. Higher exudation rates in BM 01 than BM 21 disclosed that BM 01 plants could absord more water than BM 21 under saline condition. The salt tolerance in BM 01 was associated with better water relations than that of BM 21.

Key words: *Physiological mechanisms, salt tolerance, mungbean, RWC, WRC, WUC and WSD*

Introduction

On a global scale, nearly 40% of the earth's surface is potenmtially endangered by salinity propblems (Orcutt and Nilsen 2000). Salinity affects two important plant processess; water relations and ionic balance. During initial exposure to salinity, plants experience water stress, which in turn reduces leaf expansion. During long-term exposure to salinity, a plant experiences ionic stress, which can lead to premature senescence of adult leaves, and thus a reduction in the photosynthetic area available to support continued growth (Yeo *et al.* 1985; Rawson *et al.* 1999). Better understanding of the mechanism that enables plant to adopt to salinity stress and maintain growth will ultimately help in the screening of stress-tolerant cultivars. In the previous experiment BM 01 was more salt tolerant than BM 21. The present study is part of an ongoing investigation of salt-tolerance mechanisms operation the water relations in two mungbean genotypes to clarify better the salt tolerance mechanism of BM 01 and BM 21 which differ in their salinity tolerance**.**

Materials and Methods

Mungbean seeds of two genotypes, BM 01 (tolerant one) and BM 21 (susceptible one), were sown in earthen pots in the vinylhouse at the Environmental Stress Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Each pot was filled with 12 kg air-dried soil. Compost (1/4th of the soil volume) and 0.27 – 0.28 – 0.20 g urea, TSP and MP per pot were incorporated uniformly into the soil. The pots were irrigated with tap water until the seedlings were well established. After seedling establishment tap water in control group and 12.5 mM NaCl solution were applied in salt-treated groups up to three days and 25 mM for the next three days for hardening of seedlings before applying actual treatments. When the trifoliate appeared i.e. ten days after emergence (DAE) required amount of respective salt solutions (50 and 100 mM) were applied in 25 pots per treatments. The salt solutions were applied till harvest before flower initiation.

Turgid weight was measured by cutting the leaf and immediately plased in a tray of dionized water. The tray was kept under the lights (about 1000 Lux) and at the constant tempature (at 25^0

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C) condotions. At 24 hours after floating leaf sample was transferred from tray to filter paper. Water from leaf surface was removed by pressing slightly with filter paper and immediately weighed the leaf samples.

Plant water status was measured using the following formula:

$$\text{Relative water content (RWC\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Turgid weight} - \text{Dry weight}} \times 100$$

$$\text{Water Satutation deficit} = 100 - \text{RWC}$$

$$\text{Water uptake capacity (WUC)} = \frac{\text{Turgid weight} - \text{Fresh weight}}{\text{Dry weight}}$$

$$\text{Water retention capacity (WRC)} = \frac{\text{Turgid weight}}{\text{Dry weight}}$$

Exudation rate was measured at 5 cm above from the stem base. At first dry cotton was weighed. A slanting cut on stem was made with a sharp knife. Then the weighed cotton was placed on the cut surface. The exudation of sap was collected from the stem for 1h at normal temperature. The final weight of the cotton with sap was taken. The exudation rate was calculated by deducting cotton weight from the sap containing cotton weight and expressed per hour basis as follows:

$$\text{Exudation rate} = \frac{(\text{Weight of cotton} + \text{sap}) - (\text{Weight of cotton})}{\text{Time (h)}}$$

Results and Discussion

Relative Water Content

The relative water content (RWC) of leaf signifies the water contents of plants. Salt stress decreased the RWC significantly (P=0.05). RWC was greater in plants grown at control condition than the plants at the stress (Fig. 1). The leaf of BM 01 and BM 21 showed identical RWC at the control condition. However, at the high salt concentration all the leaves of BM 21 showed consequently higher reduction in RWC (% of the control) than those of BM 01. Particularly L4 to L7 of BM 21 showed remarkable reduction in RWC compared to those of BM 01. Salinity decreased RWC was reported by Nandwal *et al.* (2000); Faruquei (2002) and Kabir (2002) in mungbean and Islam (2001) in mungbean and blackgram. It is well known that salinity decreases water potential of salt solution and plant cannot uptake water freely, and consequently RWC decreased (Orcutt and Nilsen 2000). White *et al*. (1993) reported that under severe stress condition plant cells accumulate metabolites and make the ostmotic potential of the cells more negative to maintain turgor pressure. The osmotic potential may be regulated through shifts in concentrations of potassium, sugars, amino acids, organic acids etc. across the tonoplast. This mechanism is considered to be an important adaptation of plants to stress condition. In the present study BM 21 was found to suffer more from water stress than BM 01. The better water relation in BM 01 under saline condition obviously contributed for maintenance of higher plant growth in the genotype than in BM 21.

Water Saturation Deficit

Water saturation deficit (WSD) showed an inverse trend of RWC. WSD indicates the degree of water deficit in plants. Salinity increased the WSD in both the genotypes (Fig. 1) compared to that of control. Similar results were also observed by Islam (2001) and Kabir (2002). The salt treated plants of BM 21 showed higher relative WSD (% of the control) than those in BM 01. These findings reveal that BM 21 suffered more from water deficit especially at high salt concentration than BM 01 (Greenway *et al.* 1983, Orcutt and Nilsen 2000).

Water Retention Capacity

The turgid weight: dry weight ratio illustrates the water retention capacity (WRC) of plants that are determined by the cell structures. Salt stress decreased the WRC significantly and the reduction was great at the highest level of salinity (100 mM NaCl) (Fig. 2). The relative reduction in WRC of BM 21 was much higher than that of BM 01. The higher reduction in WRC (% to the control) in BM 21 than in BM 01 indicates a greater damage in cell structure due to salinity in the former crop than the later (Sangakkara *et al*. 1996; Islam 2001; Kabir 2002).

Water Uptake Capacity

The water uptake capacity (WUC) quantifies the capacity of plants to absorb water per unit dry weight in relation to turgid weight. A higher WUC indicates a plant is subjected to a greater degree of moisture stress, as the plant would absorb a greater quantity of water to reach turgid weight (Sangakkara *et al.* 1996). Salinity resulted in an increase in WUC compared to that of control in both BM 01 and BM 21. (Fig. 2). Although BM 01 showed a little higher absolute WUC than BM 21, the relative increase in WUC (% to the control) was greater in BM 21 than in BM 01. This trend was also observed in other parameters such as RWC, WSD and WRC. As BM 21 suffered more from water stress, the plant had to uptake relatively more amount of water to reach turgidity than that by BM 01 (Sangakkara *et al.* 1996; Islam 2001).

Exudation rate

Flow of sap from the cut end of stem against the gravitational force is known as root exudation. Under normal condition root exudation rate is higher than that under salt stress or under any kind of stress conditions. Root exudation can thus be used as an indicator to measure the severity of stress. Salinity decreased drastically the root exudation rate of both BM 01 and BM 21 (Fig. 3). Islam (2001) also observed reduction in root exudation rates due to salinity in blackgram and mungbean and Faruquei (2002) and Kabir (2002) in mungbean. Decreased exudation rate means lower water uptake by plant. The exudation rate in salt treated BM 21 plants was much lower than that in BM 01 at both 50 and 100 mM NaCl levels. Compared to control plants, exudation rates in BM 01 plant treated with 50 and 100 mM NaCl were 45 and 15% and those in BM 21 were only 7 and 2% respectively. Exudation rate is directly associated with the flow of transpiration stream. Higher exudation rate means a plant can absorb more water from the soil solution than a plant with lower exudation rate. Therefor, higher exudation rates in BM 01 than BM 21 disclosed that BM 01 plants could absorb more water than BM 21 under saline condition (Sangakkara *et al.* 1996; Islam 2001; Faruquei 2002). Thus, it is concluded that salt tolerance in BM 01 was associated with better water relations than that of BM 21.

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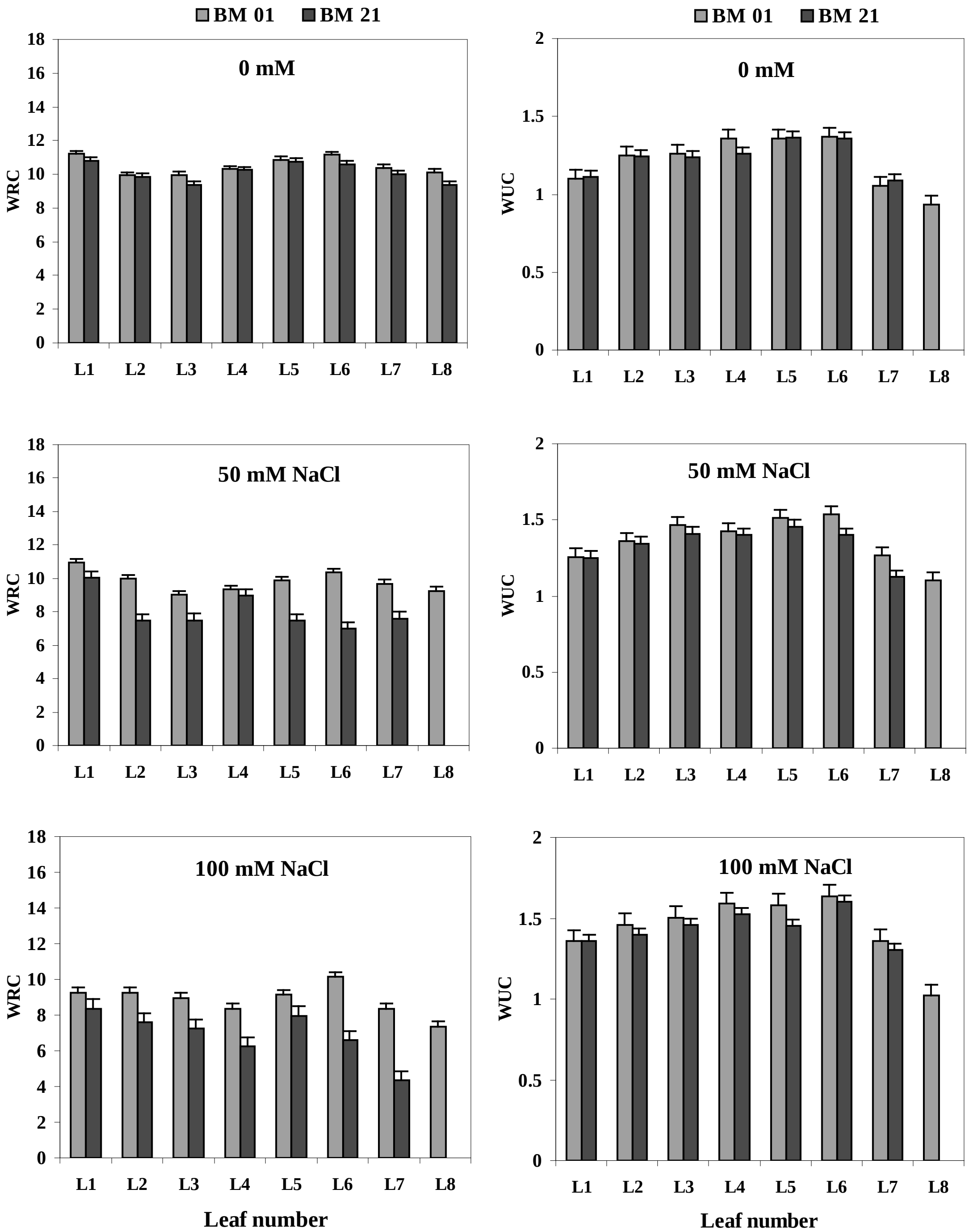
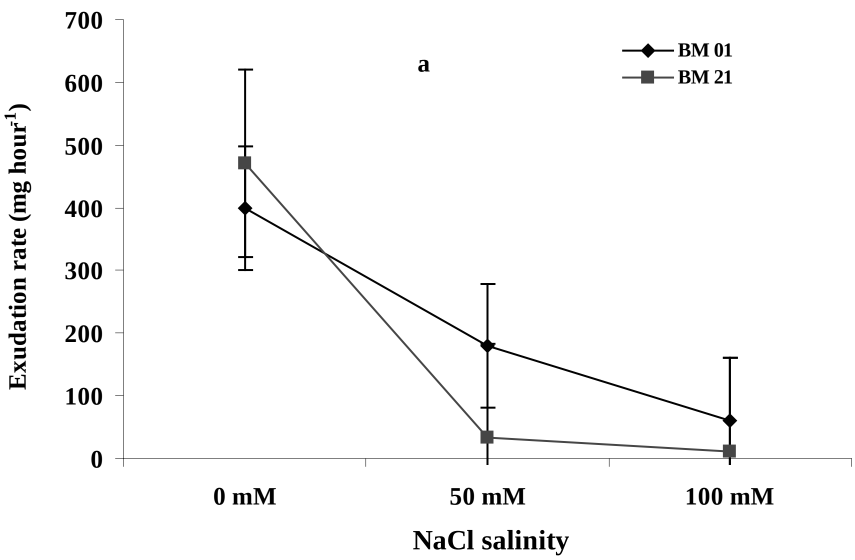


Fig. 2. Water retention capacity and water uptake capacity of individual leaf of BM 01 and BM 21 as affected by salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown



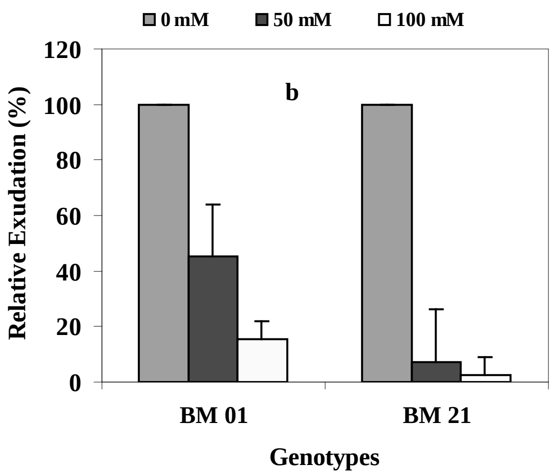


Fig. 3. Exudation rate (a) and relative exudation rate (b) of BM 01 and BM 21 as affected by salinity. Error bars represent standard error. Error bars
fit within the plot symbol if not shown

LEAF GROWTH AND GAS EXCHANGE CHARACTERISTICS AT DIFFERENT PHOTON FLUX DENSITY OF TWO MUNGBEAN GENOTYPES DIFFERING IN SALT TOLERANCE

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Abstract

The salt tolerance of two mungbean genotypes in response to leaf growth and gas exchange characteristics was evaluated at different photon flux density. Salinity reduced the growth of leaves in both genotypes and the reduction was higher in BM 21 than that in BM 01. The differences in photosynthesis (Pn) between the control and salt affected plants became wider with the increase in photon flux density (PFD) in both the genotypes but the differences were higher in BM 21 than that of BM 01. The increase in soil salinity significantly decreased the stomatal conductnce (g_s) of leaves but salt treated plants of BM 01 showed higher g_s than that of BM 21. Salinity increased the intercellular CO_2 concentration (C_i) in both the genotypes. The differences in the C_i between the control and salt stressed plants of BM 21 were sharpened at and above PFDs of 200 μmol m^{-2} s^{-1}. As BM 01 showed high tolerance, a comprehensive breeding programme should be of value for the improvement of salt tolerance of existing released mungbean variety, which has an increasing demand in the coastal area.

Key words: *Salt tolerance, mungbean, leaf growth, gas exchange characters*

Introduction

Soil salinity is one of the most important natural factors leading to severe crop losses every year. Salt can reduce plant growth by changes in dry matter allocation, ionrelation, water status and other biochemical and physiological processes or by a combination of such factors (Greenway and Munns 1980). This reduction of growth is often accompanied by alterations of gas exchange (Yeo *et al*. 1985; Rawson *et al*. 1988). At low or moderate soil salinity, decreased growth is primarily associated with a reduction in photosynthetic area rather than a reduction in photosynthesis per unit leaf area (Munns 1993). At high salinity, however, leaf photosynthesis can be reduced by lowered stomatal conductance, reduced carboxylase activity, limited tissue CO_2 availability and inhibition of light reaction mechanism (Brugnoli and Lauteri 1991; Munns 1993). In addition, the transport of photosynthates in the phloem may be inhibited (Iyengar and Reddy 1994). Thus, the amount of photosynthates reaching the growing region may be decreased. It is possible that the salt tolerant and salt susceptible cultivars proces different physiological adaptation to salinity stress (Khan *et al*. 1997). In this report we present the effect of salinity on growth and photosynthetic activity of two mungbean genotypes differing in salinity tolerance. This study was initiated following our previous experiment with the same genotypes (Aziz 2005).

Materials and Methods

The experiment was conducted at the Environmental Stress Research site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during Kharif season of 2004. Two mungbean genotypes, BM 01 (tolerant one) and BM 21 (susceptible one), were sown in earthen pots in the vinylhouse. Each pot was filled with 12 kg air-dried soil. Compost ($^1/_4$th of the soil volume) and 0.27-0.28-0.20 g Urea, TSP and MP per pot were incorporated uniformly into the soil. The pots were irrigated with tap water until the seedlings were well established. After

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seedling establishment tap water in control group and 12.5 mM NaCl solution were applied in salt-treated groups up to three days and 25 mM for the next three days for hardening of seedlings before applying actual treatments. When the trifoliate appeared i.e. ten days after emergence (DAE) required amount of respective salt solutions (50 and 100 mM) were applied in 25 pots per treatments. The salt solutions were applied till harvest.

Leaf growth rate and leaf area was measured with a portable leaf area meter (Model AAM-7, Hayashi Dehnco Co. Ltd. Tokyo, Japan). Specific leaf area (SLA) for individual leaf was calculated as the dry weight per unit leaf area (Leidi and Saiz 1997). Photosynthetic rate (Pn), stomatal conductance (g_5) and intercellular CO_2 concentration (C_i) were measured using a portable photosynthesis system (LICOR-6200) assembled with an infra Red Gas Analyzer (IRGA) and data logger following the procedure described by Kubota and Hamid (1992). The sequences of photon flux density (PFD) in the photosynthetic measurements were: 0, 50, 100, 200, 500, 1000, 1500 and 2000 μ mol m^{-2} s^{-1}, on fully expanded 3rd trifoliate from the top of the canopy. Each measurement was replicated 3 times following a factorial CRD design. The light source was artificial halogen lamp (OSRAM, HQI-TS 150/NDL). For the dark measurements (O μ mol m^{-2} s^{-1}), the leaf chamber was covered with black cloth.

Results and Discussion

Leaf growth

Salinity reduced the growth of leaves in both genotypes (Fig. 1) and the reduction was higher in BM 21 than that in BM 01. The genotypes exhibited a striking difference in leaf appearance rate in response to salt stress. Leaf appearance rate of BM 01 was insensitive to salt stress, while that of BM 21 decreased due to salinity. Genotype BM 21 failed to produce 8th leaf under saline condition. Leaf area per plant was higher in BM 21 than in BM 01 at all the treatments but the reduction due to salinity was greater in BM 21 than that in BM 01. Green leaf area per plant was reduced by 43% and 56% over the control in BM 01 and BM 21 at 100 mM NaCl respectively. It indicated that leaves of BM 21 were more sensitive to salinity than those of BM 01. BM 01 had a higher SLA than genotype BM 21 except under control condition (Fig. 1). The reduction of SLA was 8 and 34% at 50 mM in BM 01 and BM 21, while it was 24 and 40% at 100 mM NaCl respectively. Leaf expansion was less inhibited in BM 01 as shown by higher SLA, leaf area and total leaf number at harvest. Leidi and Saiz (1997) found higher relative growth rate in genotypes with leaves of higher SLA (less carbon invested per unit of area) under saline condition. This seemed for the case of BM 01 under salt stress, as plants of this genotype showed expanding L6, L7 and L8. Genotype BM 21 showed a delay in the generation of the new leaves with only half of the plants reaching the 7th leaf stage. Munns (1993) concluded from his study that salinity led to increased leaf diffusive resistance, consequently a decrease in transpiration and increase in leaf temperature. The shift in temperature may play a vital role for tissue desiccation. In addition, increased ionic concentrations in the leaves further aggravated the leaf growth along with tissue dehydration (Leidi and Saiz 1997).

Photosynthesis

The photosynthetic CO_2 assimilation rate (Pn), in general, increased with the increasing photon flux density (PFD) in both the genotypes (Fig. 2). However, salt affected plants showed less Pn at all PFD levels. Similar response was observed by Islam (2001) in blackgram and mungbean, Masojidek *et al.* (1991) in sorghum and pearl millet and Masojidek and Hall (1992) in sorghum. BM 21 plants showed higher Pn than BM 01 at all PFD levels under control condition. The differences in Pn between the control and salt affected plants became wider with the increase in PFD in both the genotypes but the differences were higher in BM 21 than that of BM 01. Radiation saturation of Pn was not observed even at 2000 μmol m^{-2} s^{-1} PFD in BM 01 at any level of salinity. The control plants of BM 21 showed the similar trend, while the salt affected plants of BM 21 showed the saturation at lower PFD. The light compensation was also at lower PFD in BM 01 that that of BM 21. Compansation irradiance for Pn occurred between 0 and 50 μmol m^{-2} s^{-1} PFD in BM 01, while it was between 50 and 100 μmol m^{-2} s^{-1} in BM 21 at 100 mM NaCl, respectively. At both 50 and 100 mM NaCl BM 01 showed higher Pn than BM 21 at all PFD levels. At high NaCl concentration Pn in BM 01 reduced to 64, 46, 34, 32, 29 and 26% and that in BM 21 to 95, 78, 60, 55 and 53% at 100, 200, 500, 1000, 1500 and 2000 μmol and m^{-2} s^{-1} PFDs, respectively. There is lack of information on the photosynthetic light response of legumes under saline conditions. However, earlier reports indicate that salinity decreased Pn in glyeophytes. The decreased Pn under salt stress may be attributed partly to reduced somatal conductance (Nagy and Galiba, 1995, Lakshmi *et al.* 1996; Khan *et al.* 1997; Sultana *et al.* 1999; Islam 2001), lowered transportation of photosyntahte (Unger 1991; Hagemayer 1997), reduction in protein concentration (Sibole *et al.* 1998; Sultana *et al*. 1999), decline in photosynthetic pigment concentration (Kolcherskii *et al*. 1995; Sultana et al 1999), reduced carboxylase activity (Unger 1991, Hagemayer, 1997; Orcutt and Nilsen 2000), imbalance in ionic concentrations (Khan *et al*. 1997) and inhibition of the light reaction mechanism (Unger 1991). Yeo *et al* (1985) reported that the inhibition of net photosynthesis by salinity is mediated by water deficit in the leaf cells due to accumulation of salt in the apoplast. It was also reported that low Pn under salt stress was associated with a low demand for photosynthates in the sink (Karim *et al.* 1993; Sultana *et al*. 1999). The less reduction in Pn of BM 01 at high salt concentration than BM 21 mungbean genotype was obviously helpful to maintain better growth in the former genotype than the later one (Seemann and Critchley 1985; He and Cramer 1996; Hagemayer 1997).

Stomatal conductnce

Stomatal conductnce (g_s) indicated the degree of exchange of CO_2 and water vapor between ambient and inner leaf. It is calculated from the transpiration rate and difference in vapor pressure between air and leaf. The increase in soil salinity significantly decreased the g_s of leaves, in both BM 01 and BM 21 (Fig. 2). Salinity induced decrease in g_s was also found in cotton and bean (Brugnoli and Lauter 1991), in triticale (Karim *et al*. 1993), in bean (Sibole *et al.* 1998), in rice (Khan *et al*. 1997; Sultana *et al.* 1999) and in blackgra and mungbean (Islam 2001). The g_s also increased with the increasing PFD, irrespective of genotypes and salinity levels. Under control condition the g_s was higher in BM 21 than in BM 01. But salt treated plants of BM 01 showed higher g_s than that of BM 21 (Fig. 2). The higher reduction of g_s in BM 21 than in BM 01 due to salinity might be attributed to the lower leaf water potential and a reduction in relative leaf water content, which resulted in loss of turgor, consequently leads to reduced photosynthetic rate. This result agrees with the findings of Sibole *et al*. (1998), Sultana *et al.* (1999) and Islam (2001). The extent to which stomatal closure affects photosynthetic capacity is indicated by the magnitude of reduction in g_s (Farquhar and Sharkey 1982, Jones, 1985). In this study, g_s declined by up to 35 and 58% (average) at 100 mM NaCl in BM 01 and BM 21, respectively, and photosynthesis declined by up to 29 and 48%. So decline in Pn under salinity is attributed partly to reduced g_s (Nagy and Galiba 1995; Lakshmi *et al*. 1996).

Intercellular CO_2 concentration

Salinity increased the intercellular CO_2 concentration (C_i) in both the genotypes. The difference in the C_i between the control and NaCl treated plants was higher in BM 21 than in BM 01 (Fig. 2).

The C_i, however, decreased with the increasing PFD irrespective of levels of salinity. The differences in the C_i between the control and salt stressed plants of BM 21 was sharpened at and above PFDs of 200 µmol m^{-2} s^{-1}. Salinity inhibits the activity of photosynthetic enzymes such as RubisCo that results in the increasing accumulation of C_i (Seemann and Critchley 1985; Jones 1985).

In conclusion the results of the study indicaed that BM 01 is more salt tolerant than the other genotypes. The leaf growth reduction of BM 21 as associated with salt stress is likely to be a consequence of a number of differing effects of salt on plant processes, including effects on photosynthetic performance. As BM 01 ingeneral showed high tolerance, a comprehensive breeding programme should be of value for the improvement of salt tolerance of existing released mungbean variety which has an increasing demand in the coastal area.

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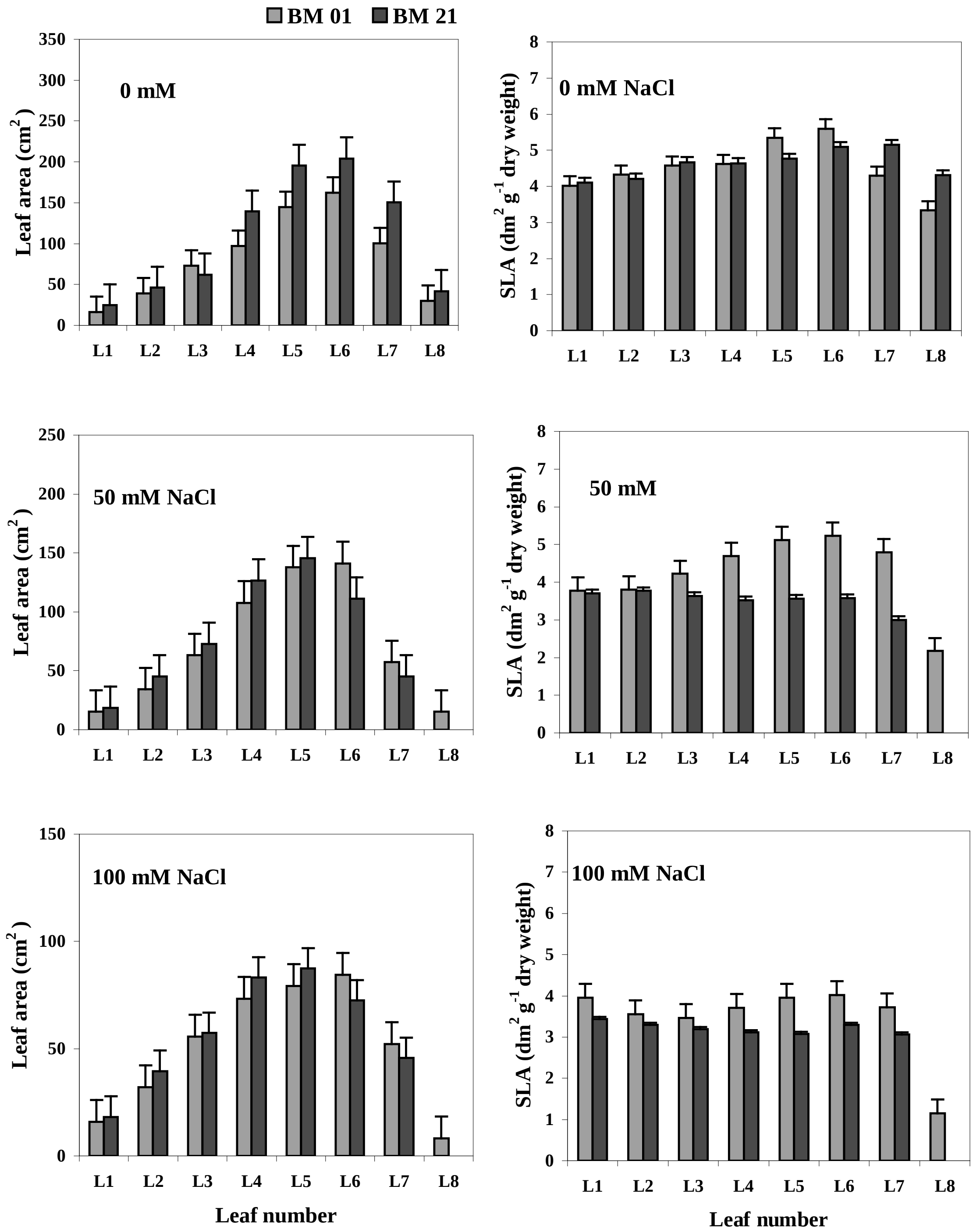

Fig.1. Leaf area and specific leaf area of individual leaf of BM 01 an BM 21 as affected by salinity. Error bars represent standard error. Error bars fit within the plot symbol if not shown

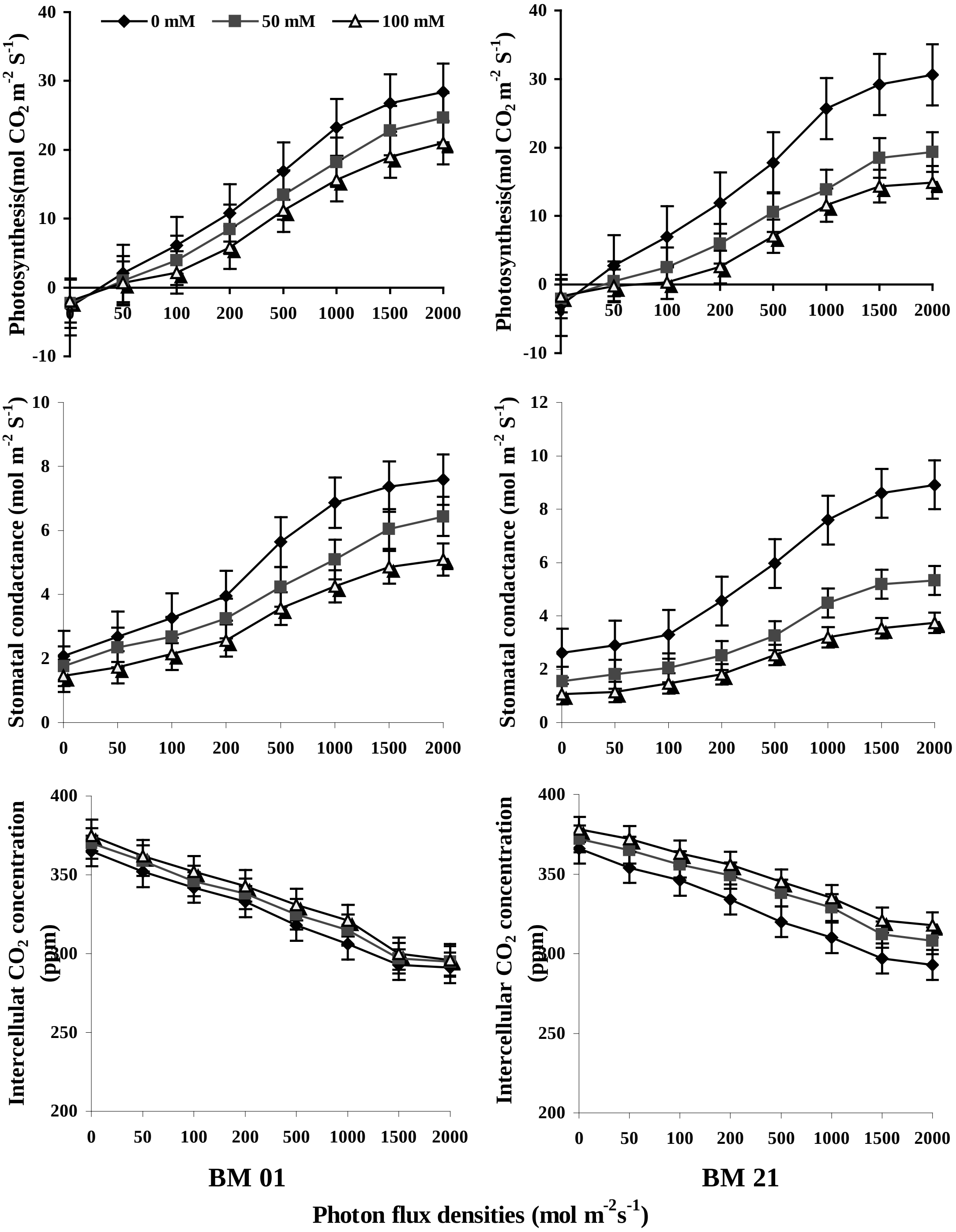

Fig.2. Photosynthetic activity of mungbean genotypes BM 01 and BM 21 as influenced by salinity. Error bars indicate standard errors. Error bars fit within the plot symbol if not shown

SCREENING OF SOYBEAN GENOTYPES FOR SALT TOLERANCE IN HYDROPONICS

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Abstract

Salt tolerance of 41 soybean genotypes was evaluated at the Banghabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur in a non-circulating hydroponic system with supplemented nutrients solution. The salinity levels of the solutions were 0, 100 and 150 mM NaCl. Leaf area was the most sensitive character to NaCl salinity, while plant height, root volume and leaf SPAD value were least affected. Similarly, shoot dry weight (32.30% to control) was more sensitive to salinity than the root dry weight (34.91%), especially at 150mM NaCl salinity. Seven genotypes were found salt tolerant which produced more than 80% shoot dry weight and 21 genotypes were moderately tolerant for their 60 to 80% relative shoot dry weight at 100mM NaCl salinity. None of the genotypes could produce more than 80% shoot dry weight at 150 mM NaCl salinity. Genotypes Galarsum, G00331, BD2342, G00041, Shohag, AGS313, G00028, BD2330, BD 2331, G00073, G00152, G00209 and PK 416 showed relatively lower salinity susceptibility index (SSI) than others and rated as salinity tolerant at the early stage of growth.

Introduction

Recently, soybean (*Glycine max* L.) has become an important crop in Bangladesh for its increasing demand as an ingredient of poultry and fish meal as well as for the consciousness of its healthy nutrition as human food. It is one of the most economic and nutritious crops in the world (Yaklich *et al*., 2002). The seeds of soybean contain 42-45% protein as well as 22% edible oil (Mondal *et al*., 2002).

Being the most populated country in the world, 1050 persons/ km^2, farmers of Bangladesh grow cereal crops for their food security in the good soils. Thus, non-cereals are mostly growing in the marginal lands including coastal land of the southern part (Mannan *et al.* 2012). Of the 2.85 million hectares of the coastal and off-shore areas, about 0.83 million hectares of the arable lands are affected by varying degrees of soil salinity (Karim *et.al.*, 1990). High levels of salts in the soil of the coastal region often cause serious limitations to crop production. Hence, most of the cultivable land remains fallow during winter. After summer rice, aman rice, soybean may be a potential crop to increase cropping intensity.

Soybean is classified as a moderately salt-tolerant crop and the final yield of soybean will be reduced when soil salinity exceeds 5 dS m^{-1} (Ashraf, 1994). Salt stress is one of the abiotic stresses that significantly reduce the yield of soybean. Genetic variation in salt tolerance is available in the soybean gene pool. The response of soybean to salinity stress depends both on genotypes and environmental conditions (Ghassemi-Golezani *et al*., 2009; Mannan, *et al*. 2013). The ultimate yield of a crop depends upon the interaction between its genetic makeup and environmental factors faced during its entire growing period (Humphreys, 1989; Ashraf, 1994).

Screening of salt tolerant genotypes from a vast number of collections under field condition is quite difficult. Besides, there can be large differences in salt level among field sites that are just a

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few feet apart or from the same site at different dates (Philip and Broadley, 2001; Rupe *et al*., 2000). It is also difficult to maintain accurate salinity levels in soil medium in different treatments. In hydroponics, it is easy to maintain the accuracy of salt in respective treatments. Thus, this study was aimed to find out the salt tolerant genotypes at the early stage of growth using hydroponics screening techniques.

Materials and Methods

The experiment was conducted in plastichouse of the Department of Agronomy of Banghabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh. Forty genotypes of soybean which were reported as salinity tolerant and moderately salinity tolerant (Mannan, 2009), and a newly released variety BARI soybean 6, a total of 41, were used for screening salt tolerance in a non-circulating hydroponic system. Seeds were washed several times in tap water for surface cleaning then sown on floating sponge (foam) in plastic buckets containing 4 liters tap water on February 28, 2010. The sponge size was 2.5 cm X 2.5 cm. Seeds were placed in the middle of the sponge blocks by cutting 1 cm depth. Three blocks were placed in a bucket where a part was opened for natural air connection. Two days after emergence of seedlings, half strength nutrient solution was added in all the buckets. Full strength nutrient solution consisted of 270 ppm KH_2PO_4, 580 ppm KNO_3, 1000 ppm $Ca(NO_3)_2$. 4 H_2O, 510 ppm $MgSO_4$. 7 H_2O, 80 ppm EDTA-Fe, 6.10 ppm $MnSO_4$. 4 H_2O, 1.8 ppm H_3BO_3, 0.40 ppm $CuSO_4$. 5 H_2O, 0.38 ppm $(NH_4)_6Mo_7O_{24}$. 4 H_2O and 0.44 ppm $ZnSO_4$. 7 H_2O. After 6 days of emergence, one fifth of the required salt was added in each bucket at 2 days intervals to reach respective salinity levels of 100 and 150 mM NaCl. After 14 days of emergence, salt concentration reached to 100 mM and 150 mM NaCl, equivalent to 10 and 15 dS/m, respectively. Three seedlings were allowed then to grow and nutrients solution was supplemented at full strength in each bucket. Tap water was used as control. Plants were subjected to these salinity levels for next 14 days. The experiment was arranged in two factors Completely Randomized Design (CRD) with 3 replications. The buckets were watered carefully to maintain the water levels 4 liters and salt was added if necessary to maintain the respective salinity levels. After 28 days of emergence, leaf SPAD (Soil Plant Analysis Development) values were measured with a portable chlorophyll meter (Minolta SPAD 502). Then, all the plants were removed carefully from the foam and washed with running water. Shoots, roots and leaves were separated and data on plant height, root volume, leaf number and green leaf area were recorded. Leaf area was measured by an automatic leaf area meter (Model. AAM-7). The plant parts were then oven dried in an oven at 70º C for 4 days to measure the dry weight. Data on growth parameters of each level of NaCl salinity treatment were compared with the respective control treatment.

The relative tolerance was calculated using the following formula:

Relative tolerance = (variable measured in salt treated plant)/ (variable measured in control plant) × 100.

All the genotypes were categorized into four different salinity tolerant groups based on their percent relative shoot dry weight (% RSDW) as follows: (i) salinity tolerant, when the RSDW was > 80%, (ii) moderately tolerant, as when the RSDW was within 60 - 80%, (iii) as moderately susceptible, when the RSDW was in the range of 40 - 60% and (iv) susceptible, when the RSDW was less than 40% (Ashraf and Waheed, 1990; Mannan, *et al*. 2012).

Salinity Susceptibility Index (SSI) for shoot, root and total dry weight of each genotype was calculated as follows: SSI = (1 – Yss / Yns) / SII, where Yss and Yns are mean dry weight of a given genotype in salinity stressed (ss) and non-stressed (ns) environment, respectively. SII (Salinity Intensity Index) = 1 – Xss/Xns, where Xss and Xns are the mean of all genotypes under salinity stressed (ss) and non-stressed environments (Fisher and Maurer, 1978). All statistical analysis were done using MSTAT-C program.

Results and Discussion

Maximum, minimum and mean values of different plant characters of 41 soybean genotypes grown under different levels of NaCl solutions at vegetative stage are presented in Table 1. All the characters were sharply decreased by the salinity. The plant height ranged from 19.33 to 74.33 cm with a mean of 39.52 cm in the control plants. However, at 100 mM NaCl salinity the height ranged from 18.33 to 68.33 with a mean of 32.74 cm and that at 150 mM NaCl from 0 to 46.67 cm with a mean of 22.15 cm. Number of leaves per plant ranged from 3.67 to 8 with a mean of 5.18 in the control plants. At 100 mM NaCl salinity, the values reduced from 1.33 to 5.67 with a mean of 3.59 and at 150 mM NaCl that from 0 to 4.33 with a mean of 1.88. Similarly, leaf area per plant varied from 162.32 to 546.62 cm^2 with a mean of 354.01 cm^2 in control, though the ranges were from 46.32 to 312.52 cm^2 with a mean of 207.97 cm^2 and from 0 to 258.68 cm^2 with a mean of 89.32 cm^2 at 100 mM NaCl and 150 mM NaCl, respectively. Salinity reduced leaf dry weight also substantially. The leaf dry weight per plant ranged from 0.31 to 1.24 g with a mean of 0.79g in the control, which was from 0.05 to 0.78 g with a mean of 0.47 g and from 0 to 0.44 g with a mean of 0.19 g at 100 mM and 150 mM NaCl salinity, respectively. Leaf SPAD values ranged from 23.10 to 36.30 with a mean of 28.60 in the control treatment, though at 100 mM NaCl salinity the value ranged from 14.40 to 30.20 with a mean of 22.52 and at the 150 mM NaCl salinity the SPAD ranged from 0 to 25.60 with a mean of 13.61. Root volume per plant varied from 2.13 to 3.67 cm^3 with a mean of 2.89 cm^3 in the control treatment, though at 100 mM NaCl salinity that reduced from 1.20 to 3.33 cm^3 with a mean of 2.20 cm^3 and at 150 mM NaCl salinity that from 0 to 2.20 cm^2 with a mean of 1.21 cm^3. The range of shoot dry weight per plant varied from 0.73 to 2.79 g with a mean of 1.72 g in control. At the 100 mM NaCl salinity the weight varied from 0.39 to 1.66 g with a mean of 1.11 g and that at 150 mM NaCl salinity ranged from 0 to 1.10 g with a mean of 0.56 g. The root dry weight per plant varied between 0.21 to 0.69 g with a mean of 0.37 g in control, though at 100 mM NaCl salinity it ranged from 0.11 to 0.36 g with a mean of 0.23 g and at 150 mM NaCl salinity from 0 to 0.25 g with a mean of 0.12 g. The total dry weight per plant varied from 1.02 to 3.42 g with a mean of 2.09 g in the control treatment. However, the weight ranged from 0.55 to 1.98 g with a mean of 1.34 at 100 mM NaCl salinity and it ranged from 0 to 1.31 g with a mean of 0.68 g at 150 mM NaCl salinity.

The results of quantitative characters indicated that there were wide variations in salinity tolerance among the 41 soybean genotypes. The plant characters also varied between the genotypes within each salinity treatment including the control. The deleterious effects of salinity on plant characters were also reported earlier in many crop species e.g., in mungbean (Raptan *et al*., 2001a; Aziz *et al*., 2005; Sultana *et al*., 2009), in barley (Karim *et al*., 1993), in rice (Khan *et al*., 1997), in soybean (Mannan, 2009; Karim *et al.*, 2012; Mannan, *et al.*, 2012; Mannan, *et al.*, 2013), in papper (Chookhampaeng, 2011), in sugerbeet (Jamil *et al*., 2007). The reduction in the growth of soybean plants subjected to salt stress may be due to an increased uptake of toxic sodium. The NaCl is readily dissolved in water solvent yielded toxic Na^+ that is easily absorbed into root tissues and transport throughout plant organs, leading to toxic ion damage, osmotic stress and nutritional imbalance (Cha-um *et al*., 2007; Siringam *et al*., 2009) resulting retardation in vegetative growth.

Average over the genotypes, the relative plant height, root volume and leaf SPAD value of the control values were 89.94%, 75.95% and 79.46% at 100 mM NaCl salinity, while those were 57.51%, 41.89% and 48.45% at 150 mM NaCl salinity, respectively (Fig. 1). Similarly, the relative number of leaves, leaf area and leaf weight were 70.17%, 59.19% and 60.12% at 100 mM NaCl salinity, while those were 36.94%, 25.53% and 26.11% at 150 mM NaCl salinity, respectively (Fig. 2). The reduction in leaf dry weight due to salinity was reported by Karim *et al*. (1993) in triticale, Khan *et al*. (1997) in rice, Aziz *et al.* (2005) in mungbean and Mannan, *et al.* (2013) in soybean. The reduction in leaf weight was mainly due to decreased in leaf area. Under salt stress condition, cell expansion of leaf is reduced due to low turgor that resulted in decreased leaf dry weight. Greenway and Munns (1980) reported that the effect of salinity on leaf area was greater than on dry weight, as salt concentration in the shoot occurs via transpiration stream, which may kill the old leaves.

The mean value of number of shoot, root and total dry weight (absolute and relative) of different soybean genotypes as affected by salinity are presented in Table 2. Shoot dry weight decreased drastically with the increasing salinity levels. The relative shoot dry weight per plant ranged from 24.48 to 91.00 % with a mean of 64.85 % at 100 mM NaCl salinity and ranged from 0 to 62.00 % with a mean of 32.30 % at 150 mM NaCl salinity. The reduction in shoot dry weight was about 35 and 68 % at 100 and 150 mM NaCl salinity, respectively. At 100 mM NaCl salinity BD2342 (91.00%) produced significantly the highest shoot dry weight. However, Galarsum (77.35%), BD2342 (91.00%), G00041 (88.04%), Shohag (86.23%), G00348 (76.37%), AGS313 (81.03), BD2330 (81.96%), BD2331 (87.36%), AGS 95 (77.52%), G00073 (76.94%), G00209 (78.67%) and G00111(77.73%) genotypes reduced less than 25% shoot dry weight as compared to control and showed relatively high tolerance. Shoot dry weight sharply decreased at 150 mM NaCl salinity though Shohag (52.10%), G00348 (62.00%), G00028 (61.54%), AGS 275 (59.96%) and G00221 (55.81%) showed relatively high tolerance as compared to control.

Root dry weight decreased with the increasing salinity levels. The relative root dry weight per plant ranged from 33.33 to 98.92% with a mean of 63.81 % at 100 mM NaCl salinity and ranged from 0 to 86.11 % with a mean of 34.91 % at 150 mM NaCl salinity. The reduction in root dry weight was about 36 and 65 % in 100 and 150 mM NaCl salinity, respectively. At 100 mM NaCl salinity significantly highest root dry weight recorded in G00041. However, root dry weight of G00331 (75.93%), G00041 (98.92%), Shohag (82.41%), AGS 313 (98.19%), G00028 (75.42%), G00154 (76.58%), BD2343 ((84.82%), ST 2 (82.08%), G00209 (88.89%), G00221 (77.22%) and PK 416 (85.59%) genotypes reduced less than 25% as compared to control and thus showed relatively high tolerance. At 150 mM NaCl salinity, G00331 (51.85%), BD2342 (63.04%), Shohag (62.96%), G00348 (50.56%), AGS 313 (55.86%), G00028 (62.71%), AGS 275 (52.00%), BD2330 (55.77%), G00336 (56.00%), G00221 (67.09%) and PK 416 (54.95%) showed relatively high salinity tolerance as compared to the control. The reduction in root and shoot dry weight due to salinity was reported by Karim *et al*. (1993) in triticale, Khan *et al*. (1997) in rice, Aziz *et al*. (2005) in mungbean, Waheed *et al.* (2006) in pigeonpea, Jamil *et al*. (2007) in sugarbeet, Sultana *et al*. (2009) in mungbean, Chookhampaeng (2011) in pepper plant and Karim, *et al.* (2012). Under salt stress condition, cell expansion is reduced due to low turgor, as well as excess accumulation sodium ion damaged cell membrane and organelles, resulting in plant growth reduction (Karim, *et al*. 2012).

The total dry matter of all the genotypes of soybean decreased as the NaCl salinity levels increased. The relative total dry weight per plant ranged from 30.35 to 89.65 % with a mean of 64.59 % in 100 mM NaCl salinity and from 0 to 61.76 % with a mean of 32.68 % in 150 mM

NaCl salinity. The reduction in total dry weight was about 35 and 67 % in 100 and 150 mM NaCl salinity, respectively. However, genotypes were varied in their total dry matter production under different salinity levels as compared to control. At 100 mM NaCl salinity, significantly the highest total dry matter recorded in G00041. However, the maximum dry matter as compared to control was obtained from the genotypes Galarsum (76.54%), BD2342 (87.95%), G00041 (89.65%), Shohag (85.55%), AGS 313 (83.85%), G00028 (84.32%), BD2330 (79.15%), BD2331 (82.96%), AGS 95 (75.75%), G00073 (76.58%), G00209 (80.37%) and PK 416 (75.06%). At 150 mM NaCl salinity, total dry weight of all the genotypes drastically reduced. However, the soybean genotypes Shohag (54.02%), G00348 (60.36%), G00028 (61.76%), AGS 275 (58.72%) and G00221 (57.40%) showed relatively high tolerance as compared to control. Reduction in total dry matter due to salinity was also reported by Raptan *et al.* (2001) and Egeh and Zamora (1992).

Shoot dry weight (32.30% to control) was found more sensitive to salinity than the root dry weight (34.91% to control), especially at 150mM NaCl salinity. Karim *et al.* (1992) suggested that shoot growth is one of the most important characters for screening against salt tolerance in plants at early stage of growth. Therefore, all the genotypes were categorized in different groups based on relative shoot dry weight (RSDW) grown under different salinity levels. Out of 41 genotypes, 7 genotypes categorized as tolerant which produced more the 80% RSDW and 21 genotypes as moderately tolerant that produced 60-80% RSDW at 100 mM NaCl salinity (Table 3). The genotypes BD 2342, G00041, Shohag, AGS 313, G00028, BD2330 and BD2331 had more than 80% RSDW. But in moderately tolerance genotypes Galarsum, G00331, G00343, BARI soybean 5, G00348, AGS275, G00138, AGS95, G00154, BD2343, BARI soybean 6, G00073, ST2, G00062, G00152, G00209, G00221, PK327, AGS399, PK416 and G00111 had RSDW in between 60 to 80%. Out of 41 genotypes, only 2 categorized as moderately tolerant but none of the genotypes produced more than 80% RSDW at 150 mM NaCl salinity. The moderately tolerance was found in genotypes G000348 and G00028 had RSDW in between 60 to 80%.

Salinity Susceptibility Index (SSI) of soybean genotypes under different levels of salinity is presented in Table 4. At 100 mM NaCl salinity SSI of shoot, root and total dry matter ranged between 0.26 to 2.16, 0.03 to 1.75 and 0.33 to 1.93, respectively. At 150 mM NaCl salinity the SSI of shoot, root and total dry matter ranged in between 0.57 to 1.49, 0.54 to 1.47 and 0.57 to 1.49, respectively. At all the levels of NaCl salinity, SSI of shoot, root and total dry matter was obtained lower in genotypes Galarsum, G00331, BD2342, G00041, Shohag, AGS313, G00028, BD2330, G00073, G00152, G00209 and PK 416 as compared to other genotypes.

Conclusion

In conclusion the results of this study indicated that variation in salt tolerance among soybean genotypes was obvious at the vegetative stage of growth. Among the different plant characters plant height, root volume, leaf SPAD value were lesser affected than leaf number, leaf area and leaf weight by NaCl salinity. In leaf characters, the area was more sensitive to salinity than others. Shoot dry weight was more sensitive than root at higher levels of NaCl (150mM) salinity. Based on percent relative shoot dry weight (RSDW), 7 genotypes were found tolerant and 21 genotypes were found moderately tolerant at 100mM NaCl salinity, but none of the genotypes were tolerant at 150 mM NaCl salinity.

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Table 1. Range and mean values of different quantitative characters of 41 soybean genotypes grown at different NaCl salinity levels

Plant characters	Control		100mM NaCl		150mM NaCl	
	Range	Mean	Range	Mean	Range	Mean
Plant height (cm)	19.33 – 74.33	39.52 ± 10.29	18.33 – 68.33	32.74 ± 9.39	0 – 46.67	22.15 ± 10.09
Leaf number ($plant^{-1}$)	3.67 – 8.00	5.18 ± 0.84	1.33 – 5.67	3.59 ± 0.89	0 – 4.33	1.88 ± 1.21
Leaf area (cm^2 $plant^{-1}$)	162.32 – 546.62	354.01 ± 94.88	46.32 – 312.52	207.97 ± 69.13	0 – 258.68	89.32 ± 60.23
Leaf dry weight (mg $plant^{-1}$)	0.31 – 1.24	0.79 ± 0.24	0.05 – 0.78	0.47 ± 0.17	0 – 0.44	0.19 ± 0.13
SPAD value	23.10 – 36.30	28.60 ± 3.01	14.40 – 30.20	22.52 ± 3.64	0 – 25.60	13.61 ± 8.24
Root volume (cc $plant^{-1}$)	2.13 – 3.67	2.89 ± 0.34	1.20 – 3.33	2.20 ± 0.51	0 – 2.20	1.21 ± 0.67
Shoot dry weight (g $plant^{-1}$)	0.73 -2.79	1.72 ± 0.36	0.39 - 1.66	1.11 ± 0.34	0 - 1.10	0.56 ± 0.32
Root dry weight (g $plant^{-1}$)	0.21 - 0.69	0.37 ± 0.09	0.11 - 0.36	0.23 ± 0.06	0 - 0.25	0.12 ± 0.06
Total dry weight (g $plant^{-1}$)	1.02 - 3.42	2.09 ± 0.43	0.55 - 1.98	1.34 ± 0.39	0 - 1.31	0.68 ± 0.38

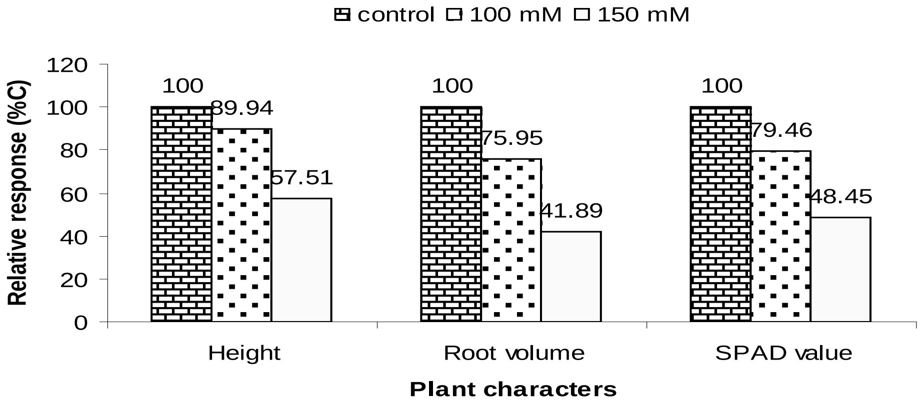

Fig. 1. Relative plant height, root volume and leaf SPAD value of soybean genotypes at different levels of salinity.

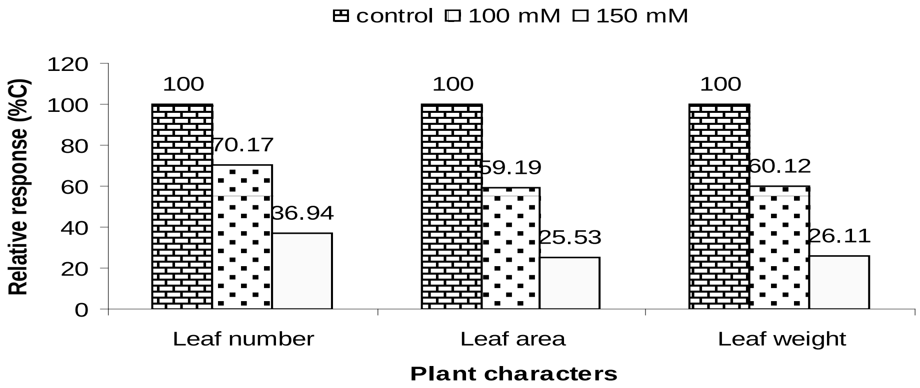

Fig. 2. Relative leaf number, area and weight of soybean genotypes at different levels of salinity.

Table 2. Relative dry matter production (% to control) of soybean genotypes at different levels of NaCl salinity

Genotypes	Shoot			Root			Total		
	C	100mM	150mM	C	100mM	150mM	C	100mM	150mM
Galarsum	1.74	77.35	33.59	0.32	72.16	37.11	2.06	76.54	34.14
G 00331	1.98	66.67	45.12	0.36	75.93	51.85	2.34	68.09	46.15
BD 2342	1.63	91.00	47.03	0.31	71.74	63.04	1.94	87.95	49.57
G 00041	1.78	88.04	40.37	0.31	98.92	49.46	2.09	89.65	41.72
G 00343	1.54	68.40	35.06	0.30	60.44	37.36	1.84	67.09	35.44
G 00197	2.08	38.84	6.58	0.52	38.06	9.68	2.59	38.69	7.20
BARI S.5	1.61	74.95	18.43	0.36	62.62	12.15	1.97	72.71	17.29
Shohag	1.67	86.23	52.10	0.36	82.41	62.96	2.03	85.55	54.02
G 00362	2.38	53.58	23.84	0.43	47.29	27.13	2.81	52.61	24.35
G 00348	1.76	76.37	62.00	0.30	59.55	50.56	2.06	73.95	60.36
AGS 313	1.88	81.03	45.92	0.37	98.19	55.86	2.25	83.85	47.56
G 00028	1.69	86.39	61.54	0.39	75.42	62.71	2.08	84.32	61.76
G 00283	2.79	53.17	33.33	0.63	43.92	28.57	3.42	51.46	32.46
AGS 275	1.81	73.25	59.96	0.33	59.00	52.00	2.14	71.03	58.72
BD 2330	1.94	81.96	46.39	0.35	63.46	55.77	2.29	79.15	47.81
MTD 459	1.74	30.90	25.53	0.36	43.52	34.26	2.10	33.07	27.03
G 00138	2.28	65.84	48.32	0.51	60.53	41.45	2.79	64.87	47.07
BD 2331	1.50	87.36	47.23	0.41	66.94	22.58	1.92	82.96	41.91
AGS 95	1.56	77.52	26.12	0.33	67.35	27.55	1.88	75.75	26.37
G 00307	2.37	51.90	6.47	0.69	33.33	6.28	3.06	47.71	6.43
G 00032	1.65	41.82	12.12	0.53	54.72	15.09	2.18	44.95	12.84
G 00053	1.59	24.48	0.00	0.38	54.78	0.00	1.98	30.35	0.00
BD 2340	1.96	43.63	25.30	0.40	38.84	32.23	2.37	42.82	26.48
G 00154	1.86	66.25	8.80	0.37	76.58	9.01	2.23	67.96	8.83
BD 2343	1.77	71.62	12.97	0.37	84.82	10.71	2.15	73.91	12.58
G 00336	1.54	57.02	45.57	0.33	73.00	56.00	1.88	59.86	47.42
BARI S.6	1.69	62.25	8.70	0.38	54.78	16.52	2.07	60.87	10.14
G 00073	1.72	76.94	41.09	0.34	74.76	45.63	2.06	76.58	41.84
ASET 93	1.42	56.34	28.17	0.35	57.14	29.52	1.77	56.50	28.44
ST 2	1.56	68.23	11.94	0.35	82.08	9.43	1.92	70.78	11.48
G 00062	1.42	66.59	40.94	0.32	59.38	33.33	1.74	65.26	39.54
G 00152	1.29	70.47	41.19	0.23	66.67	44.93	1.52	69.89	41.76
G 00209	1.50	78.67	38.44	0.30	88.89	46.67	1.80	80.37	39.81
G 00207	1.70	40.70	33.07	0.31	38.71	33.33	2.01	40.40	33.11
G 00312	1.33	43.72	39.20	0.33	48.48	42.42	1.66	44.67	39.84
G 00221	1.61	63.69	55.81	0.26	77.22	67.09	1.87	65.60	57.40
PK 327	1.33	54.77	8.04	0.27	51.25	8.75	1.59	54.18	8.16
BD 2329	1.17	37.32	5.98	0.21	51.56	12.50	1.38	39.52	6.99
AGS 399	1.84	72.41	40.29	0.37	61.61	49.11	2.21	70.59	41.78
PK 416	2.26	73.34	34.46	0.37	85.59	54.95	2.63	75.06	37.34
G 00111	0.73	77.73	27.27	0.29	54.65	25.58	1.02	71.24	26.80
Mean	100	64.85	32.30	100	63.81	34.91	100	64.59	32.68
LSD(0.05)		19.39			17.89			17.59	

Table 3. Categorization of soybean genotypes based on percent relative shoot dry weight (RSDW) at 100 mM NaCl salt solution.

(%) RSDW	>80	60-80	40-60	<40
Tolerance	Tolerant	Moderately tolerant	Moderately susceptible	Susceptible
Genotypes	BD 2342 G00041 Shohag AGS 313 G00028 BD2330 BD2331	Galarsum G00331 G00343 BARI soybean 5 G00348 AGS275 G00138 AGS95 G00154 BD2343 BARI soybean 6 G00073 ST2 G00062 G00152 G00209 G00221 PK327 AGS399 PK416 G00111	G00362 G00283 G00307 G00032 BD2340 G00336 ASET93 G00207 G00312	G00197 MTD459 G00053 BD2329
Total	7	21	9	4

Table 4. Salinity susceptibility index (SSI) of soybean genotypes at different levels of NaCl salinity

Genotypes	100mM NaCl			150mM NaCl		
	Shoot	Root	Total	Shoot	Root	Total
Galarsum	0.65	0.73	0.65	0.99	0.92	0.98
G 00331	0.95	0.63	0.89	0.82	0.71	0.80
BD 2342	0.26	0.74	0.33	0.79	0.54	0.75
G 00041	0.34	0.03	0.29	0.89	0.74	0.87
G 00343	0.90	1.04	0.91	0.97	0.92	0.96
G 00197	1.75	1.63	1.70	1.39	1.33	1.39
BARI S.5	0.72	0.98	0.76	1.22	1.29	1.23
Shohag	0.39	0.46	0.40	0.71	0.54	0.69
G 00362	1.33	1.39	1.32	1.14	1.07	1.13
G 00348	0.68	1.06	0.72	0.57	0.73	0.59
AGS 313	0.54	0.05	0.45	0.81	0.65	0.78
G 00028	0.39	0.65	0.44	0.57	0.55	0.57
G 00283	1.34	1.48	1.35	1.00	1.05	1.01
AGS 275	0.76	1.08	0.80	0.60	0.71	0.62
BD 2330	0.52	0.96	0.58	0.80	0.65	0.78
MTD 459	1.97	1.49	1.86	1.11	0.97	1.09
G 00138	0.98	1.04	0.98	0.77	0.86	0.79
BD 2331	0.36	0.87	0.47	0.79	1.14	0.87
AGS 95	0.64	0.86	0.67	1.10	1.07	1.10
G 00307	1.37	1.75	1.45	1.40	1.38	1.40

Genotypes	100mM NaCl			150mM NaCl		
	Shoot	Root	Total	Shoot	Root	Total
G 00032	1.66	1.19	1.53	1.31	1.25	1.30
G 00053	2.16	1.19	1.93	1.49	1.47	1.49
BD 2340	1.61	1.61	1.59	1.11	1.00	1.10
G 00154	0.96	0.62	0.89	1.36	1.34	1.36
BD 2343	0.81	0.40	0.72	1.30	1.31	1.30
G 00336	1.23	0.71	1.12	0.81	0.65	0.78
BARI S.6	1.08	1.19	1.09	1.36	1.23	1.34
G 00073	0.66	0.66	0.65	0.88	0.80	0.87
ASET 93	1.25	1.13	1.21	1.07	1.04	1.07
ST 2	0.91	0.47	0.81	1.31	1.33	1.32
G 00062	0.95	1.07	0.97	0.88	0.98	0.90
G 00152	0.84	0.88	0.84	0.88	0.81	0.87
G 00209	0.61	0.29	0.55	0.92	0.78	0.90
G 00207	1.69	1.61	1.66	1.00	0.98	1.00
G 00312	1.61	1.36	1.54	0.91	0.85	0.90
G 00221	1.04	0.60	0.96	0.66	0.48	0.64
PK 327	1.29	1.28	1.27	1.37	1.34	1.37
BD 2329	1.79	1.27	1.68	1.40	1.29	1.39
AGS 399	0.79	1.01	0.82	0.89	0.75	0.87
PK 416	0.76	0.38	0.69	0.98	0.66	0.94
G 00111	0.64	1.19	0.80	1.09	1.09	1.09

GENOTYPIC DIFFERENCES IN SOYBEAN IN RELATION TO GROWTH AND IONS ACCUMULATION UNDER NACL SALINITY AND WATER STRESS CONDITIONS

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Abstract

Salt and water stress tolerance of the seven soybean genotypes viz., BARI Soybean 6, BD 2329, BD 2342, AGS 95, BGH 02026, Galarsum and BD 2331 were evaluated for their performance under the salinity levels of 0 and 100 mM NaCl at the Banghabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur. The results of this study indicated that all the growth parameters like plant height, shoot dry weight, root dry weight and dry matter distribution in different plant parts of the genotypes sharply decreased when the plants were exposed to water stress, salt stress and, combined salt and water stress conditions. Among the genotypes reduction in dry matter production was least in Galarsum and BD 2331 in both the salt stress and, the combined salt and water stress conditions. These genotypes also accumulated lower amount of Na^+ and higher amount of K^+ in leaf tissues under salt stress and, combined salt and water stress environments as compared to others.

Introduction

Soybean is classified as a moderately salt-tolerant crop and the yield will be reduced when soil salinity exceeds 5 dS/m (Maas and Hoffman, 1977). High levels of salts in the soil can often cause serious limitations to crop production. Raptan *et al.* (2001) found that salinity decreased root, stem and leaf dry weights, and reduced plant height of mungbean plants. The adverse effect of salinity on plant is dependent on salt concentration in the substrate, duration of exposure to salinity and stages of plant growth (Blum, 1988; Maas and Poss, 1989; Gill, 1990).

It is well known that salinity harms crop growth. Plants under high saline conditions cannot always absorb sufficient water for metabolic activities or maintain turgidity because of the low osmotic potential in the growth media. At the same time, plants absorb damaging amounts of Na and Cl (Blum, 1988; Greenway and Munns, 1980; Karim *et al*., 1992).

Na^+ is the primary cause of ion specific damage, resulting due to a range of disorders in enzyme activation and protein synthesis (Tester and Davenport, 2003). Therefore, exclusion of Na^+ at root level and maintenance of high K^+ at shoot level are vital for the plants to grow under saline conditions (Munns *et al*., 2000; Tester and Davenport, 2003).

It is very common in the arid and semi-arid regions that when the crop growth season progresses, the precipitation decreases, and temperature and evapotranspiration increase, resulting in rising salt concentration in the soil solution (Abdulrahman and Williams, 1981). Thus, salt and water stress prevails at the same time in the dry seasons, which very often add extra harm on plant growth (Karim *et al*., 1993). Normally, salinity stress produces high osmotic potential in the soil solution (Hayward and Spurr, 1943), whereas water stress impairs soil moisture transmission due to matric potential (Gingrich and Russell, 1957). However, the adverse effects of both salt and water stress are primarily due to the restriction of water uptake by the roots (Karim *et al*., 1993). The response of soybean to salinity stress depends both on both genotypes and environmental conditions (Ghassemi-Golezani *et al*., 2009).

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In the coastal area of Bangladesh, soil salinity increases during dry period (March – May) due to lack of rainfall. Thus, salinity and drought exist together during that particular period. It is well known that salinity exerts more deleterious effect on plant growth when drought prevails along with salinity. Therefore, this study was undertaken to analyze the growth and mineral ions accumulation pattern in some soybean genotypes.

Materials and Methods

The experiment was conducted in a polyethylene house of the Department of Agronomy at Banghabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur, Bangladesh. Seven genotypes of soybean including BARI Soybean 6 were used for testing their salt and water stress tolerance. Selected genotypes were denoted as moderately salt tolerant (Khan, 2013). Seeds were washed several times in the tap water for surface cleaning then sown in the soil medium on January 13, 2011 in plastic pots having 30 cm in height and 24 cm inner diameter. Each pot contained 12 kg air dried sandy loam soil. Chemical fertilizers of 0.30 g urea, 0.90 g TSP, 0.60 g MOP and 0.60 g Gypsum per pot were also incorporated into the soil before sowing. The pots were watered daily for easy germination. After the emergence and establishment, three uniform healthy seedlings per pot were allowed to grow for three weeks (21 DAE) in equal environment. The seven genotypes were BARI Soybean 6, BD 2329, BD 2342, AGS 95, BGH 02026, Galarsum and BD 2331. After three weeks of emergence, all the genotypes were divided into 6 groups. The treatment groups were; Control (T_1), Water shortage (irrigated with 70% depletion of available soil water when wilting sign developed) from 21 DAE (T_2), 50 mM NaCl irrigated from 21 DAE (T_3), 50 mM NaCl irrigated from 21 DAE + Water shortage from 35 DAE (T_4), 100 mM NaCl irrigated from 21 DAE DAE (T_5) and 100 mM NaCl + Water shortage from 35 DAE (T_6). The control groups of plants were irrigated with tap water only. The experiment was arranged in two factors Completely Randomized Design (CRD) with 8 replications. Plant samples were collected in 42 DAE and different plant parts were separated and then oven dried at 70 ºC for 4 days to measure the dry weight. Dried leaves were finely ground and the samples were dry-ashed at 500 ºC for 8 hours and then digested with concentrated hydrochloric acid. Na and K concentrations were determined by a Flame Spectrophotometer. Data were analyzed by MSTAT-C program and the treatment means were compared by using Least Significant Difference (LSD).

Results and Discussion

Plant height

Plant height of soybean genotypes significantly decreased under water stress, salt stress and, combined salt and water stress environment (Fig. 1). Under only water stress condition, significantly the tallest plant recorded in BARI Soybean 6 and the shortest in BD 2331 genotype. Plant height was affected more in combined salt and water stress conditions than only in salt stress conditions in both the salinity levels (50 and 100 mM NaCl), though the reduction was higher at higher salinity levels. At higher salinity (100 mM NaCl), the tallest plant recorded in AGS 95 (26.13 cm) which was followed by BD 2342 (25.63 cm) and the shortest recorded in Galarsum (22.47 cm). At higher salinity (100 mM NaCl) combined with water stress condition, the tallest plant recorded in BD 2342 (25.23 cm) which was followed by BGH02026 (25.13 cm), while the shortest recorded in BD 2329 (20.10 cm). The reduction of plant height was also more in higher salinity both in only salt stress and, combined salt and water stress conditions (Fig. 2). At higher salinity, significantly the highest relative plant height recorded in BD 2331 (97.70%)

which was followed by AGS 95 (95.82 %) and the lowest recorded in BD 2329 (75.95 %). But at higher salinity combined with water stress condition, the highest relative plant height recorded in AGS 95 (87.28 %) which was followed by Galarsum (86.84 %) and the lowest relative plant height recorded in BD 2329 (67.75 %).

Salt stress and water deficit significantly affected the plant height of soybean which is in agreement with Ozturk *et.al*. (2004); Sari and Ceylan (2002). Osmotic potential of soil decreased due to salt water, and matric potential decreased due to water shortage in soil, which made interruption in water uptake by the plant resulting in reduction of shoot growth, is commonly expressed by stunted shoot growth. Genotypic difference in the reduction of plant height due to salinity were also reported earlier by Aziz *et al*. (2005); Sultana *et al*. (2009) and Padder *et al.* (2012) in mungbean, Mannan *et al* (2012) in soybean.

Shoot dry weight

Shoot dry weight of soybean genotypes sharply decreased when plants were exposed to water stress, salt stress and, combined salt and water stress (Fig. 3). Under only water stress conditions, BD 2342 produced the highest shoot dry weight (1.94 g) which was followed by BARI Soybean 6 (1.87 g), and the least recorded in BD 2331 (1.03 g). Shoot dry weight was affected more in the combined salt and water stress conditions than only in the salt stress conditions in both the salinity levels (50 and 100 mM NaCl). But the reduction was higher in higher salinity levels. At higher salinity (100 mM NaCl), the highest shoot dry weight recorded in BD 2342 (1.89 g) which was followed by BARI Soybean 6 (1.75 g) and the lowest recorded in BGH 02026 (1.18 g). At the higher salinity combined with water stress condition, the highest shoot dry weight recorded in by BARI Soybean 6 (1.64 g) which was followed by BD 2342 (1.63 g) and the lowest recorded in BGH 02026 (1.18 g).

The relative shoot dry weight of soybean reduced in water stress, salt stress and, combined salt and water stress conditions (Fig. 4). Under only water stress condition, the highest relative shoot dry weight recorded in BARI Soybean 6 (77.5 %) which was followed by Galarsum (76.7 %) and the lowest recorded in AGS 95 (39.7 %). The relative shoot dry weight was reduced more in the combined salt and water stress conditions than only salt stress in both the salinity levels. At higher salinity (100 mM NaCl), the highest relative shoot dry weight recorded in Galarsum (79.9 %) which was followed by BD 2331 (77.9 %) and the lowest recorded in BD 2329 (50.2 %). But at higher salinity combined with water stress condition, the highest relative shoot dry weight recorded in Galarsum (68.4 %) which was followed by BARI Soybean 6 (68.0 %) and the lowest recorded in BD 2329 (44.1%).

Wang *et al* (2011) also reported that total biomass, shoot biomass, leaf biomass decreased significantly in saltcedar (*Tamarix chinensis*) seedlings due to water scarcity under salt and water stress condition. Under only water stress, when soil dries up, the matric potential decreases, therefore increases the resistance of water flow to the roots in a non-linear fashion (Homaee *et al*., 2002). Application of salt water increases in soil salinity. At given salt water content, the soil water potential reduces but does not reduce water flow to the roots. Root cortical cells can osmotically adjust to some extent allowing water to readily move into the root. Therefore, shoot dry weight of soybean was affected more in combined salt and water stress conditions than only in salt stress conditions. The finding is also in agreement with the findings of Meiri (1984) that the matric potential preferentially affected the shoot growth of bean more than did the osmotic potential.

Under salt stress condition, cell expansion is reduced due to low turgor, beside these excess sodium ion damages cell membrane and organelles, resulting in plant growth reduction. The reduction in shoot dry weight due to salinity was reported by Karim *et al*. (1993) in triticale, Khan *et al*. (1997) in rice, Aziz *et al*. (2005) in mungbean, Waheed *et al*. (2006) in pigeonpea, Jamil *et al*. (2007) in sugarbeet, Sultana *et al*. (2009) in mungbean, Chookhampaeng (2011) in pepper plant and Mannan *et al*. (2012) in soybean.

Root dry weight

Root dry weight of soybean genotypes decreased under water stress, salt stress and, combined salt and water stress condition (Fig. 5). Under water stress, the highest root dry weight (0.30 g) recorded in BGH02026 and the lowest (0.10 g) recorded in BD 2342. Root dry weight affected more in combined salt and water stress than only in salt stress in both the salinity levels (50 and 100 mM NaCl). At higher level of salinity, the highest root dry weight (0.31 g) recorded in both BD 2342 and BD 2331, and the lowest recorded in BGH02026 (0.21 g). At higher level of salinity combined with water stress condition, the highest root dry weight (0.24 g) recorded in both BD 2342 and AGS 95 genotypes, and the lowest recorded in BD 2331(0.19 g).

The relative root dry weight reduced in water stress, salt stress and, combined salt and water stress conditions (Fig. 6). The relative root dry weight was reduced more in combined salt and water stress conditions than only salt stress in both the salinity levels (50 and 100 mM NaCl). At higher level of salt stress condition, the highest relative root dry weight recorded in Galarsum (88.4 %) which was followed by BD 2331 (74.6 %) and the lowest recorded in BD 2329 (49.4%). At higher level of salt combined with water stress condition, the highest root dry weight also recorded in Galarsum (69.8 %) which was followed by BGH02026 (61.1%) and the lowest recorded in BD 2329 (42.4 %).

Under salt and water stress condition, cell expansion is reduced due to low turgor, beside these excess sodium ion damages cell membrane and organelles, resulting in reduction of root growth. Wang *et al* (2011) reported that root biomass decreased significantly in tamarisk seedlings due to water severity under salt and water stress condition. Decreased in radical dry weight of mungbean under salinity and water stress was also reported by Padder *et al*. (2012). The reduction in root dry weight due to salinity were reported by Aziz *et al*. (2005); Sultana *et al*. (2009) in mungbean, Waheed *et al*. (2006) in pigeonpea, Jamil *et al*. (2007) in sugarbeet and Chookhampaeng (2011) in pepper plant.

Dry matter distribution

Dry matter distribution in different plant parts of soybean genotypes as affected by water stress, salt stress and, combined salt and water stress condition is presented in Fig. 7. All plant parts were reduced by stresses. Under water stress, the highest stem in BARI Soybean 6 (0.77 g), petiole (0.25 g) and leaves (0.95 g) in BD 2342 were recorded while the lowest stem (0.36 g), petiole (0.14 g) and leaves (0.53 g) were recorded in BD 2331. All plant parts reduced more in all genotypes in the combined salt and water stress than only in the salt stress in both the salinity levels (50 mM and 100 mM NaCl). But the reduction was more in leaves than stem and petiole. At higher salinity, the highest leaves dry weight recorded in BD 2342 (0.93 g) which was followed by BD 2329 (0.92 g) and the lowest recorded in BGH02026 (0.71 g). But at higher level of salinity combined with water stress condition, the highest leaves dry weight recorded in BD 2329 (0.81 g) and the lowest (0.59 g) in BGH 02026.

Under water stress condition, cell expansion of leaf is reduced due to low turgor, which is controlled by the processes related to cellular water uptake and cell wall extension (Cramer and Bowman, 1993). Therefore, leaf area was decreased resulted in decreased leaves dry weight under salt and water stress condition. Long term exposure to salinity lead to premature leaf senescence; and thus reduced the photosynthetic area (Cramer *et al*., 1991) in soybean plants. The highest reduction of leaf dry weight in the genotype BGH02026 at 100 mM NaCl salinity might be due to high salt load in the leaf. The salt that exceeds the capacity of compartmentation in the cell vacuoles of leaf causing salt to build up in the cytoplasm to toxic levels (Munns, 2002; Munns *et al*., 2006). The reduction in leaf dry weight due to salinity was reported by Karim *et al*. (1993) in triticale, Khan *et al*. (1997) in rice, Aziz *et al*. (2005) in mungbean and Mannan *et al*. (2013) in soybean.

Sodium accumulation

Sodium (Na) uptake in leaf tissue (%) of soybean genotypes was significantly affected by water stress, salt stress and, combined salt and water stress condition (Table 1). The accumulation of Na was lower in leaves of all the genotypes under water stress than control. Significantly the lowest Na content was found in BD 2329 (0.072 %) which was identical with BARI Soybean 6 (0.091 %) in only water stress treatment.

The accumulation of Na was more in the salt stress than in the combined salt and water stress conditions in both the salinity levels (50 and 100 mM NaCl). Results reveal that concentration of Na increased with increasing salinity levels. Genotypic differences were also observed in Na accumulation.

At higher level of salt stress (100 mM NaCl), Galarsum (0.223 %) accumulated significantly the lowest concentration of Na which was identical by the accumulation of BD 2331 (0.226 %) and the highest was accumulated by BGH 02026 (0.495 %). At higher level of salinity combined with water stress condition, Galarsum (0.173%) was also accumulated lower amounts of Na which was at par with the accumulation of BD 2331 (0.182 %) and the highest in AGS 95 (0.330 %).

The results are in agreement with the earlier reports that tolerant genotypes accumulate lower amount of Na than the salt sensitive ones (Karim *et al*., 1992; Khan *et al*., 1997; Ahmadi *et al*., 2009; Mannan *et al*., 2013). Kao *et al*. (2006) also reported that differences among soybean species in leaf accumulation of Na^+ might be responsible for the differential sensitivity to NaCl treatments.

Plant responses to salt and water stress have much in common phenomenon. Salinity leads to many metabolic changes identical to those caused by water stress, and there are still salt-specific effects. Accumulation of Na^+ in leaves results in necrosis and premature leaf senescence (Munns, 2002).

Potassium accumulation

Accumulation of potassium (K) in leaf tissue (%) of soybean genotypes was also affected by water stress, salt stress and, combined salt and water stress condition (Table 2). The accumulation of K was higher in leaves under water stress than control. Under only water stress treatment, significantly the highest K content was found in BD 2331 (2.52 %) which was identical by the accumulation of BD 2342 (2.42 %) and the lowest in AGS 95 (1.96 %).

The accumulation of K was more in the combined salt and water stress than in the salt stress conditions in both the salinity levels (50 and 100 mM NaCl) in all the genotypes, except BARI Soybean 6 and BGH 02026. The accumulation of K decreased with increasing salinity levels.

At higher level of salt stress (100 mM NaCl), Galarsum (1.75 %) accumulated significantly the highest amounts of K which was identical by the accumulation of AGS 95 (1.70 %), BD 2331

(1.70 %) and BARI Soybean 6 (1.65 %). The least amount of K was accumulated by BD 2342 (1.55 %) at this level of salinity. At higher level of salinity combined with water stress condition, Galarsum (1.80 %) also accumulated significantly the highest amounts of K, which was identical by the accumulation of BD 2331 (1.75 %), AGS 95 (1.75 %) and BD 2329 (1.70 %), while BGH 02026 (1.34 %) accumulated the least.

Under water stress as well as under salt stress conditions, K plays an important role in osmoregulation, and stress tolerant genotypes accumulate higher amounts of K than susceptible ones (Blum, 1988; Qadar, 1988). Here, soybean genotype Galarsum accumulated higher amount of K in leaves than others under the salt and water stress conditions. A greater degree of salt tolerance in plants was found to be associated with a more efficient system for selective uptake of K over Na (Neill *et al*., 2002). The selective uptake of K in contrast to Na is considered as one of the important physiological mechanisms contributing to salt tolerance in many plant species (Poustini and Siosemardeh, 2004). There was a negative relationship between Na and K concentration in leaves. Similar results had been observed by Khan *et al*. (1997); Goudarzi and Pakniyat, (2008).

Conclusion

The results of this study indicated that all the growth characters of the soybean genotypes sharply decreased when plants were exposed to water stress, salt stress and, combined salt and water stress conditions. Variation in salt and water stress tolerance of soybean genotypes was obvious. Among the genotypes, reduction in dry matter production was least in Galarsum and BD 2331 in both salt and, combined salt and water stress conditions. These genotypes also accumulated lower amount of Na and higher amount of K in leaf tissues under the salt stress and, the combined salt and water stress environments as compared to others.

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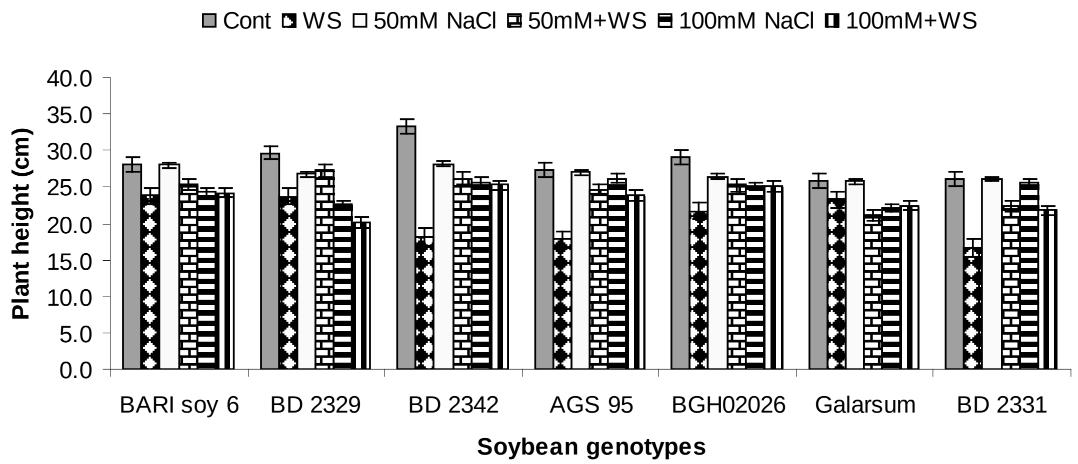

Fig.1. Plant height of soybean genotypes as affected by salinity and water stress at 42 DAE.

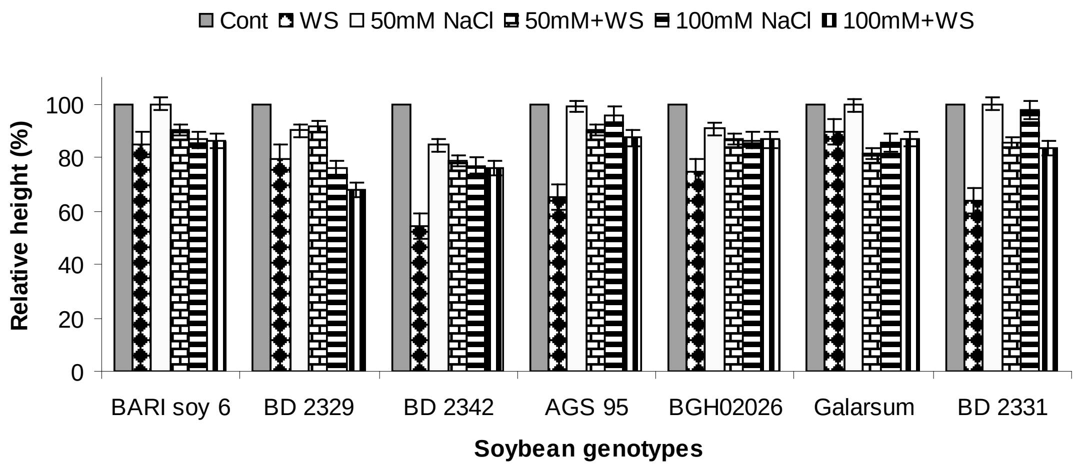

Fig. 2. Relative plant height of soybean genotypes as affected by salinity and water stress at 42 DAE. Here, Cont = Control, WS = Water stress, mM = NaCl concentration.

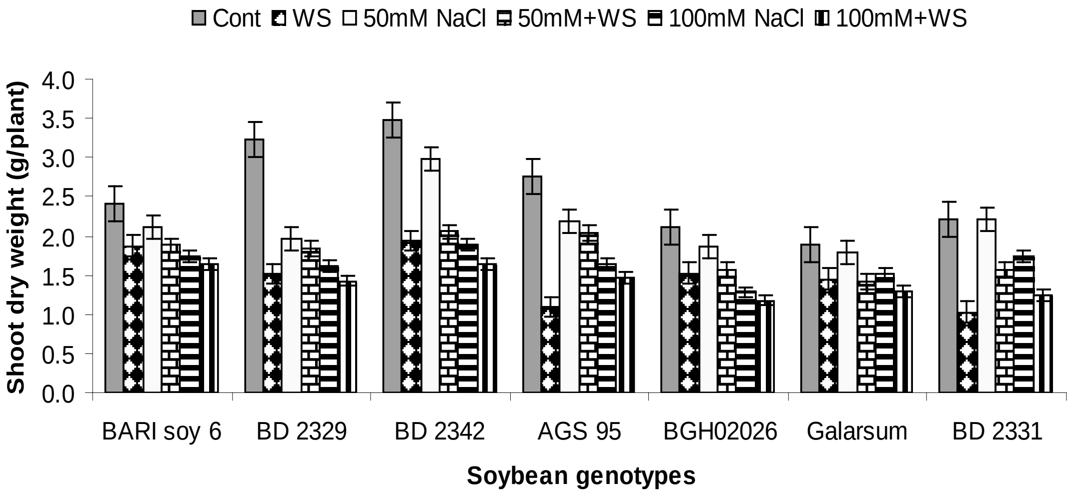

Fig. 3. Shoot dry weight of soybean genotypes as affected by salinity and water stress at 42 DAE.

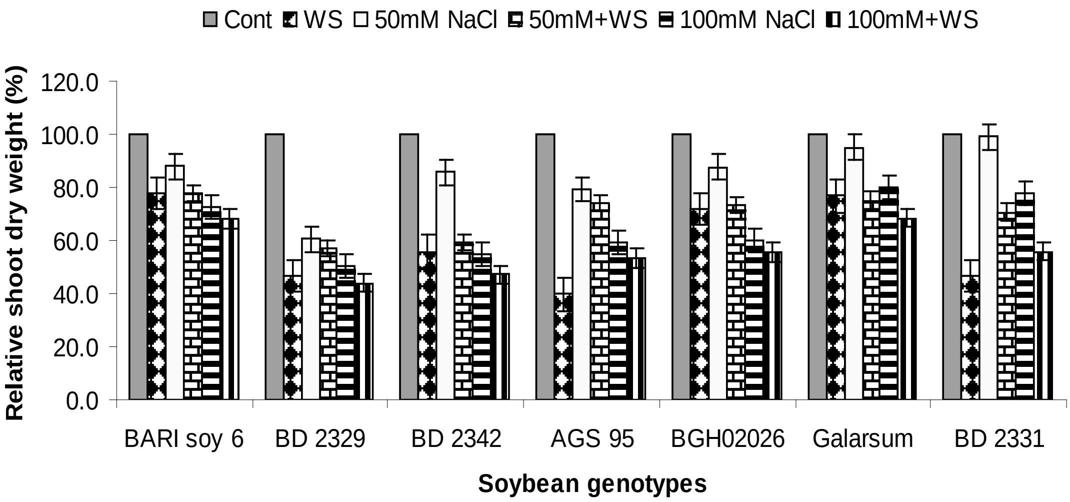

Fig. 4. Relative shoot dry weight of soybean genotypes as affected by salinity and water stress at 42 DAE. Here, Cont = Control, WS = Water stress, mM = NaCl concentration.

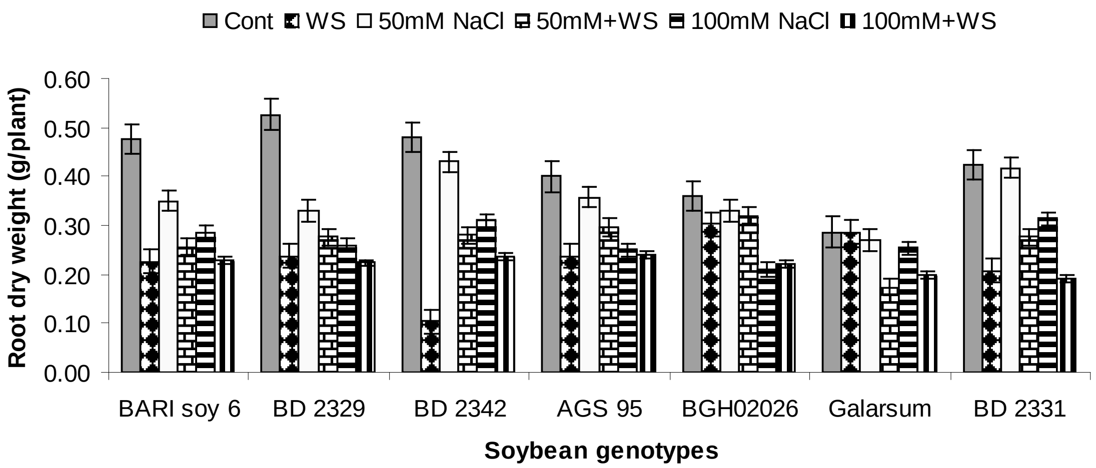

Fig. 5. Root dry weight of soybean genotypes as affected by salinity and water stress at 42 DAE.

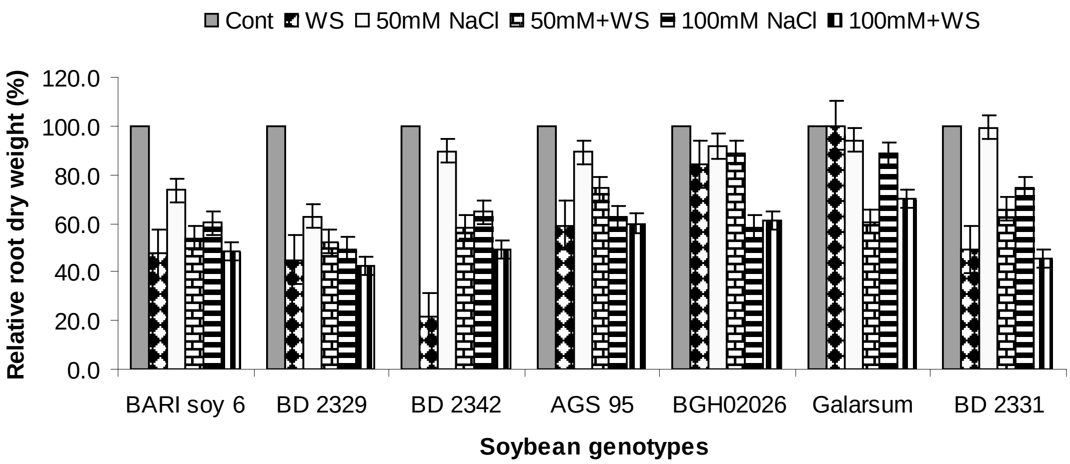

Fig. 6. Relative root dry weight of soybean genotypes as affected by salinity and water stress at 42 DAE. Here, Cont = Control, WS = Water stress, mM = NaCl concentration.

Salinity Stress

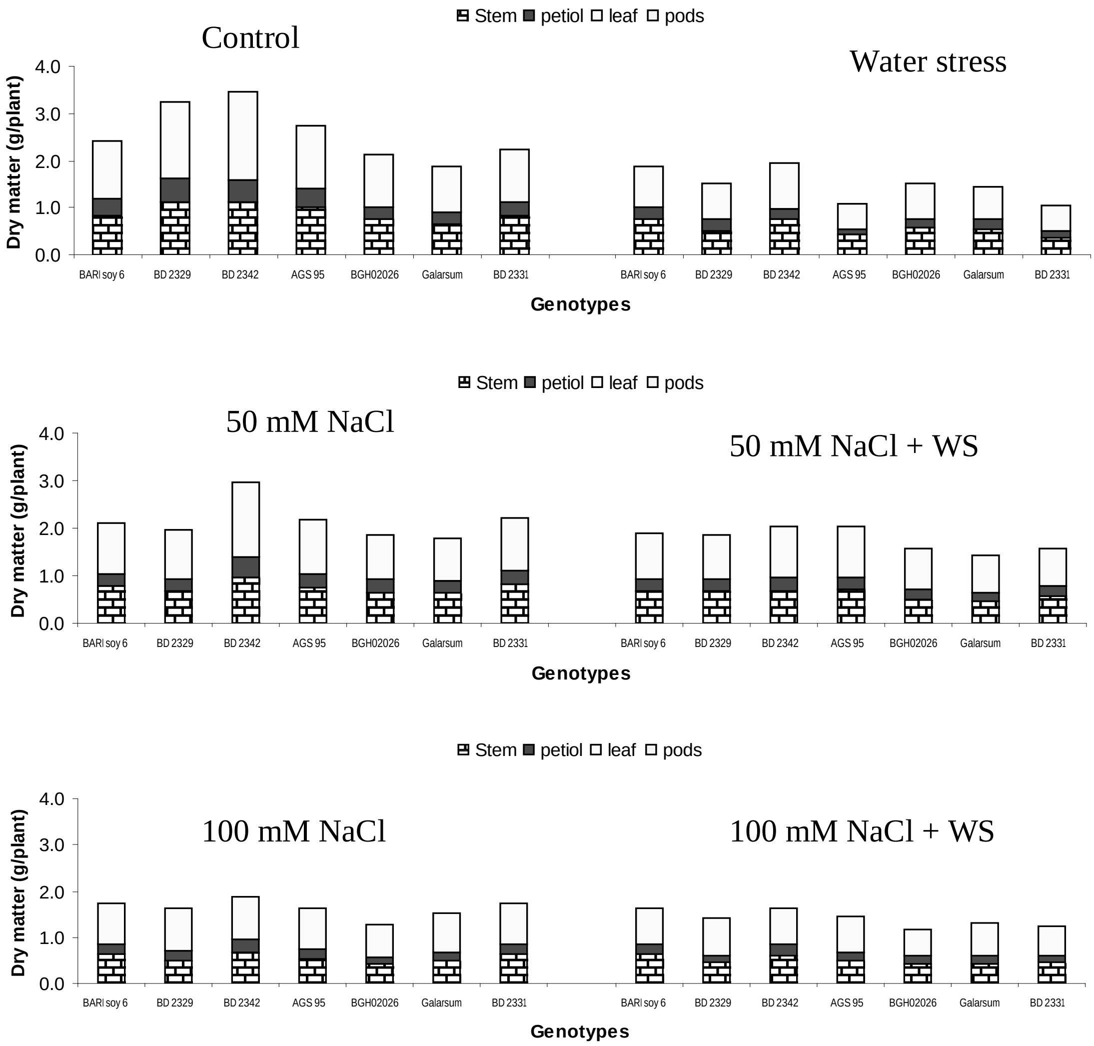

Fig. 7. Dry matter accumulation in different plant parts of soybean genotypes as affected by salinity and water stress at 42 DAE.
Here, Cont = Control, WS = Water stress, mM = NaCl concentration.

Table 1. Sodium (Na) uptake in leaf tissue (%) of soybean genotypes as affected by salinity and water stress

Genotypes	Control	Water stress (WS)	50 mM NaCl	50 mM NaCl + WS	100 mM NaCl	100 mM NaCl + WS
BARI Soy-6	0.136	0.091	0.319	0.179	0.390	0.226
BD 2329	0.083	0.072	0.275	0.195	0.330	0.198
BD 2342	0.143	0.121	0.283	0.217	0.358	0.303
AGS 95	0.162	0.094	0.286	0.239	0.385	0.330
BGH 02026	0.165	0.143	0.413	0.253	0.495	0.292
Galarsum	0.132	0.105	0.160	0.138	0.223	0.173
BD 2331	0.105	0.094	0.162	0.143	0.226	0.181
LSD (0.01)			0.022			
CV (%)			4.98			

Table 2. Potassium (K) uptake in leaf tissue (%) of soybean genotypes as affected by salinity and water stress

Genotypes	Control	Water stress (WS)	50 mM NaCl	50 mM NaCl + WS	100 mM NaCl	100 mM NaCl + WS
BARI Soy-6	1.96	2.16	2.06	1.56	1.65	1.44
BD 2329	2.06	2.37	1.96	2.11	1.56	1.70
BD 2342	2.37	2.42	1.75	1.96	1.55	1.65
AGS 95	1.75	1.96	1.80	1.85	1.70	1.75
BGH 02026	2.16	2.22	2.01	2.06	1.56	1.34
Galarsum	1.85	2.16	1.96	2.06	1.75	1.80
BD 2331	1.70	2.52	2.16	2.16	1.70	1.75
LSD (0.01)			0.15			
CV (%)			3.74			

SCREENING OF LENTIL GENOTYPES AGAINST NaCl SALINITY STRESS AT EARLY VEGETATIVE STAGE

M. A. Aziz, F. Begum, S. S. Kakon, A. Rahman and A. Afjal

Abstract

The response of 75 lentil genotypes, to NaCl salinity at the germination and seedling stage, was examined. A great amount of variation of NaCl tolerance in lentil was observed. The salt solution was applied with an increment of 25 mM NaCl in every alternate day till respective concentration of 100 mM was attained. There were 13 accessions (tolerant) that produced greater than 90 percent relative total dry weight (RTDW). In the second group (moderately tolerant), there were 29 accessions that had RTDW in the range of 70-90%. In the third (susceptible) and fourth (highly susceptible) groups, there were 21 and 12 accessions that RTDW in the ranges of 50-70 and <50% respectively. Salt tolerant accessions found in the diverse germplasm of lentil, examined in this study and would be of considerable economic value in increasing yield on saline areas, provided the lines show salt tolerance till maturity.

Introduction

Soil salinity is one of the major impediments to agriculture in arid and semi-arid regions of the world (Epstein. 1985, Shannon. 1985 and Ashraf *et al*. 1986). A biotic approach to overcoming the salinity problem has been considered the most feasible and economic path and it has recently received much attention. The different strategies that have been adopted by various plant scientists, in employing biological approach to overcoming the salinity problem, have been listed (Ashraf and McNeilly. 1988). One of the procedures which is of prime importance, is the screening of available germplasm of a crop for salt tolerance to fully sustain a relatively reasonable yield on salt affected soils (Ashraf and McNeilly, 1987).

Lentil is a salt sensitive crop like other leguminous crops (Ashraf and Rasul 1992). Despite its great economic importance no work has been done to improve its salt tolerance in Bangladesh. For importance of salt tolerance existence of genetic variation in lentil accessions available in BARI would be screened for their salt tolerance at early vegetative stage.

Materials and Methods

The pot-culture experiment was carried out under semi-controlled environment (inside venyl house) of Central Research Station, BARI, during winter 2003-2004. The soil used in the pot was silty loam in texture with pH 7.1 and poor fertility status. Seventy-five genotypes of lentil were used in the experiment. Ten bold seeds were sown in each plastic pot (24 cm × 30 cm) containing 12 kg air dried soil and kept inside venyl house under natural light. Compost ($^1/_4$ of the soil by volume) and 0.27-0.28-0.20 g of urea, TSP and MP per pot was incorporated uniformly into the soil. After seedling establishment five uniform and healthy plants were allowed to grow in each pot. Ten days after emergence sufficient quantities of salt solutions were applied in 2 pots per treatment. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 100 mM NaCl solution. Tap water was used as control. The salt solution was applied with an increment of 12.5 mM in every alternate day till respective concentration was attained. Plants in control group were irrigated with tap water. Ten plants of each genotype per treatment were harvested at vegetative stage (before flowering). Roots were carefully cleaned with tap water and the plant samples were than separated into roots, stem and leaf. The samples were oven-dried to a constant weight at 70^0C.

Relative growth performance of whole plant was analyzed for each genotype. Salt tolerance levels were calculated from relative total dry weight (RTDW) of the genotypes.

$$RTDW = \frac{\text{Total dry weight of NaCl treated plant}}{\text{Total dry weight of control plant}} X100$$

All the genotypes were than categories as tolerant (0-3), moderately tolerant (4&5), susceptible (6-7) and highly susceptible (8-9) based on 0-9 scale. The scales measured from RTDW of the genotypes are as follows:

Scale	RTDW (%)	Tolerance group
0	>120	Tolerant
1	110-120	
2	100-110	
3	90-100	
4	80-90	Moderately tolerant
5	70-80	
6	60-70	Susceptible
7	50-60	
8	40-50	Highly susceptible
9	<40	

Source: Ashraf and Waheed, 1990

Results and Discussion

Under control condition (0 mM NaCl) the TDM per plant of the genotypes varied from 0.14 g/plant to 1.25 g/plant. The lowest TDM was produced by BL 61 and the highest obtained from BL 24. However, the TDM production was statistically significant among the genotypes (Fig. 1). The TDM at 100 mM NaCl varied between 0.24 g/plant and 1.09 g/plant (Fig.2). The accession BL 65 produced the lowest TDM and while BL 25 produced the highest TDM.

The relative TDM per plant (% TDM to control conditions) was significantly reduced due to salinity in all the genotypes tested except in accession BL 14, BL 16, BL 28, BL 69, BL 73 and BL 74. The accession BL 28 produced 18% higher TDM at 100 mM NaCl salinity than the control (Fig. 3). Asharf and Waheed (1990) obtained 3 genotypes of lintil that produced more than 20% dry shoot biomass under 100 mM NaCl. The minimum affected TDM of BL 14, BL 16, BL 28, BL 69, BL 73 and BL 74 at high salinity could be attributed for the less reduction in the production of stem, petiole and leaf dry matters.

All the accessions examined in this study were classified into ten groups based on 0-9 scale (Fig.4), on the basis of their performance in relative total dry weight production. The accessions were than categorized as tolerant, moderately tolerant, susceptible and highly susceptible. At 100 mM NaCl there were 13 accessions that produced greater than 90 percent RTDW, 29 accessions that had 70-90%, 21 accessions had 50-70% and 12 accessions had <50% RTDW (Fig. 5). Among the 75 accessions, at 100 mM the tolerant was 17 %, moderately tolerant 39 %, susceptible 28 % and higher susceptible 16 % (Fig.6).

It is now evident that the existence of genetic variation in salt tolerance is a prerequisite for the development of salt tolerant cultivars through selection and/or breeding. To explore such variation in lentil 75 accessions were screened at the early growth stages, as salt tolerance throughout this stages is crucial for establishment of a crop in a saline environment.

The results presented in this study deal with the salt tolerance of the accessions at the vegetative growth stage. The tolerance observed in the 13 accessions at 100 M NaCl may or may not be conferred at the adult stage. Nevertheless tolerance observed at the vegetative stage is of great importance because it has been emphasized by many workers that the assessment of salt tolerance at vegetative stage of a plant species is of considerable value in determining the ultimate tolerance of the species (Akbar and Yabuno, 1974; Ashraf and MeNeilly, 1987). Therefore, knowing the tolerance which was observed at the vegetative stage of some accession would be of considerable economic value for crop establishment on salt affected soils.

Conclusion

The salt tolerant accessions found in the diverse germplasm of lentil, examined in two consecutive years (2002-2003 and 2003-2004), could be considerable economic value in increasing yield on saline areas with moderate salinity, provided the lines are still tolerant when adult and also have adaptability to other factors encountered in salt affected soils. The accessions BL-11, BL-12, BL-14, BL-16, BL-28, BL-34, BL-66, BL-69, BL-72, BL-73 and BL-74 should be tested in Banarpota Farm, Sathkhira in the next season.

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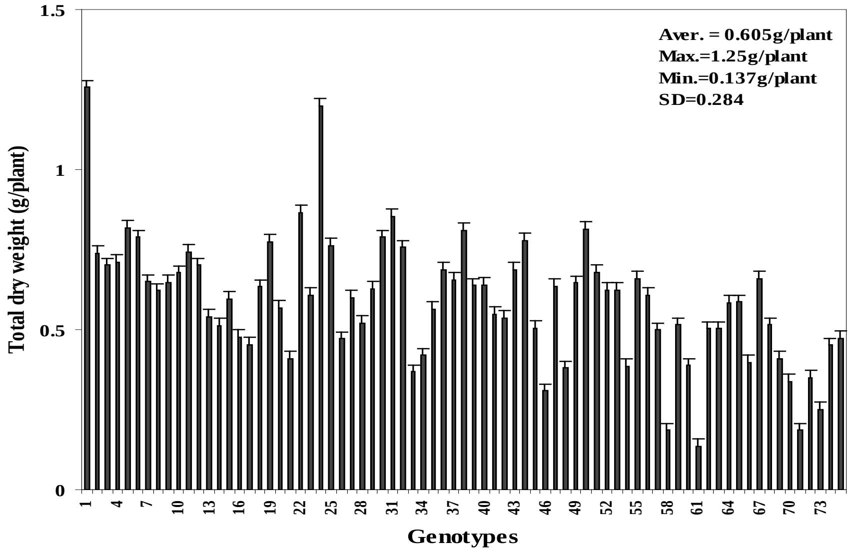

Fig.1. Total dry weight of 75 lentil genotypes at 0 mM NaCl salinity. Error bars represent standard error

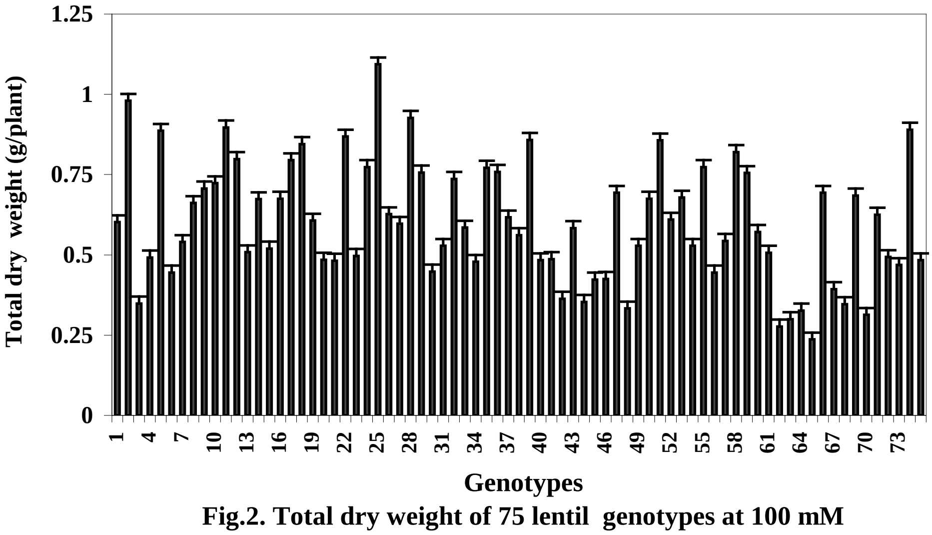

Fig.2. Total dry weight of 75 lentil genotypes at 100 mM NaCl salinity. Error bars represent standard error

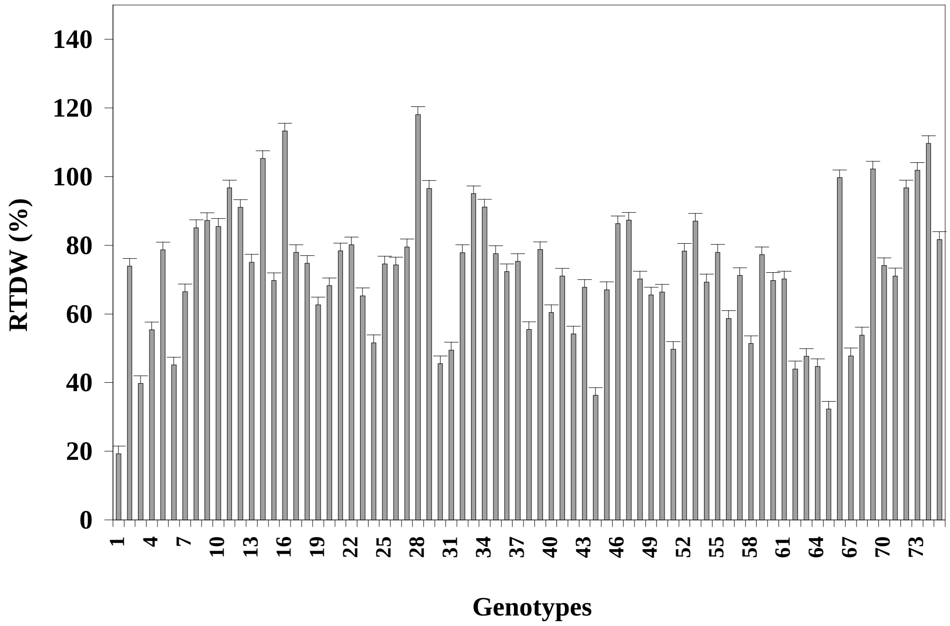

Fig. 3. Relative total dry weight (RTDW) of 75 lentil genotypes. Error bars represent standard error

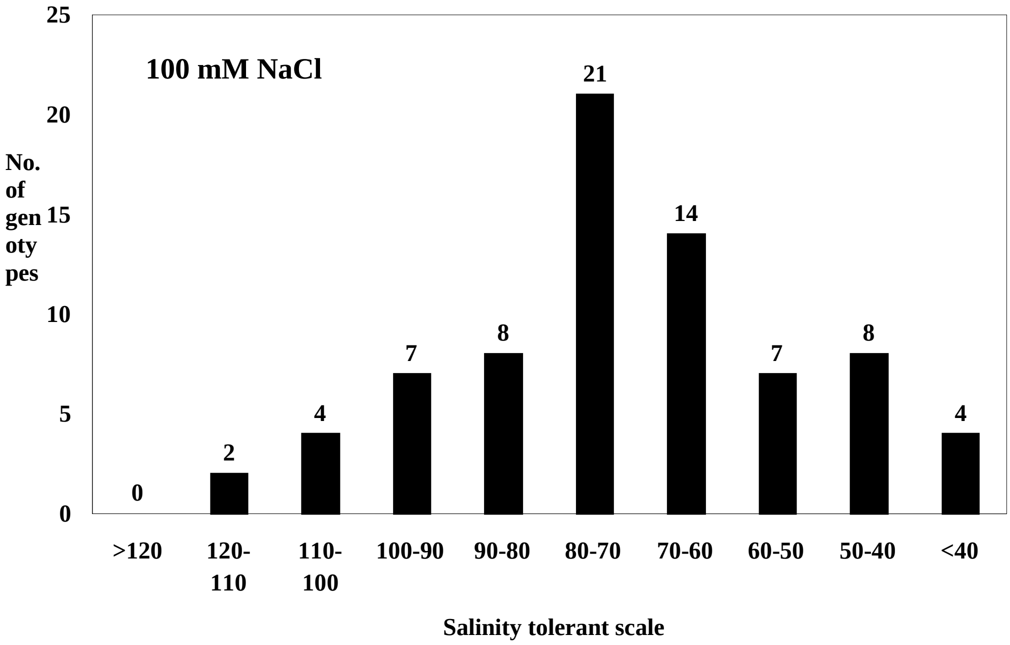

Fig. 4. Friquency distributioon of 75 lentil genotypes based on salinity tolerant scale

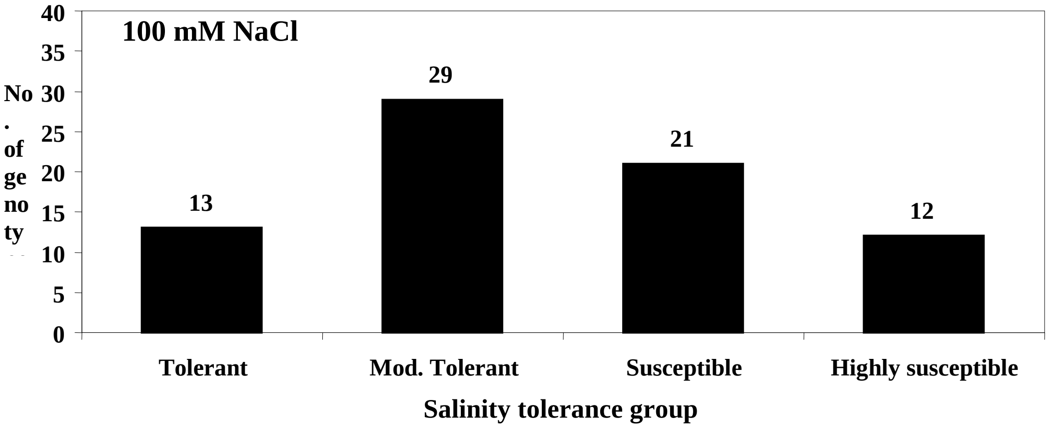

Fig.5. Friquency distribution of 75 lentil genotypes based on relative performance and salinity tolerance levels

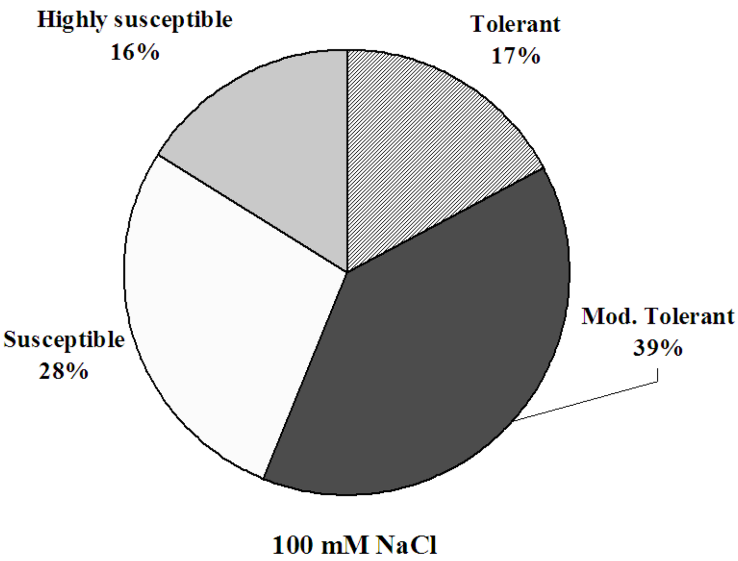

Fig. 6. Percentage of NaCl salinity tolerance of 75 lentil genotypes

FIELD PERFORMANCE OF SALT TOLERANT MUNGBEAN GENOTYPES IN COASTAL AREA

M. A. Aziz, S. M. Zaman, S. Rafiquizzaman and M. S. Aktar

Abstract

The field trial was conducted at three locations Banarpota, Satkhira, Paikgacha, Khulna and Kolapara, Patuakhlai to assess weather salt tolerance in BM 01 under pot culture has relationship with that under field condition. Four mungbean varieties / lines viz. BARI Mug 2, BARI Mug 4, BARI Mug 5 and BM 01 were tested in a randomized block design with three replications. Except Kolapara site the salt tolerant line showed better adaptability in coastal area. The results indicated that the salt tolerance in BM 01 made in pot culture showed consistence with that made under field condition. Farmers performed BM 01 for resistance to viral diseases.

Introduction

A vast coastal and offshore area (2.85 m/ha) in the southern part of Bangladesh exhibits soil salinity of various magnitudes due to onrush of salt water from the Bay. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the underground moves up by capillary forces. Thus a considerable amount of salt from the subsoil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. As a result, most of the areas remain fallow during dry months. To increase mungbean area and production these marginal lands may be considered as it is mostly grown in the southern part of Bangladesh. The variation in salinity tolerance between crops and/or varieties of crop is well known (Mass and Hoffman, 1977; Karim *et al.* 1994; Richards *et al*. 1987). A judicial choice to grow a crop under saline soils is, therefore, considered an important management option to minimize yield loss by salinity. Blum (1988) rightly pointed out that, for sustainable crop production in the saline soils. It is more important to select a salt tolerant crop rather than a relatively better yielding variety of susceptible crops. The present study was therefore, undertaken to assess whether salt tolerance in BM 01 under control condition (pot culture) has relationship with that under field condition.

Materials and Methods

The trial was conducted at three locations at Banarpota farm, Satkhira; Paikgacha MTL site, Khulna and Kolapara, Patuakhali during late rabi season of 2003-2004. Mungbean was sown on 28 January, 22 January and 31 January 2004 respectively at Kolapara, Banorpota and Paikgacha. Four mungbean varieties/lines BARI Mug 2, BARI Mug 4, BARI Mug 5 and BM 01 were included in the study. The unit plot size was 1.2m x 1m at Banorpota and Paikgacha and 4m x 2m at Kolapara. Seeds were sown in 30cm x 10cm line following RCB design with three replications. Fertilizers @ of 20-16-15 kg/ha of N-P-K was applied as basal. Weeding, thinning and all other intercultural operations were done as and when necessary. Soil salinity level was measured time to time. Data on yield and yield components were collected and analyzed statistically.

Results and Discussion

Banarpota Farm: The performance of mungbean varieties/line at Banarpota Farm presented in Fig. 1 to Fig. 3. The soil salinity level was 8.3 dS/m on 22 January. Soil salinity increased upto 8 March and than declined (Fig. 1). On 8 March, 2004 the soil salinity level was 15.1 dS/m. Soil salinity significantly influenced the population/m^2. At the initial stage (15 DAS), plant population was higher in all the varieties (Fig. 2). With the increase in salinity level the population/m^2 decreased in all the varieties but the reduction was minimum in BM01. Between 15-30 DAS the percent mortality was the highest in BARI Mug 5 (93%) and the lowest in BM01 (70%) (Fig.3). Between 30-45 DAS the highest mortality was in BARI Mug 2 and lowest in BM 01 15-30. The mortality was 100% in BARI Mug 2, BARI Mug 4 and BARI Mug 5 between 45-60 DAS but it was 56% in BM 01. It was observed that 100% mortality in BM 01 occurred between 60-70 DAS. The slope of the line in Table 1 represents the reduction in percent of population per unit increase per dS/m of salinity. The slope value was minimum in BM 01 while the change was a great in other varieties on the slope for population. An increase in each dS/m of salinity reduced the population/m^2 by 0.37% in BM 01. It was much higher in other varieties. The results indicated that BM 01 was more salt tolerant than other varieties. Therefore, the salt tolerance of BM01 made in pot culture showed consistence with that made under field condition.

Paikgacha MLT site: The soil salinity level at Paikgacha was between 3.35 dS/m to 6.82 dS/m during the crop growth period (Fig. 4). Maximum soil salinity was (6.82 dS/m) on 10 February and minimum (3.35 dS/m) was on 25 March. The crop maturity period varied from 59 days (BARI Mug 5) to 62 days (Table 1). The plant population per unit area was varied significantly among the varieties. Highest population was in BM 01 and lowest in BARI Mug 2. Plant height influenced significantly by soil salinity. BARI Mug 5 produced the shortest plant among the mungbean varieties.

Soil salinity significantly influenced the yield and yield components of mungbean varieties (Table 2). The number of pods per plant were significantly lower in BARI Mug 2 under stress condition. Highest number of pods per plant was obtained in BM01. Similar results were obtained by Raptan (2001). Aziz *et al*. (2002) and Faruquei (2002). The influence of salt stress on reduction of number of seed per pod was significant. Significantly the highest individual grain weight was obtained from BARI Mug 5 and lowest from BM 01 followed by BARI Mug 2. Grain yield is the function of pods per plant, seeds per pod and individual seed weight. The effects of soil salinity on grain yield closely matched its effects on number of pods per plant. Grain yields were decreased by soil salinity and the decrease differed among the varieties. Significantly the highest grain yield (693 kg/ha) was obtained from BM01 followed by BARI Mug 5. The lowest grain yield was obtained from BARI Mug 4 followed by BARI Mug 2. Under salt stress condition in pot culture at about 10 dS/m. The observations are in line with the results obtained by Raptan (2001), Aziz et at. (2002), Faruque (2002) and Aziz (2003) obtained the highest grain yield per plant from BM01.

Kolapara MLT site: The results presented in Table 3 at Kolapara, Patuakhali indicated that the soil salinity level was very low. As a result no significant differences in yield and yield components among the varieties were observed although it showed at other sites.

Farmers reaction: Farmers preferred BM01 for higher yield and also due to adaptability in saline area. Farmers also preferred BM 01 for resistant to viral diseases. Farmers dislike pod-harvesting system.

Conclusion

The salt tolerance in BM 01 made in pot culture showed consistence with that observed under field condition. The salt tolerant line BM 01 showed better adaptability in coastal area. Further investigation may be continued to evaluate the performance of the above-mentioned line for more saline areas and confirmation.

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Table 1. Equation of linear regression relating salt stress (x) to plant population (y), where y = a+bx

Variety / line	Parameters of regression		
	a	b	R^2
BARI Mug 2	166.7	-0.44	94
BARI Mug 4	162.9	-0.41	93
BARI Mug 5	177.4	-0.48	94
BM 01	154.2	-0.37	96

Table 2. Yield and yield attributed of mungbean as affected by varieties/lines tested at Paikgach MLT Site during rabi season, 2003-04.

Variety/Line	Days to maturity	Plant pop^n/m^2 at harvest	Plant height (cm)	Pod/ plant	Seed /pod	1000 seed weight(g)	Seed yield (kg/ha)
BARI Mug 2	62	24.00c	33.67 ab	10.57 b	8.73	23.33 c	520 b
BARI Mug 4	62	26.33bc	36.00 a	11.53 ab	9.60	30.33 b	511 b
BARI Mug 5	59	28.33ab	31.67 b	10.20 bc	7.80	34.66 a	680 a
BM-01	62	24.00c	36.67 a	12.37 a	7.60	21.00 c	693 a
F-test	-	*	*	*	NS	*	*
CV(%)	-	4.84	4.56	7.56	19.02	6.20	6.05

Table 3. Performance of mungbean varieties / line at Kolapara, Patuakhali during the rabi season of 2003-2004

Treatments	Plant population/m^2 at harvest	Plant height (cm)	No. of branches/ plant	No. of pod/pod	No. of seed/pod	Grain yield (kg/ha)
BARI Mug 2	54	25.47	3.6	5.20	10.13	713
BARI Mug 4	53	29.40	3.9	5.37	9.47	579
BARI Mug 5	48	30.60	43.4	6.53	10.33	566
BM 01	41	28.13	3.5	5.60	10.27	438
F-test	NS	NS	NS	NS	NS	NS
CV (%)	22.0	11.3	14.2	11.8	5.7	19.7

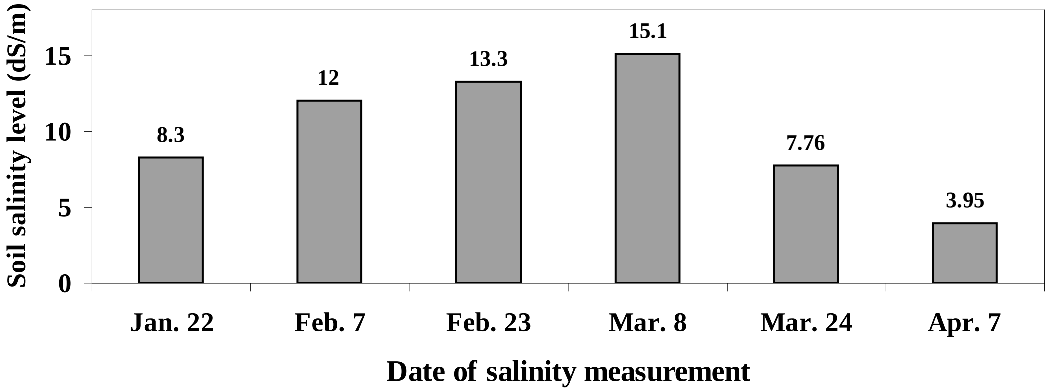

Fig. 1. Soil salinity level at Banarpota Farm, Satkhira

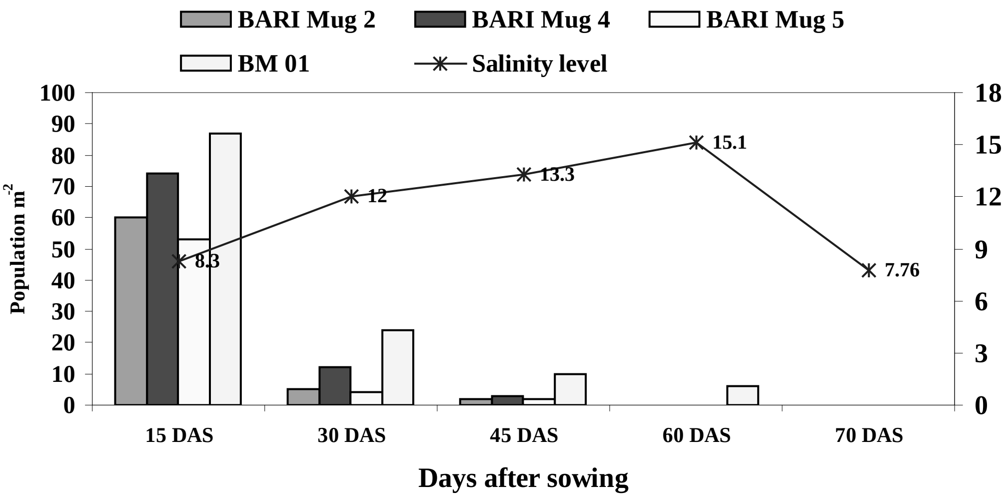

Fig. 2. Performance of mungbean varieties/line at Banarpota Farm during rabi season of 2003-2004

YIELD PERFORMANCE OF MUNGBEAN AS AFFECTED BY SALINITY IN COASTAL AREA

M. A. Aziz, S. M. Zaman, F. Begum and M.A. Rahman

Abstract

The field trial was conducted at Banarpota Farm, Satkhira, to assess the yield performance of salt tolerant genotype BM 01 under natural field condition. Five mungbean varieties / lines viz. BARI Mug 2, BARI Mug 4, BARI Mug 5, BM 01 and local were tested in a randomized block design with three replications. The salt tolerant line BM 01 showed better adaptability in coastal area. Significantly the highest yield (844 kg/ha) was obtained from BM 01. BARI mug 5 produced the lowest yield (389 kg/ha). The results indicated that the salt tolerance in BM 01 made in pot culture showed consistence with that made under field condition. Farmers performed BM 01 for resistance to viral diseases.

Introduction

A vast coastal and offshore area (2.85 m/ha) in the southern part of Bangladesh exhibits soil salinity of various magnitudes due to onrush of salt water from the Bay. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the underground moves up by capillary forces. Thus a considerable amount of salt from the subsoil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. As a result, most of the areas remain fallow during dry months. To increase mungbean area and production these marginal lands may be considered as it is mostly grown in the southern part of Bangladesh. The variation in salinity tolerance between crops and/or varieties of crop is well known (Mass and Hoffman, 1977; Karim *et al.* 1994; Richards *et al*. 1987). A judicial choice to grow a crop under saline soils is, therefore, considered an important management option to minimize yield loss by salinity. Blum (1988) rightly pointed out that, for sustainable crop production in the saline soils. It is more important to select a salt tolerant crop rather than a relatively better yielding variety of susceptible crops. The present study was therefore, undertaken to assess whether salt tolerance in BM 01 under control condition (pot culture) has relationship with that under field condition.

Materials and Methods

The trial was conducted at Banarpota Farm, Satkhira during late rabi season of 2004-2005. Four mungbean varieties/lines BARI Mug 2, BARI Mug 4, BARI Mug 5, BM 01 and local were included in the study. The unit plot size was 1.2m × 1m. Seeds were sown in 30cm × 10cm line following RCB design with three replications. Fertilizers @ of 20-16-15 kg/ha of N-P-K was applied as basal. Mungbean was sown on 13 February 2005 Weeding, thinning and all other intercultural operations were done as and when necessary. Soil salinity level was measured time to time. Data on yield and yield components were collected and analyzed statistically following 'MSTAT' programme.

Results and Discussion

The performance of mungbean varieties/line at Banarpota Farm presented in Table1. The soil salinity level was 6.90 dS/m on 04 February. Soil salinity increased upto 6 March and than declined (Fig. 1). On 6 March, 2005 the soil salinity level was 8.30 dS/m.. The crop maturity period varied from 65 to 68 days (Table 1). The plant population per unit area was varied significantly among the varieties. Highest population (25 plants/m^2) was in BM 01 and lowest (11.33 plants/m^2) in BARI Mug 4. Plant height influenced significantly by soil salinity. BARI Mug 5 produced the shortest plant among the mungbean varieties.

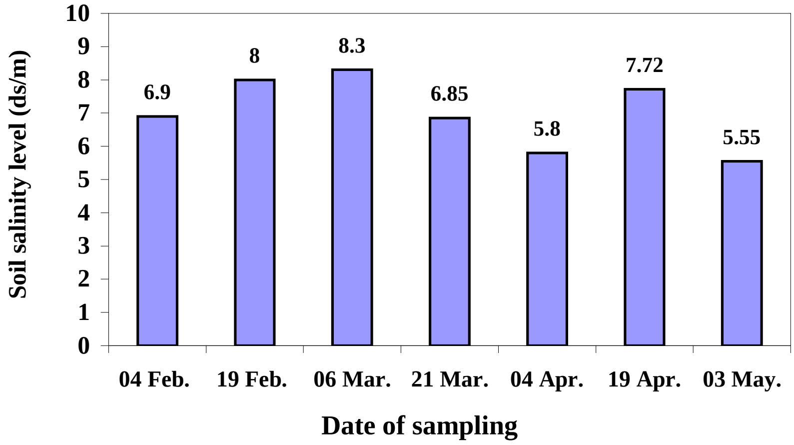

Fig.1. Soil salinity level at Banarpota Farm during the crop growing season

Soil salinity significantly influenced the yield and yield components of mungbean varieties (Table 1). The number of pods per plant were significantly lower in BARI Mug 5 under stress condition. Highest number of pods per plant was obtained in BM01. Similar results were obtained by Raptan (2001). Aziz *et al*. (2002) and Faruquei (2002). The influence of salt stress on reduction of number of seed per pod was significant. Significantly the highest individual grain weight was obtained from BM 01 and local followed by BARI Mug 2. Grain yield is the function of pods per plant, seeds per pod and individual seed weight. The effects of soil salinity on grain yield closely matched its effects on number of plants per unit area and pods per plant. Grain yields were decreased by soil salinity and the decrease differed among the varieties. Significantly

Table 1. Yield and yield attributes of mungbean as affected by natural soil salinity at Banerpota farm, Satkhira during rabi season, 2004-05

Variety/line	Days to maturity	Plant population/m^2 at harvest	Plant height (cm)	Pod/plant	Seed/pod	1000-seed weight (g)	Seed yield (kg/ha)
BARI Mung-2	65	19.00	49.67	14.33	10.00	34.00	766
BARI Mung-4	68	11.33	53.33	17.00	10.33	33.33	467
BARI Mung-5	68	21.00	44.00	9.67	8.67	33.33	389
BM 01	65	25.00	49.00	12.33	10.67	34.67	844
Local	68	22.00	47.00	12.33	10.00	34.67	728
LSD (.05)	-	2.10	1.75	1.65	1.49	NS	67.30
CV (%)	-	5.67	1.92	6.67	8.18	2.67	5.60

the highest grain yield (844 kg/ha) was obtained from BM01 followed by BARI Mug 2 (766 kg/ha). The lowest grain yield was obtained from BARI Mug 5 followed by BARI Mug 4. Under salt stress condition in pot culture at about 10 dS/m the observations are in line with the results obtained by Raptan (2001), Aziz *et al*. (2002), Faruque (2002) and Aziz (2003). They obtained the highest grain yield per plant from BM01. The salt tolerance in BM 01 made in pot culture performed better under natural field condition.

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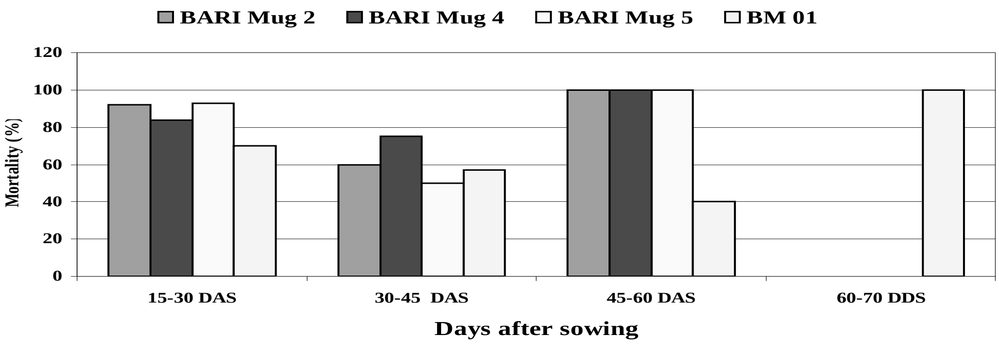

Fig. 3. Percent mortality of mungbean varieties/line at Banarpota Farm during rabi season of 2003-2004

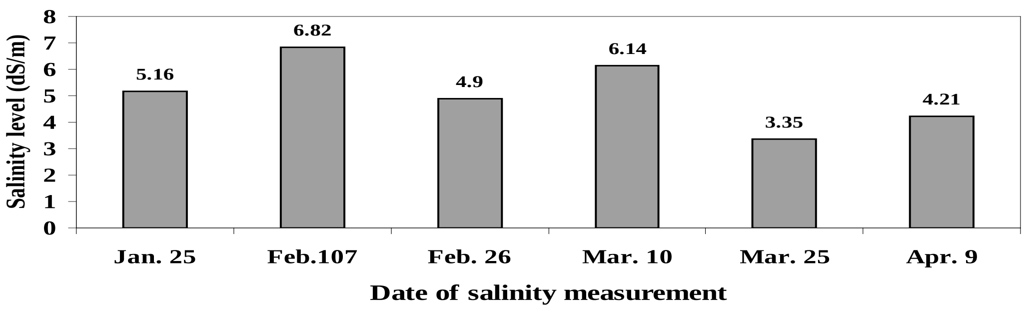

Fig. 4. Soil salinity level at Paikgacha MLT site, Khulna

SURVEY AND MONITORING OF EXISTING CROPS GROWN IN SALINE AREA

F. Begum, M. A. Aziz, R.R. Saha, M.A. Rahman, M. Amin
S.R. Zaman, S. Zaman and Idrish Ali

Introduction

Survey of existing crops in the saline areas has some special advantages in contrast with the designed experiments where certain selected crops are tested for survival in the saline environment. Infact, survey work and designed experiment can be taken as complementary to find out the diverse effect of salinity on crops. Controlled experiments provide selective information and short term effects while survey of natural environment in saline area will provide versatile effects on naturally grown plants with long term effects.

Methodology

Four saline areas namely Khulna Satkhira, Potuakhali and Noakhali were selected for the study. The village Loudobe of Khulna, Benarpota of Satkhira, Islampur and kuakata of potuakhali and Charmazid and Hazigong of Noakhali were surveyea. The data were collected through a questionare.rs. The collected data were analyzed and presented in a tabular from. To analyze the data percentage and mean values are used.

Result and Discussion

Land topography

Different types of land are observed in the surveyed area. On the basis of observation the land can be classified as low, medium and high. The highest percentage (72%) was medium type among these three. Only 2%is high land and rest 26% is low land. The highest percentage of medium type land is observed in Khulna area. The highest percentage of low land is observed in satkhira which was 46% (Table 1).

Land ownership pattern

Majority of the farmers found to have 6 to 20 Bigha with an average of bigha in the area we studied considerins total land area including shared land. Out of total land area, 77% is found to be farmers personal property and the rest 23% land is cultivated by renting. In respect of personal ownership of the land different areas present different pictures. For example, the village satkhira 100% cultivated land belong to the responded farmers themselves, in laudova, Khulna the personally posses land was 90%. While in potuakhali and Noakhali around 56% percent cultivated land around belongs to the farmers themselves and the rest was rented (Table 2).

Source of income

The farmers can not devote themselves completely to agriculture and for his survival he has to depend on some secondary income. Only 26% of the farmers can earn their living from Agriculture alone. These farmers belong mostly in khulna area and they are relatively affluent (Loudove). 52% of the respondent farmers have to depend on some business to supplement their income from Agriculture. 9% of the respondent farmers do some regular job in addition to farming. Some farmers (13%) who are mostly poor have to serve as day labourer besides farming for their livelihood. These farmers belong mostly in Noakhali (36%) and Patuakhali (9%) (Table 3).

Yearly income

In respect of yearly income the farmers can be catagorised are as having yearly income above 75,000/year, farmers above 50,000/year, whose income is above 50,000 and above 25,000 and to above 50% 25000/-. The respondent farmers in come at Laudobe and Potuakhali around more than 75,000 taka/year (Table 4).

Cropping pattern

Five different cropping patterns are followed by respondent farmers. Among these five cropping pattern 50% of the respondent farmers followed Aman-Rabi-Aus pattern, 15% followed Aman-Rabi-Fallow, 24% followed Aman-Boro-Fallow, 11% followed Aman-Fallow-Aus and 17% followed. T.Aman-Fallow-Fallow pattern. It is observed that Amana-Rabi-Aus is mostly followed in Potaukhali area. In Sathkira 90% of the responds follow Aman-Boro-Fallow pattern. Aman-Rabi-fallow as only followed in potuakhali (Table 5).

Land area occupied by crops

From the survey it is observed that the maximum land (87%) is occupied by Aman crop. Farmers cultivated aus and boro only in 6 to 7 % area and 22% land is used by the respondents farmers for rabi crops.

In general Aman is the dominant crop almost irrespective of the geographical location. Aus is grown mostly in Satkhira where low land privails. Cultivation of boro is dependent on irrigation and therefore reguired availability of water source and financial investment. This may explain why the boro cultivation is so scanty in khulna and satkhira (5%) in Noakhali (11%) and potuakhali (16%) (Table 6)

Crops grown in rabi season

Different rabi crops like pulses, Oil seeds, Different types of vegetables and watermelon are grown in different area. In satkhira only pulses (50%) and Oilseed (50%) crops are grown. In Noakhali, although the land occupied by all four type of crops oil seeds crops was dominant (60%) where as in Potuakhali water melon dominates (Table 7).

Source of seed

Most of the farmers (65%) depend for their seeds partly on the market supplemented by their own grown seeds 28% farmers used their own seeds only. Only 7% farmers depends entirely on market for their seeds. In satkhira 100% farmer used their seeds and partly from the market (Table 8).

The adverse effects on cultivated crops due to salinity

Obtained from the information gathered from the respondent farmers show that the salinity cause the following adverse effect on crops:

(1) Reduction of germination percentage
(2) Burning of the leaves and early leaf senescence
(3) Reduction of plant growth
(4) Reduction of yield
(5) wilting effect

Some suggested remedy

The cause of salinity can sometimes be checked. For example, due to shrimp culture, gher is used to confined saline water; this increases the salinity of the neighboring field. This can be stopped. Irrigation with fresh water can reduce salinity. Proper crop can be chosen which are more tolerant to saline environment. The systematic research can be carried out to identify and quantify the real problems, which gather only from verbal information. Agronomic practices of the crop can be practiced which is not follow at the moment by the farmers. Proper agronomic practices of the rabi crop should be introduced for better yield. Rain water management through water shed development.

Salinity Stress

Table 1. Land Topography

(a) Total basis

	No. of respondents	%
High	4	2
Medium high	46	72
Low	19	26

(b) Location basis

	High	Medium high	Low
Khulna	2%	85%	13%
Sathkira	0%	54%	46%
Potuakhali	3%	60	37
Noakhali	1	81	18

Table 2. Land ownership pattern

(a) Total basis

	No. of respondents	%
Own	44	77
Share in	2	23
upto 5	8	17
6-20	31	67
21-40	5	11
>40	2	4

(b) Area basis

	No. of respondents	%
Khulna	90	10
Satkhira	100	-
Potuakhali	59	41
Noakhali	56	44

Table 3. Source of income

(a) Total basis

	No. of respondent	%
Agriculture	12	26
Agril + business	24	52
Agril + Service	4	9
Agril + day labour	6	13

(b) Location basis

	Khulna		Satkhira		Potuakhali		Noakhali	
	no. of res	%	no. of res	%	no. of res	%	no. of res	%
Agriculture	7	70	-		3	27	2	14
Agril + business	1	10	11	100	7	64	5	36
Agril + Service	2	20	-	-	-	-	2	14
Agril + day labour	-	-	-	-	1	9	5	36

Table 4. Yearly income

(a) In total survey area

	No. of respondents	%
upto 25,000/-	5	11
26-50,000/-	15	33
51,000-75,000/-	5	11
>76,000/-	21	45

(b) Location basis

Amount	Yearly income (%)			
	Khulna	Satkhira	Potuakhali	Noakhali
upto 25,000/-	10	18	0	14
26-50,000/-	30	27	27	43
51,000-75,000/-	10	9	18	7
>76,000/-	50	46	55	36

Table 5. Cropping pattern followed by farmers

(a) In total survey area

Cropping pattern	Persone respondents	%
Aman-Rabi-aus	23	50
Aman-Rabi-fallow	7	15
Aman-boro-fallow	11	24
Aman-fallow-aus	5	11
Aman-fallow-fallow	8	17

(b) Location basis

Cropping pattern	Kkulna	Satkhira	Potuakhali	Noakhali
Aman-Rabi-aus	80	18	73	57
Aman-Rabi-fallow	-	-	27	-
Aman-boro-fallow	0	90	0	-
Aman-fallow-aus	10	0	27	7
Aman-fallow-fallow	20	-	-	43

Table 6. Land distribution for different crops.

(a) Total survey area

Area	Crop based area			
	Aman	Boro	Aus	Rabi crops
Total area	87	7	6	22

(b)Location basis

Location	Crop based area			
	Aman	Boro	Aus	Rabi crops
Kulna	90	-	5	20
Satkhira	86	20	5	4
Potuakhali	85	0	16	31
Noakhali	84	0	11	29

Table7. Crops grown in Rabi season

Location wise

Crops	Kulna	Satkhira	Potuakhali	Noakhali
Pulse	20	50	20	10
Oilseeds	20	50	20	60
Veg.	30	-	10	10
Water malon	30	-	50	20

Table 8. Source of seed

(a) Total survey areas

Own		Own + market		Market	
No. of respondents	%	No. of respondents	%	No. of respondents	%
13	28	30	65	3	7

(b) Source of seed (area basis)

Location	No.of Res.	%	No.of Res.	%	No.of Res.	%
Kulna	4	40	4	40	2	20
Satkhira	-	-	11	100	-	-
Potuakhali	3	27	7	64	1	9
Noakhali	6	43	8	57	-	-

PERFORMANCE OF COWPEA UNDER DIFFERENT SOWING TIME IN COASTAL AREA

M. A. Aziz, S. M. Zaman, Mohammad Amin, F. Begum and M.A. Rahman

Abstract

An experiment was conducted at Banerpota Farm, Satkhira and Noakhali to find out the optimum date of sowing of cowpea for the coastal area of Bangladesh to avoid salinity stress as well as moisture stress and to get maximum yield. Five date of sowing from 1 January to 1 March with 15 day interval was adapted with four replications in a RCB design. January sown performed maximum growth and yield of cowpea. It might be concluded that January sowing would be the optimum time of sowing for cowpea in the coastal area of Bangladesh to avoid salinity stress. The experiment should be repeated in the next season for final conformation.

Introduction

Cowpea (Vigna unguiculata L.) is a comparatively cheap source of quality protein, iron and vitamin B and excellent substitute for meat, eggs and other protein yielding foods when served as grains and vegetables. Cowpea is moderately tolerant to salinity. Farmers are growing local variety in the middle of January in southern belt. About 30,000 ha are under cowpea mostly in Barisal, Patuakhali, Chittagong, Cox'sbazar, Noakhali areas. During the reproductive phase of the crop soil moisture dries up and the crop suffers from drought as well as salinity stress. Sowing time is one of the most important factors to avoid the stress conditions. The optimum sowing time of cowpea in coastal region is not yet determined. The present study was therefore, undertaken to determine the optimum sowing time of cowpea for the coastal region.

Materials and Methods

The trial was conducted at Noakhali and Banerpota, Satkhira during the rabi season of 2005-2006 with five date of sowing. RCB design with four replications was adopted to test the study. The unit plot size was 3m × 2m. The experiment was initiated on 01 January and 04 January 2006 at Noakhali and Satkhira, respectively. The crop was sown in line with a spacing of 30cm. Fertilizer were applied at the rate of 20-16-17-10 kg/ha of N, P, K and S respectively from urea, TSP, MP and gypsum. All Urea, TSP, MP and gypsum were applied as basal. All other intercultural operations were done as and when necessary. Data on yield and yield attributes were collected and analyzed statistically following MSTAT program. The means were separated by LSD.

Results and Discussion

Satkhira

The soil salinity level at Banerpota, Satkhira during the crop growth period varied from 3.23 to 9.18 ds/m. It was 3.23 ds/m on 1 January and maximum 9.18 on 16 March (Fig.1.). Significant variation for different characters among the treatments was observed in the study due to salinity stress (Table 1). The highest plant population was observed in 3 February sowing followed by 4 January sowing. Cowpea sowing on 3 February gave significantly the tallest plant. The plant height gradually increased with the advancement of date of sowing.

Pods per plant and seed per pod followed the reverse trend as plant height. Cowpea sown on 4 January produced significantly the highest number of pods (12.75) per plant followed by 19

January (9.75) and 3 February produced the lowest number of pods per plant. Similar trend was observed in seed per pod. Significantly the highest number of seed per pod was obtained from 4 January sowing followed by 19 January sowing. The crop sown beyond 3 February failed to produce any seed. 4 January sowing gave significantly the highest seed weight (81.50 g/1000-seed) and 19 January sowing gave the lowest seed weight (74.75 g/1000-seed). All the yield contributing characters finally contributed to the grain yield. The highest seed yield (1083 kg/ha)

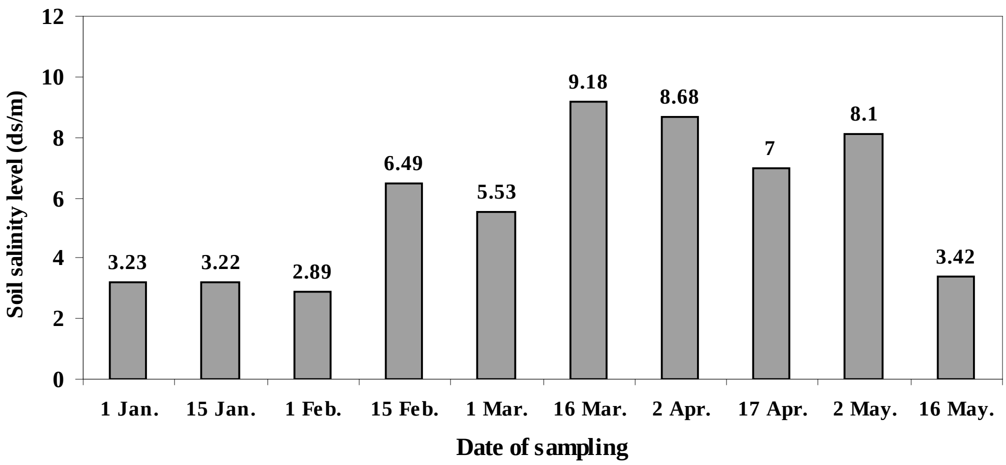

Fig.1. Soil salinity level at Banerpota Farm during the crop growing season

was obtained from 4 January sowing followed by 19 January sowing. 3 February sowing produced significantly the lowest yield (633 kg/ha). The highest yield from 4 January sowing could be contributed due to maximum number of pod per plant, seed per pod and 1000-seed weight. Cowpea sown beyond 3 February failed to produce any seed might be due to the toxic effect of salinity accompanied with high temperature.

Noakhali

The soil salinity level at Noakhali during the crop growth period varied from 1.65 to 10.01 ds/m. The data presented in Table 2 indicated the plant and growth decreased with the advancement of sowing date from 1 January to 1 March. Significantly the tallest plant (53.37 cm) was found in 1 January sowing which was identical with 15 January sowing the crop sown on 1 March gave the shortest plant (49.05 cm). The number of branch although varied insignificantly was higher in 1 January sowing (4.36) which was reduced gradually up to 15 February sowing. Cowpea sown on 15 January produced significantly the highest number pod/plant (5.91) 1 February sowing gave 5.60pods/plant and was identical with 1 January (5.59). 15 February sowing produced significantly the lowest number of pod/plant (4.93). The crop sown on 1 March failed to produce any pod. This might be due to higher salinity stress accompanied with moisture stress. The longest pod was at 15 January sowing and was similar with 1 January and 1 February sowing. 15 February sowing gave shorter pod which was identical with 1 February sowing. Significantly the highest number of seed/pod (14.30) obtained from 1 January sowing but was identical with 15 January and 1 February sowing. 15 February sowing gave significantly the lowest number of seed/pod (10.53). 1000-seed weight varied significantly due to different date of sowing and it was maximum on 15 January sowing (92.33 g) and minimum on 15 February sowing (80.00).

Significantly the highest yield (1177 kg/ha) was obtained from 15 January sowing which was identical with 1 February sowing (1083 kg/ha) and 1 January sowing (1037 kg/ha). Cowpea sown on 15 February gave significantly the lowest yield. Maximum yield from 15 January sowing might be attributed due to maximum number of pods/plant seed/pod and 1000-seed weight. Cowpea plant grown on January perform better growth and maximum yield indicated that the crop avoid salinity stress as well as moisture stress. It might be concluded that January sowing would be the optimum time of sowing for cowpea in the coastal area of Bangladesh to avoid salinity stress accompanied with moisture stress. The experiment should be repeated in the next season for final conformation.

Table 1. Yield and yield attributes of cowpea for different date of sowing as affected by salinity stress at Banerpota Farm, Satkhira

Date of sowing	Plant popoulation/m^2	Plant height (cm)	Pod/ plant	Seed/ pod	1000- seed weight (g)	Grain yield (kg/ha)
4 January	20	59.50	12.75	10.00	81.50	1083
9 January	19	64.00	9.75	9.00	74.75	917
3 February	21	70.00	5.75	6.75	76.00	633
18 February	-	-	-	-	-	-
5 March	-	-	-	-	-	-
LSD (.05%)	1.63	1.91	3.26	2.21	3.37	131.1
CV(%)	4.75	1.71	20.02	14.91	2.52	8.63

Table 2. Yield and yield attributes of cowpea for different date of sowing as affected by salinity stress at Noakhali

Date of sowing	Plant height (cm)	Branches/ Plant	Pod/ plant	Pod length (cm)	Seed/ pod	1000-seed weight (g)	Yield (kg/ha)
1 January	53.37	4.36	5.59	17.00	14.30	89.00	1037
15 January	53.19	4.23	5.91	17.58	13.83	92.33	1177
1 February	50.80	4.06	5.60	15.78	12.91	91.00	1083
15 February	50.14	4.00	4.93	14.80	10.53	80.00	833
1 March	49.05	4.00	-	-	-	-	-
LSD (.05%)	1.81	0.80	0.22	2.00	2.52	2.83	235
CV(%)	1.75	9.67	2.02	6.20	9.77	1.64	11.42

EFFECT OF DATE OF SOWING ON GROWTH, YIELD AND YIELD COMPONENTS OF MUNGBEAN

M. A. Aziz, S. M. Zaman, F. Begum and M.A. Rahman

Abstract

The experiment was conducted at Agricultural Research Station, Daulatpur, Khulna during the rabi season of 2005-2006 to investigate the influence of sowing date on the performance of mungbean varieties as well as to avoid moisture stress caused due to late sowing after 15 January. Four varieties/line of mungbean such as BARI mug 2, BARI mug 5, BM 01 and Local were sown on different date under rainfed situation in a split-plot design. Among the mungbean varieties BM 01 performed better on 18 December sowing and 7 January sowing but BARI mug 2 performed better on 28 December sowing. It might be concluded that BM 01 followed by BARI mug 2 would be suitable for north-western non saline region provided that the sowing could be completed within 1st week of January to avoid moisture stress. The experiment should be repeated in the next season for final conformation.

Introduction

Mungbean is the fifth important pulse crop of Bangladesh and contributes about 11.53% of total pulses production. Its area and production are increasing now a days. About 65% of mungbean grow in the southern areas. In the coastal areas where soil salinity is minimum, farmers are growing local mungbean cultivar with poor yield potential. It was observed that BM 01 performed better than local varieties in the coastal non saline area. Farmers are growing local variety in the middle of January. During the reproductive phase of the crop, soil moisture dries up and the crop suffers from drought. Early sowing in December could save the crop from severity of drought. The present study was therefore, undertaken to find out optimum date of sowing for maximum growth and yield of mungbean for coastal non saline areas of Bangladesh.

Material and Methods

The trial was conducted at Agricultural Research Sub-Station, Daulatpur, Khulna during the rabi season of 2005-2006. The experiment was laid out in a randomized complete block design with four replications. The unit plot size was 2m x 2m. Three dates of sowing viz. 18 December 2005, 28 December 2005 and 07 January 2006 and four varieties/line of mungbean viz. BARI mug 2, BARI mug 5, BM 01, and Local variety were adopted in a split-plot design. Fertilizer was applied at the rate of 20-16-17-10 kg/ha of N, P, K and S respectively from urea, TSP, MP and gypsum. All Urea, TSP, MP and gypsum were applied as basal. All other intercultural operations and plant protections were done as and when necessary. Soil samples are collected at 15 days interval. Data on yield and yield attributes were collected and analyzed statistically following ‘MSTAT’ program. The means were separated by LSD.

Result and Discussion

Date of sowing influenced insignificantly among the characters studied except plant population/m^2 and plant height (Table 1). Significantly the highest population was found in 28 December sowing followed by December 18 sowing. Mungbean sown on 28 December gave significantly the tallest plant and 18 December sown gave the shortest plant. The maximum yield (977 kg/ha) was obtained from 18 December sowing followed by 28 December sowing.

Significant variation among the varieties was observed for different plant characters. Variation in population/m^2 at harvest was observed among the varieties that might be due to management practices i.e. thinning operation. Minimum population/m^2 was observed in BARI mug 5 (Table 1).

Highest plant height of 32.22 cm was observed in BARI mug 5 and lowest plant height was observed in BARI mug 2. BM 01 produced significantly the highest number of pod per plant (8.59) which was identical with local and BARI mug 2. BARI mug 5 gave significantly the lowest number of pod per plant (6.02). Number of seed per pod also varied significantly among the varieties and it was maximum in Local (9.90) but was similar with BM 01 (9.38) and BARI mug (9.53). The lowest number of seed per pod was observed in BARI mug 2 (8.57). Significantly the highest seed weight was found in BARI mug 5 (38.70 g/1000 seed) followed by BARI mug 2 (34.68 g/1000 seed). Local variety was significantly lowest in seed weight (19.15 g/1000 seed). BM 01 produced significantly the highest yield (1114 kg/ha). The lowest yield was obtained from BARI mug 5 (871 kg/ha) followed by local variety (886 kg/ha). The highest yield in BM 01 may be due to the maximum number of pod per plant, seed per pod and maximum population per unit area.

The results presented in Table 2 indicated that among the mungbean varieties BM 01 performed better on 18 December sowing and 7 January sowing but BARI mug 2 performed better on 28 December sowing. It might be concluded that BM 01 followed by BARI mug 2 would be suitable for north-western non saline region provided that the sowing could be completed within 1st week of January to avoid moisture stress. This is one year result, the experiment should be repeated in the next season for final conformation.

Table 1. Yield and yield attributes of mungbean as influenced date of sowing and variety at ARS Daulatpur, Khulna Rabi season, 2005-06

Treatment	Plant/ population/ m^2	Plant height (cm)	Pod/plant	Seed/pod	1000-seed weight (g)	Seed yield (kg/ha)
Sowing date						
18 December	51.87 b	26.80 c	7.93 b	9.39 a	28.65 a	977 a
28 December	56.75 a	31.97 a	7.43 a	9.32 a	28.91 a	933 a
07 January	49.44 b	29.58 b	7.99 c	9.33 a	29.47 a	966 a
Variety/line						
BARI mug-2	49.25 b	25.34 c	7.99 a	8.57 b	34.68 b	963 b
BARI mug-5	48.33 b	32.22 a	6.02 b	9.53 a	38.70 a	871 c
BM-01	54.83 a	29.72 b	8.59 a	9.38 a	23.51 c	1114 a
Local	58.33 a	30.51 b	8.53 a	9.90 a	19.51 d	886 c

Table 2. Yield and yield attributes of mungbean as influenced of sowing date at ARS Daulatpur, Khulna rabi season, 2005-06

Sowing date	Variety/line	Plant height (cm)	Plant population/m^2	Pod/ plant	Seed/pod	1000-seed weight (g)	Seed yield (kg/ha)
December 18	BARI mug-2	23.65 f	50.25 bc	7.75 ab	8.00 d	33.10 c	900 c
	BARI Mung-2	31.60 bc	47.00 cd	6.83 bc	9.48 ab	38.60 a	953 c
	BM-01	24.00f	54.75 abc	8.45 a	10.30 a	23.93 d	1187 ab
	Local	27.95 e	55.00 abc	8.70 a	9.78 ab	18.98 f	868 cd
December 28	BARI mug-2	27.63 e	51.50 bc	7.98 ab	8.35 cd	35.73 bc	1125 b
	BARI mug-5	30.70 cd	58.50 ab	4.85 d	9.55 ab	38.13 ab	781 d
	BM-01	34.10 ab	54.75 abc	8.65 a	9.00 bcd	23.60 d	921 c
	Local	35.45 a	62.75 a	8.23 ab	10.38 a	18.81 f	906 e
January 07	BARI mug-2	24.75 f	46.00 cd	8.25 ab	9.35 abc	35.20 c	865 cd
	BARI mug-5	34.35 a	35.00 d	6.38 c	9.55 ab	39.38 a	881 cd
	BM-01	31.05 c	55.50 abc	8.68 a	8.86 bcd	23.00 de	1234 a
	Local	27.15 de	57.25 ab	8.68 a	9.55 ab	20.30ef	884 cd

- Means followed by common letters are statistically similar at 5% level.

SCREENING OF BARLEY CULTIVARS/LINES AGAINST SALINITY UNDER LABORATORY CONDITION

F. Begum, A.K.M. Alom, W. Sultana and M. A. Matin

Abstract

Fifteen hull-less barley cultivars/lines were tested under laboratory and artificial saline environment during 2006-2007 to study the salt tolerance at germination, seedling stage and crop maturity stage. For salinity gradients 4, 8, 12 and 16 dS^{-m} was used against distilled water (control) for germination and with Hoagland nutrient solution for seedling stages. Germination percentage, seedling length and seedling dry weight decreased at 16 dS^{-m}. Crop yield was also affected under salinity. On the basis of germination, seedling growth, vigour index including yield/plant, lines BHL-10, BHL-15, BHL-18, BHL-19, EM BSN-06 and EM BSN-58-06 showed better performance. These lines can be selected for further investigation in the coastal saline areas.

Introduction

In Bangladesh, about 52.8 percent of the net cultivated land in the coastal area is affected by varying degrees of soil salinity. This vast land remains mostly uncultivated except some selected areas where T. aman crop is cultivated. So, introduction of salt tolerant crops is the most acceptable ways of intensifying crop production in these areas. It was reported that germination is the most sensitive stage of plant growth and development in saline environments (Roth 1989, Onkare *et a*l. 1993). Seedling development of different crops is also affected by varying level of salinity (Islam *et al*, 1989).Since barley is relatively more salinity tolerant, the crop can be grown in saline areas. For successful cultivation, in coastal areas salt tolerant lines/varieties need to be identified. Screening of barley germplasm against salinity is one of the accepted methods to select lines for saline soil.

Materials and Methods

The experiment was conducted in plant physiology laboratory, Agronomy Division, to study germination and seedling growth during the period Nov 1 to Nov. 30, 2006.

The seeds of 15 hullless barley lines were used for this study. The seeds were collected from Plant Breeding Division; BARI. The germination was carried out in petridishes according to ISTA rules (1985). Four levels of salinity 0,8, 12 and 16 dS^{-m} sodium chloride solution were used for germination test. For seedling growth, plants were grown in black plastic pots. The treatment solutions were prepared as follows: To = Tap water mixed with Hoagland Nutrient solution (0.4 dS^{-m}). T_1, T_2, T_3, = Salt of sodium chloride added to Hoagland nutrient solution to prepare 8.0, 12.0 and 16.0 dS^{-m} salinity levels respectively. Seedlings were grown for two weeks. Seedling length and dry weight were recorded.

To observed yield variation, plants were grown in the crop season of 2006-07 in seed bed (2 m x 1 m).A polythene sheet was placed at a depth of 1.5 feet of the seed bed.Before sowing, treatment solution (8, 12 and 16 dS^{-m} was imposed. The salinity levels were raised to 0.71 2.96 dS^{-m} 6.30 dS^{-m} and 12.46 dS^{-m} by adding NaCl solution externally. This concentration was maintained by adding salt solution. Plant height and yield/plant was recorded after harvest.

Result and Discussion

The result obtained from laboratory trial under control condition are presented in table 1-7.The germination percentage of Barley decreased with the increase in salinity level. At 8 dS^{-m}, 93%

seeds of the lines BHL-19 and BHL-08 were germinated (table1). The minimum germination occurred in lines EMBSN-43-05 and BHL-03 at 8dS^{-m}.At 8dS^{-m} lines, BHL-09, BHL-10, BHL-18, BHL-19, EMBSN-06, and EMBSN-58-06 showed above 80% germination. At higher salinity (16dS^{-m}), 80% seeds germinated in case of BHL-19. Where as, only 7% seeds were germinated in line BHL-12. A decrease in germination was also observed in rice (Dubey and Rani ,1989), wheat (Hossain *et al*, 2000) at 1% level of NaCl. The mean seedling length under control was 57 cm which decreased to 34.69, 24.85 and 16.78 cm at 8, 12 and 16 dS^{-m} respectively (table 2). At 8 dS^{-m} the maximum seedling length (46.49 cm) observed in EMBSN-06 and minimum (17.25 cm) in EM-BSN-17. EMBSN-06 also performs better under higher salinity (16 dS^{-m}).

This line EMBSN-06 performed better when seedling dry weight (table 3) is considered. Considering seelding vigour (length basis), lines BHL-10,BHL-11,BHL-15,BHL-19, BHL-08 EM BSN-06, EM BSN-22-06, EM BSN-58-06 have been chosen for better performance at 4 dS^{-m} level (table 4). Lines BHL-18, BHL-03, BHL-14 and EM-BSN-22-06 showed good performance even at higher salinity. A decrease in germination percentage, seedling growth and vigour index was also observed in rice (Onkoware, 1993). Plant height was recorded after harvest and is shown in table 5. The mean plant height in control was 70. 81 which decreased to 62.90cm at 12.46 dS$^{-m.}$.

The results obtained from seed bed trial are presented in Table-6. Yield/plant was also affected under salinity. At lower salinity only BHL-03, BHL-11 and EM-BSN 24-06 lines were largely affected and varied from 22 % to 44% decrease as compared to control. Lines BHL-10, BHL-12, BHL-15, EM-BSN-06 and EM-BSN-58-06 have a stimulatory affect under lower salinity. The yield /plant did not vary much upto 6.30 dS^{-m} in lines BHL-15, BHL-18, BHL-19 and EM-BSN-06. Yield per plant was not affected by higher salinity (12.46 dS^{-m}) in EMBSN-06 (2.06g).

Considering all the parameters like germination percentage, seedling vigour and also yield/plant, Line EM-BSN-58-06 was the most tolerant one. Lines BHL-15, BHL-18, BHL-19, and EMBSN-06, also performed better under salinity upto 6.30 dS^{-m}.

Table 1. Effects of salinity on germination of barley

Lines	Germination (%)			
	Salinity level			
	Control	8 dS^{-m}	12 dS^{-m}	16 dS^{-m}
BHL-03	53	27	20	13
BHL-08	67	60	60	47
BHL-09	93	93	87	67
BHL-10	87	83	67	47
BHL-11	73	67	67	65
BHL-12	60	33	27	7
BHL-15	80	77	67	47
BHL-18	87	80	40	40
BHL-19	**100**	**93**	**80**	**80**
EMBSN-43-05	53	27	13	7
EMBSN-06	87	86	67	53
EMBSN-17-06	87	60	47	20
EMBSN-22-06	80	73	73	60
EMBSN-24-06	80	35	30	27
EMBSN-58-06	100	87	80	47
Mean	**79**	**66**	**55**	**42**
Max	100	93	87	67
Min	53	27	13	7
SD	4	6	6	6

Salinity Stress

Table 1(ii). Relative germination percentage under salinity as compared to control

Lines	Relative G% of barley as per control		
	Salinity		
	8 dS^{-m}	12 dS^{-m}	16 dS^{-m}
BHL-03	-49	-62	-75
BHL-08	-10	-10	-43
BHL-09	0	-6	-28
BHL-10	-5	-16	-45
BHL-11	-8	-8	-10
BHL-12	-45	-55	-88
BHL-15	**-4**	**-16**	**-41**
BHL-18	-8	-64	-64
BHL-19	**-7**	**-20**	**-20**
EMBSN-43-05	-49	-75	-87
EMBSN-06	**-1**	**-16**	**-39**
EMBSN-17-06	-31	-46	-77
EMBSN-22-06	-9	-9	-25
EMBSN-24-06	-56	-63	-66
EMBSN-58-06	**-9**	**-20**	**-53**

Table 2. Effects of salinity on seedling length (root length + shoot length) of barley

Lines	Seedling length (cm)			
	Salinity level			
	Control	8 dS^{-m}	12 dS^{-m}	16 dS^{-m}
BHL-03	65.75	40.75	25.62	24.50
BHL-08	55.74	31.83	18.74	13.12
BHL-09	49.75	39.88	31.50	12.50
BHL-10	57.99	45.82	17.33	10.10
BHL-11	44.25	30.17	20.33	15.83
BHL-12	53.41	30.50	22.5	-
BHL-15	59.08	58.75	26.66	13.25
BHL-18	63.08	60.41	30.1	22.1
BHL-19	69.50	**61.17**	29.08	20.17
EMBSN-43-05	48.83	20.70	19.0	-
EMBSN-06	**54.83**	**52.49**	**33.13**	**31.58**
EMBSN-17-06	57.99	17.25	12.0	8.25
EMBSN-24-06	63.24	26.70	24.91	18.75
EMBSN-22-06	50.82	35.66	34.24	15.75
EMBSN-58-06	**61.74**	**54.24**	**27.57**	**12.2**
Mean	**57.0**	**40.42**	**24.85**	**16.78**
Max	69.50	61.17	34.24	31.58
Min	44.25	17.25	12.0	0
SD	2	2.33.74	1.7	1.8

Table 3. Effects of salinity on seedling dry weight of barley

Lines	Dry weight (g/seedling)			
	Salinity level			
	Control	8 dS^{-m}	12 dS^{-m}	16 dS^{-m}
BHL-03	0.132	0.058	0.05	0.014
BHL-08	0.118	0.056	0.04	0.012
BHL-09	0.180	0.114	0.08	0.026
BHL-10	0.134	0.108	0.042	0.01
BHL-11	0.06	0.04	0.04	0.024
BHL-12	0.106	0.01	0.01	-
BHL-15	0.106	0.094	0.03	0.03
BHL-18	0.112	0.098	0.032	0.02
BHL-19	0.156	0.146	0.07	0.036
EMBSN-43-05	0.082	0.02	0.02	-
EMBSN-06	0.102	0.096	0.046	0.046
EMBSN-17-06	0.188	0.016	0.05	0.01
EMBSN-22-06	0.11	0.08	0.06	0.026
EMBSN-24-06	0.134	0.074	0.06	0.042
EMBSN-58-06	0.13	0.106	0.04	0.042
Mean	**0.119**	**0.056**	**0.045**	**0.026**
Max	0.188	0.146	0.08	0.046
Min	0.06	0.01	0.01	.01
SD	0.007	0.007	0.005	0.006

Table 4. Effects of salinity on vigour index (Length basis)

Lines	**Vigour index (Length basis)**			
	Salinity level			
	Control	8 dS^{-m}	12 dS^{-m}	16 dS^{-m}
BHL-03	3484	1100	512	980
BHL-08	3735	1910	1161	617
BHL-09	4627	3709	**2741**	836
BHL-10	5545	3803	2615	475
BHL-11	3230	2021	1362	1029
BHL-12	4770	1007	608	-
BHL-15	4726	4534	1786	623
BHL-18	5488	3806	1208	884
BHL-19	6950	5689	2326	1614
EMBSN-43-05	2588	559	247	-
EMBSN 06	4770	4514	2220	1674
EMBSN-17-06	5045	1035	564	165
EMBSN-22-06	4066	2603	2500	945
EMBSN-24-06	5059	935	996	506
EMBSN-58-06	6171	4936	2206	573
Mean	**4684**	**2810**	**1537**	**840**
Max	6950	5689	2741	1614
Min	2588	559	247	165
SD	295	441	221	119

Table 5. Effect of salinity on plant height of barley

Lines	**Plant height (cm)**			
	Salinity level			
	0.71 dS^{-m}	2.96 dS^{-m}	6.30 dS^{-m}	12.46 dS^{-m}
BHL-03	69.4	69.6	73.3	67.3
BHL-08	68.9	71.0	72.9	71.4
BHL-09	71.8	68.6	61.8	60.4
BHL-10	71.8	79.1	70.4	51.2
BHL-11	74.6	60.2	59.5	62.9
BHL-12	73.1	71.2	75.7	68.1
BHL-15	73.3	61.8	63.5	58.8
BHL-18	76.4	70.6	72.5	68.6
BHL-19	72.4	60.2	66.3	64.4
EMBSN-43-05	63.9	54.8	51.1	58.7
EMBSN-06	66.5	64	61.1	63
EMBSN-17-06	68.5	72.2	67.7	52.2
EMBSN-22-06	69.5	69.2	69.7	60.6
EMBSN-24-06	73.0	64.0	62.5	65.8
EMBSN-58-06	69.1	69.1	69.7	67.6
Mean	**70.81**	**67.04**	**66.51**	**62.9**
Max	76.4	76.1	75.7	71.4
Min	63.9	54.8	51.1	51.23
SD	0.8	1.5	1.7	1.6

Table 6. Effect of salinity on number of seed per spike

Lines	No. of seed/spike			
	Salinity level			
	0.71 dS^{-m}	2.96 dS^{-m}	6.30 dS^{-m}	12.46 dS^{-m}
BHL-03	37	44	36	32
BHL-08	42	40	40	36
BHL-09	52	46	35	30
BHL-10	51	54	48	44
BHL-11	45	43	26	24
BHL-12	53	54	49	34
BHL-15	51	46	40	19
BHL-18	55	49	48	40
BHL-19	44	50	48	34
EMBSN-43-05	15	12	11	11
EMBSN-06	22	22	26	23
EMBSN-17-06	44	41	36	33
EMBSN-22-06	38	29	29	20
EMBSN-24-06	48	42	29	29
EMBSN-58-06	54	59	50	48
Mean	**43.4**	**41.0**	**36.87**	**31.14**
Max	55	59	50	48
Min	15	12	11	11
SD	3	12	2.9	2.7

Table 7. Yield performance of Barley under salinity

Liens	Yield/plant (g)			
	Salinity level			
	0.71 dS-m	2.96 dS^{-m}	6.30 dS^{-m}	12.46 dS^{-m}
BHL-03	2.88	1.62	1.23	1.04
BHL-08	2.58	2.55	1.89	1.67
BHL-09	2.43	1.84	1.39	0.92
BHL-10	2.52	2.88	2.80	1.67
BHL-11	2.52	2.02	1.31	0.84
BHL-12	2.64	2.72	1.54	1.10
BHL-15	2.45	2.58	2.53	0.90
BHL-18	2.64	2.60	2.69	1.29
BHL-19	2.20	2.09	2.31	1.57
EMBSN-43-05	2.36	1.83	1.60	1.55
EMBSN-06	1.78	2.01	1.96	0.88
EMBSN-17-06	2.37	2.08	1.80	1.41
EMBSN-22-06	2.12	2.03	1.45	0.83
EMBSN-24-06	2.65	2.04	1.74	1.35
EMBSN-58-06	2.08	2.15	2.09	2.04
Mean	**2.41**	**2.20**	**1.89**	**1.27**
Max	2.88	2.88	2.80	2.04
Min	1.78	1.62	1.23	0.84
SD	0.07	0.10	0.13	0.10

Table 8. Relative yield of barley

Lines	Relative yield of barley as per control		
	Salinity		
	2.96 dS^{-m}	6.30 dS^{-m}	12.46 dS^{-m}
BHL-03	-44	-57	-64
BHL-08	-1	-27	-35
BHL-09	-6	-44	-62
BHL-10	+14	-29	-34
BHL-11	-20	-48	-67
BHL-12	+3	-40	-58
BHL-15	+5	+3	-63
BHL-18	-2	+2	-51
BHL-19	-5	+5	-40
EMBSN-43-05	-22	-32	-34
EMBSN-06	+13	-10	-50
EMBSN-17-06	-12	-24	-41
EMBSN-22-06	-4	-32	-61
EMBSN-24-06	-23	-34	-49
EMBSN-58-06	+3	+10	-2

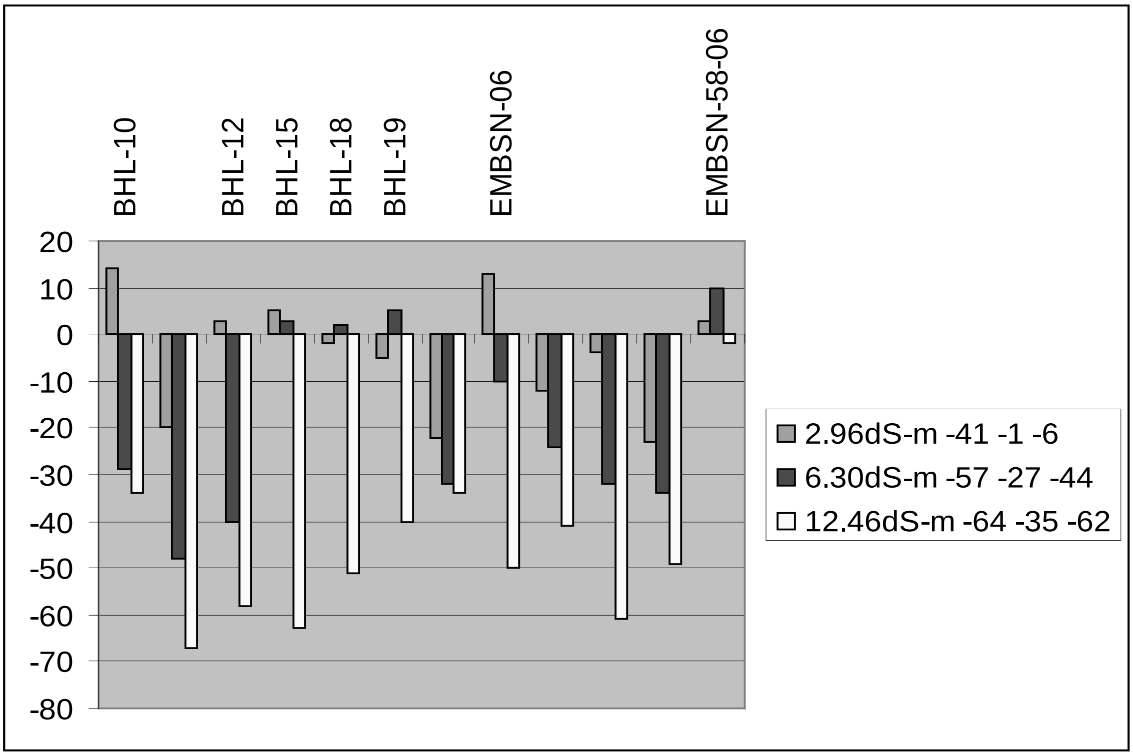

Fig 1.Relative yield as affected by salinity

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PERFORMANCE OF DIFFERENT SELECTED TOLERANT LINES/VARIETIES OF MAIZE AS FODDER GROWN IN COASTAL REGION OF BANGLADESH

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Abstract

Seeds of 15 lines/cultivars of maize were subjected to salinity stress during germination and seedling growth using different concentrations of NaCl solution. Germination percentage and vigour index decreased with the increase in NaCl solution. On the basis of germination percentage (G%), seedling growth and vigour indices, eight lines/cultivars were selected and grown in the coastal saline areas of Noakhali and Potuakhali to evaluate their performance as fodder in those areas. In Potuakhali, out of these eight var./lines, the maximum fodder yield was observed in pacific 11 which is closely followed by pacific 60, BHM-4 and khoibhutta, though there is no significance difference of fodder yield (t/ha) observed among the cultivars/lines. The fodder yield ranged between 12 to 18 t/ha in Kuakata. But in Noakhali due to higher salinity, the fodder yield was 2 to 12 t/ha. In both the areas, khoibhutta gave best results in respect of fodder yield (24.52 and 20.08 t/ha) which is closely followed by BHM-4 (27.54 t/ha and 18.40 t/ha). This result was in keeping with that obtained under laboratory condition.

Introduction

Fodder shortage in the coastal areas of Bangladesh is acute from November to May. This shortage of animal feed can be overcome by introducing saline tolerant forage species in the coastal areas. Among the fodder crops, maize production ranks first (Anon, 1981) and is used as fodder as the plant is succulent, sweet palatable and free from toxicants (Patel *et al*.1990). So maize may be used as fodder in Bangladesh, as it is a high yield and high energy forage species. Tolerant lines/varieties of maize will be identified under laboratory condition and the selected lines may be introduced for cultivation as fodder in coastal areas as fodder is scare during winter season. The present investigation was undertaken to find out suitable maize var. / lines as fodder for cultivation in the saline areas of Bangladesh.

Materials and Methods

Fifteen different cv./lines of maize were tested against varying salinity level under laboratory condition. Salinity levels used were 0, 4 dS^{-m}, 8 dS^{-m}, 12 dS^{-m} and 16 dS^{-m}. Germination was carried out according to ISTA rule, 1985. To findout seedling growth, plants were grown in Hoagland nutrient solution with varying salinity level (0.4 dS^{-m}, 4 dS^{-m}, 8 dS^{-m}, 12 dS^{-m} and 16 $dS^{-m\,)}$. On the basis of seedling growth and vigour index, 6 lines/cultivars along with pacific-11 and pacific 60 are also grown in coastal areas (Noakhali and Potuakhali) to evaluate their performance as fodder. The unit plot size was 4 m x 3 m with three replications. Fertilizer doses were given according to standard recommended practices. Line to line distance was 40 cm and plant to plant distance was 20 cm. The crop was grown on 15th December'06 in Kuakata, Potuakhali and 11th December'06 in Hazigong, Noakhali. Plants were harvested at 40 DAE, 60 DAE and 80 DAE to measure fodder yield. Vigour was measure by multiplying germination percentage with seedling length.

Results and Discussion

Results under laboratory condition:

Effects of salinity on germination of seedling growth under laboratory condition. The germination percentage decreases with the increase in salinity level. The mean germination was 78% in case of control which decreased to 60% at 8dS^{-m}, 53% at 12 dS^{-m} & 43% at 16 dS^{-m} (Table1). Seedling growth in terms of length (Table 2) and dry wt.(Table 3) also decreased as compared to control under salinity ranging from 8 to 16 dS^{-m} . The mean vigour index in case of control was 4713 and it decreased up to 730 (16 dS^{-m}). A similar decrease in germination and seedling growth in rice is reported by Dubey and Rani, 1989 and also in wheat by Hossain and others, 1999.

The maximum vigour index in control was observed in SCO 303 which is closely followed by TCO 404. Under salinity condition, these two lines also gave better result while khoibhutta was best in performance. At 8 dS^{-m} a 40% decrease as compared to control were found in BARI sweet corn, Khoibhutta BHM-4, BM-6, Barnali and SCO303 and TCO 404. On the basis of relative germination percentage, seedling growth and relative vigour index the variety BARI sweet corn, Khoibhutta, BHM-3, BHM-4, were selected for further investigation in the coastal areas of Bangladesh.

Results obtained in the coastal areas of Noakhali and Potuakhali under field condition. On the basis of the results obtained under laboratory condition, six cultivars/lines along with Pac-11 and Pac-60, were cultivated in the saline areas of Noakhali and Potuakhali.

The results obtained from Kuakata, Potuakhali is shown in table 5. The salinity level did not vary much within the experimental plots and is quite low (1-2 dS-^{m}). No significant variation on fodder yield was observed among the cultivars/lines. Variety Pac. 60 gave the highest yield (29.09 t/h) which is followed by Pac. 11 (28.64 t/h), BHM-4 (27.54 t/h) and Khoibhutta (24.52t/h).

The fodder yield performance in Hazigong, Noakhali, coastal area is shown in table 6. The soil salinity in Noakhali area is varied from 2 to 12 dS^{-m} as shown in table 8. The highest fodder yield was obtained in khoibhutta, which was followed by BHM-4. It appears that although at lower salinity Pac. 60 and Pac 11 gives higher yield, as the salinity increases these two crops show greater susceptibility. This is observing from the experimental result carried out in Noakhali where salinity is higher compare to Potuakhali.

Out of these eight cultivars/lines, BM 4 and khoibhutta performed better in both Noakhali and Potuakhali. Salinity level of Kuakata, Potuakhali was almost insignificant and as such, the results obtained for these areas are taken as control. The relative yield of Noakhali as compared to control is shown in table 7. From this table it can be said that Khoibhutta and BHM-4 have better tolerance against salinity.

Conclusion

Of the six varieties which were selected from the laboratory test two varieties, Khoibhutta and BHM-4 can be recommended for cultivation in the coastal aeras of Noakhali and Potuakhali.. The fodder yield in Potuakhali was conclusively higher compared to that in Noakhali. This is possibly due to higher salinity in Noakhali. Further investigations will hopefully clarifying the reason for this difference.

Table 1. Effects of salinity on germination of maize

Cultivars/ lines	Germination percentage			
	Salinity level			
	Control	8 dS-m	12 dS-m	16 dS-m
Bari sweet corn	73	67	67	67
Khoibhutta	87	73	67	67
Mohor	60	33	27	27
Barnali	87	40	40	40
Shuvra	53	27	13	13
BHM-1	53	27	20	13
BHM-2	80	40	27	27
BHM-3	87	73	67	47
BHM-4	80	73	67	67
BHM-5	67	60	53	47
BM-5	87	47	40	20
BM-6	100	87	80	47
BM-7	80	67	67	67
Sco303	100	93	80	80
Tco404	80	93	87	67
Mean	78.27	60	53.46	42.80
Max	100	93	87	80
Min	53	27	13	13
SD	5.12	5.93	6.17	6.06

Table 1 (ii). Relative germination percentage of maize compared to control

Cultivars/ lines	Relative G % as per control		
	Salinity		
	8 dS-m	12 dS-m	16.46 dS-m
Bari sweet corn	-8	-8	-8
Khoibhutta	-16	-23	-23
Mohor	-40	-55	-55
Barnali	-54	-54	-54
Shuvra	-49	-23	-23
BHM-1	-49	--62	-23
BHM-2	-50	-66	-66
BHM-3	--16	-23	-46
BHM-4	-9	-16	-16
BHM-5	-10	-21	-30
BM-5	-46	-54	-77
BM-6	-13	-20	-53
BM-7	-16	-16	-16
Sco303	-7	-20	-20
Tco404	+16	+9	-16

Salinity Stress

Table 2. Effects of salinity on seedling length (root length +shoot length) of maize

Cultivars/ lines	Seedling length (cm.)			
	Salinity level			
	Control	8 dS-m	12 dS-m	16 dS-m
Bari Sweet Corn	44.25	30.17	19.58	16.58
Khaibhutta	54.83	46.49	31.58	30.71
Mohor	53.41	30.50	22.50	-
Barnali	63.08	40.41	30.10	22.10
Shuvra	48.83	20.70	19.00	-
BHM-1	65.75	40.75	25.62	24.50
BHM-2	63.24	31.70	24.91	18.75
BHM-3	63.74	37.33	35.82	10.10
BHM-4	50.82	34.24	35.66	15.75
BHM-5	55.74	31.83	18.74	13.12
BM-5	57.99	17.25	12.0	8.25
BM-6	61.74	34.24	27.57	12.20
BM-7	59.08	38.75	26.66	13.25
Sco303	69.50	31.17	29.08	20.70
Tco404	73.85	39.42	31.50	12.50
Mean	59.06	33.66	26.02	16.55
Max	73.85	40.75	35.82	30.71
Min	44.25	17.25	12.00	10.10
SD	2.06	1.96	1.74	1.74

Table 3. Effects of salinity on seedling dry weight of maize

Cultivars/ lines	Seedling dry weight (gm./plant)			
	Salinity level			
	Control	8 dSm^{-1}	12 dSm^{-1}	16 dSm^{-1}
Bari sweet corn	0.05	0.03	0.020	0.015
Khaibhutta	0.085	0.064	0.048	0.039
Mohor	0.109	0.03	0.02	-
Barnali	0.094	0.04	0.027	0.032
Shuvra	0.068	0.026	0.02	-
BHM-1	0.110	0.053	0.048	0.035
BHM-2	0.112	0.105	0.074	0.015
BM-5	0.128	0.023	0.021	0.01
BHM-4	0.092	0.066	0.05	0.022
BHM-5	0.095	0.046	0.039	0.016
BHM-3	0.112	0.056	0.035	0.006
BM-6	0.108	0.050	0.047	0.022
BM-7	0.088	0.045	0.031	0.025
Sco303	0.130	0.063	0.059	0.03
Tco404	0.150	0.095	0.045	0.022
Mean	0.102	0.053	0.039	0.01
Max	0.150	0.105	0.074	0.039
	0.05	0.023	0.075	0.006
SD	0.006	0.006	0.004	0.003

Table 4. Effects of salinity on vigour index

	Vigour index			
	Salinity level			
Cultivars/ lines	Control	8 dS-m	12 dS-m	16 dS-m
Bari sweet corn	3230	2021	1312	547
Khoibhutta	5483	3394	2116	1628
Mohor	3204	1007	608	-
Barnali	5488	1616	1204	221
Shuvra	2588	559	247	-
BHM-1	3485	1100	672	319
BHM-2	5058	1268	498	506
BHM-3	5545	2725	2400	475
BHM-4	4066	2500	2389	1055
BHM-5	3746	1910	993	617
BM-5	5045	811	480	165
BM-6	6174	2979	2206	573
BM-7	4726	2596	1786	888
Sco303	6950	2891	2326	1656
Tco404	5908	3666	2741	838
Mean	4713	2070	1465	730
Max	6950	3666	2741	1628
Min	3204	559	247	165
SD	328	342	221	132

Table 5. Fodder yield of maize grown in saline area of Kuakata, Potuakhali

Varieties/lies		Fodder yield (t/ha)			
		40 DAE	60 DAE	80 DAE	Total
Hybrid	BHM-3	2.06	6.17	15.83	24.06
	BHM-4	2.44	7.32	17.78	27.54
	Pacific-11	2.62	7.85	18.17	28.64
	Pacific-60	2.87	8.61	17.61	29.09
Composite	Khoibhutta	2.35	7.06	13.11	24.52
	Barnali	2.10	6.30	13.41	21.81
	BM-6	1.59	4.76	12.86	19.21
	BM-7	2.23	6.70	14.53	23.46
	Level of significance	NS	NS	NS	

Table 6. Fodder yield of maize grown in saline areas of Noakhali

Varieties/lies		Fodder yield (t/ha)		
		60 DAE	80 DAE	Total
Hybrid	BHM-3	2.46 b	3.33 b	5.79
	BHM-4	7.67 a	10.73 a	18.40
	Pacific-11	2.60 b	2.95 b	5.55
	Pacific-60	1.04 b	1.37 b	2.41
Composite	Khoibhutta	8.58 a	11.50 a	20.08
	Barnali	3.42 b	3.40 b	6.82
	BARI sweet corn	1.79 b	1.94 b	3.73
	BM-6	2.69 b	3.02 b	5.71
	Level of significance	**	**	

Table 7. Relative yield of Noakhali as compared to control (Potuakhali)

Cultivars/ lines		Relative yield as per control (%)	
		60 DAE	80 DAE
Hybrid	BHM-3	-60	- 79
	BHM-4	+ 5	- 40
	Pacific-11	- 67	- 84
	Pacific-60	- 88	- 93
Composite	Khoibhutta	+ 22	- 13
	BARI sweet corn	- 46	- 75
	Barnali	- 43	- 77
	BM-6	- 73	- 87

Table 8. Soil salinity level at Noakhali during crop duration

Month	Salinity level (dS-m)
December	6.14
January	6.77
February	No salinity due to heavy rainfall (355.8 mm)
March	6.38
April	7.97

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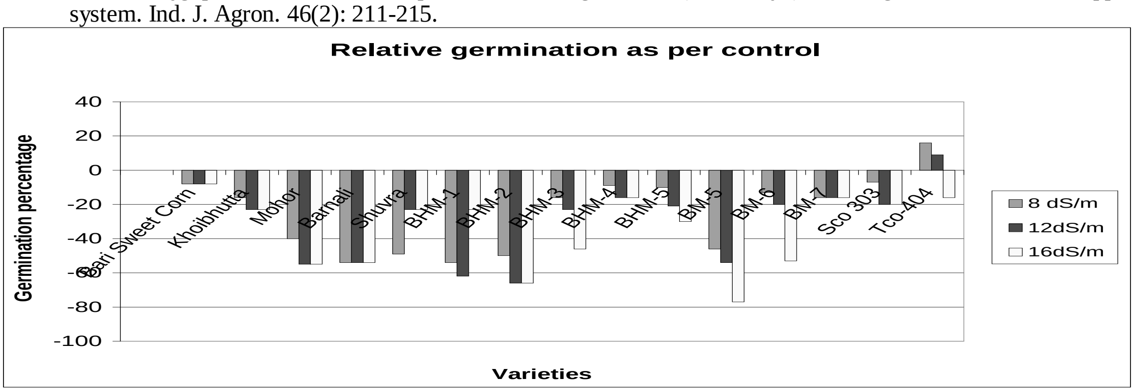


Table 1. Effect of salinity accumulation of Na^+ and K^+

Salinity level	Ion accumulation (mgm/gm dry tissue)			
	Root		Shoot	
	Na+	K+	Na+	K+
Control	1.24± 0.2	32.64± 4	0.17± 0.03	51.51± 4
12 dS-m	5.58± 1	11.18± 1.2	1.64± 0.3	25.93± 3.3

PERFORMANCE OF MUSTARD VARIETIES RELAYING WITH T.AMAN IN COASTAL REGION OF BANGLADESH

M. A. Aziz, W. Sultana, F. Begum, R. R. Saha and S. M. Zaman

Abstract

The experiment was carried out in the coastal area of the MLT site Shatkhira during the rabi season of 2007-08 to find out suitable variety of mustard for relay cropping with T.aman in the coastal saline areas. Five mustard varieties were sown on 02 November, 2007 in a randomized complete design with three replications. The highest yield was obtained from BARI sarisha-11 (1.57 t/ha) followed by BARI sarisha-9 (1.20t/ha). The experiment should be repeated in the next season for further verification.

Introduction

A vast coastal and offshore area (2.85m ha) in the Southern part of Bangladesh exhibit soil salinity of various magnitudes due to onrush of salt water from the Bay. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the under ground moves up by capillary forces. Thus a considerable amount of salt from the subsoil is carries to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. As a result, most of the areas remain fallow during dry months. To increase mustard area and production especially under relay condition marginal lands should be considered. It was observed that salinity rises from first week of March. A judicial choice to grow a crop under saline soil is, therefore considered an important management option to minimize yield loss by salinity. Blum (1998) rightly pointed out that, for sustainable crop production in the saline soils, it is more important to select a salt tolerant crop rather than a relatively better yielding variety of susceptible crops. The present study will be under taken to find out suitable variety of mustard to be grown under relay condition in the coastal areas of Bangladesh.

Materials and Methods

The experiment was conducted in coastal of the Shatkhira, MLT site during the rabi season of 2007-08. The design of the experiment was RCB with 3 replications. Five mustard varieties viz. BARI Sarisha-9, BARI Sarisha-11, BARI Sarisha-15, Tori-7 and BINA Sarisha-5 were tested under relay condition with T.aman rice. The mustard seed was broadcast in T.aman paddy field 15 days before T.aman (var. BINA Dhan-4) harvest. The seed rate was 10 kg/ha and was sowing on 02 November’07. Initially the experimental plots were fertilized with 250-170-85-150-15 kg/ha Urea, TSP, MP, Gypsum, Zinc Sulphate and Borax respectively. All the fertilizers were applied as basal except urea. Urea was applied as top dress on 20 and 35 days after relaying of mustard. The crop was harvest recording to their maturity. Intercultural operation and plant protection measures were taken as and when necessary. The data on different plant characters were collected from 10 randomly selected plants from each plot and yield was recorded plot wise. All necessary data were collected and analyzed statistically. During this period salinity was 3.72 to 5.05 dS/m.

Result and Discussion

The performance of different mustard varieties under relay condition with T.aman rice presented in Table 1. The salinity range of the experimental plot was 3.72 to 5.05 dS/m during the crop growing period. The variety Tori-7 and BARI sarisha-9 was the short duration variety and took 85 days for maturity. BARI sarisha-11 was the long duration variety and took 100 days for maturity. Significantly the highest yield of 1.57 t/ha was obtained from BARI sarisha-11 followed by BARI sarisha-9 (1.2 t/ha). BINA sarisha-5 gave significantly the lowest yield (0.75 t/ha). The highest yield in BARI sarisha-11 was due to maximum number of siliqua/plant all though seed/siliqua was maximum in BARI sarisha-9 and Tori-7. BINA sarisha-5 was bold seeded (4.70 g/1000 seed) followed by BARI sarisha-11 (4.07 g/1000 seed). Significantly the highest straw yield obtained from BARI sarisha-15 (3.63 t/ha) which was identical with BARI sarisha-11 (3.53 t/ha) and BINA sarisha-5 (3.53 t/ha).

Farmer's Reaction

- Farmers of Satkhira area are interested to grow mustard as relay cropping with T.aman rice because of timely sowing, less cultivation cost under relay condition using residual moisture and avoid salinity stress.
- The farmers those cultivate boro rice preferred BARI sarisha-9 and Tori-7 because of short duration variety.
- Cultivation of early maturing T.aman rice (var. BINA Dhan-4) can also extrapolate the technology in the coastal area.

Conclusion

BARI sarisha-11 could be grown under relay condition with T.aman rice in the coastal area of south-west Bangladesh in T.aman-fallow-fallow cropping pattern. BARI sarisha-9 could be grown in T.aman boro cropping pattern. The experiment should repeated in the next season over locations for further verification.

Table 1. Yield and yield attributing characters of mustard relaying with T.aman at Satkhira MLT site during rabi season of 2007-08

Variety	Days to maturity	Plant popu./m^2	Plant height (cm)	Siliqua/ plant (no.)	Seed/ siliqua (no.)	1000 seed wt. (g)	Seed yield (t/ha)	Straw yield (t/ha)
BINA sarisha-5	94	98.67	74.60	37.50	22.87	4.70	0.75	3.53
Tor-7	85	114.7	78.30	38.70	25.20	3.70	1.00	2.47
BARI sarisha-9	85	113.7	86.07	48.93	17.80	3.87	1.20	2.60
BARI sarisha-11	100	93.33	124.1	71.60	17.80	4.07	1.57	3.53
BARI sarisha-15	92	128.3	87.83	41.97	19.90	3.10	1.06	3.63
LSD(.05)	-	20.89	6.26	9.65	3.67	6.24	0.13	0.74
CV(%)	-	10.11	3.69	10.96	8.69	3.25	6.17	12.41

PERFORMANCE OF HYBRID MAIZE VARIETIES IN THE COASTAL CYCLONE PRONE AREAS OF BANGLADESH

M. A. Aziz, W. Sultana, F. Begum, R. R. Saha, S. M. Zaman and M. Idridh

Abstract

The experiment was conducted in coastal area of Banerpota Farm, Shatkhira and MLT site Kuakata, Potuakhali during the rabi season of 2007-08 after the last devastating cyclone to select suitable hybrid maize variety adaptive for coastal cyclone prone area of Bangladesh. BARI hybrid maize 3 (9.08 t/ha) perform better at Kuakata and pacific 11(7.91 t/ha) followed by BARI hybrid maize 3 (6.89 t/ha) perform better at Shatkhira. The experiment should be repeated in the next season for further verification.

Introduction

The last devastating cyclone in the coastal areas of Bangladesh especially Potuakhali and Khulna has broken the backbone of all most all farmers. T.aman crop in those areas in completely damaged. Maize could be grown as cyclone rehabilitation program in the cyclone affected areas. Among the popular hybrid maize varieties which one will be most suitable for those areas is not yet studied. The present study have been undertaken to find out suitable hybrid maize variety for the cyclone prone area of Bangladesh.

Materials and Methods

The experiment was conducted in coastal area of Banerpota Farm, Shatkhira and MLT site Kuakata, Patuakhali during the rabi season of 2007-08 after the last devastating cyclone. Five hybrid maize. Varieties viz BARI hybrid maize-2, BARI hybrid maize-3, BARI hybrid maize-5, Pacific-11, Pacific-60, Pacific-983 and Pacfic-984 were tested in a randomized complete block design with three replications. Seeds of different varieties were sown on 28 December 07 at Benarpota and 10 November 07 at Kuakata with a spacing of 75cm x 25cm. The trial was fertilized with 253-52-110-46-5-1.2 kg/ha of N-P-K-S-Zn-B+CD respectively. All fertilizer along with 6 t/ha cowdung/ha and $^{1}/_{3}$ N were applied as basal during final land preparation. The rest of urea was applied in two equal split at 35 and 65 DAS. Two irrigations were given following the urea top dressing. Earthing up was done after 2nd top dress of urea. There times weeding and necessary plant protection measures were taken. The crop was harvested on 10 May, 2008 at Satkhria and 2 May 2008 at Kuakata. The salinity level at satkhira during the crop growth period presented in Fig.1Data on different plant characters and yield were record and analyzed statistically.

Results and Discussion

Satkhira

The yield and yield contributing characters as influence by natural soil salinity at Satkhira are presented in Table 1. Soil salinity influenced significantly all the yield contributing characters. Significantly the highest cob length was recorded from Pacific 984 (19.66 cm) followed by BARI hybrid maize 2 (19.33 cm). BARI hybrid maize 5 gave the lowest cob length (17.33 cm). The highest cob diameter was obtained from Pacific 11 and Pacific 60 (12.36cm) followed by Pacific 983 (12.33 cm). The lowest cob diameter was obtained from BARI hybrid maize 5 (12.11cm). Significantly the highest the number of per cob was obtained from Pacific 983 (492.00 seed/cob) which was identical with Pacific 60, BARI hybrid maize 5 and BARI maize 3. Significantly the lowest of number of seed/cob was obtained from Pacific 11 (425.66). The highest grain weight (296.66 g/1000 grain) was recorded in BARI hybrid maize 2 followed by Pacific 11 (276.66 g/1000 grain). Pacific 983 gave the lowest grain weight (250 g/1000 grain). All yield components contribute to the final grain yield. Significantly the highest grain yield (7.91 t/ha) was obtained from Pacific 11. BARI hybrid maize 3 gave identical yield with BARI hybrid maize 2, Pacific 60 and Pacific 984. BARI hybrid maize 5 significantly the lowest the grain yield (4.61 t/ha).

Kuakata

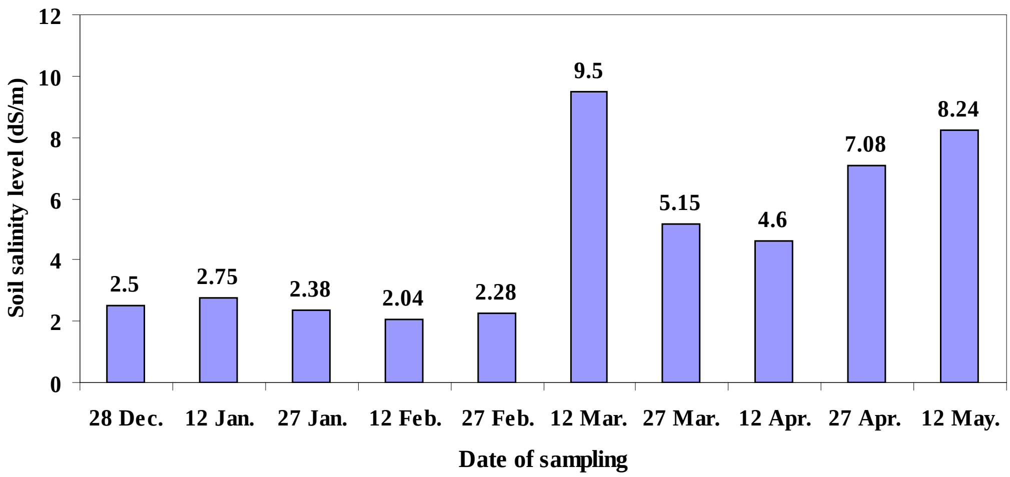
The yield and yield contributing characters as influence by natural soil salinity at Kuakata are presented in Table 2. The yield contributing characters varied insignificantly among the varieties due to the influence of natural soil salinity but the grain yield varied significantly among the varieties. All though insignificant the maximum number of grain per cob was recorded from BARI hybrid maize 3 (612) and the minimum number of grain per cob were recorded from Pacific 983. BARI hybrid maize 3 gave maximum 1000 grain weight (286 g) and Pacific 984 gave the minimum 1000 grain weight (269 g). The highest grain yield was recorded from BARI hybrid maize 3 (9.08 t/ha). BARI hybrid maze 5 (8.26 t/ha) gave identical grain yield with BARI hybrid maize 2 (8.12 t/ha). Pacific 983 gave significantly the lowest grain yield (7.59 t/ha) which was identical with Pacific 60, Pacific 984 and Pacific 11.

Farmers reaction

1. Yield of hybrid maize was satisfactory, so farmers are interested to grow hybrid maize.
2. Farmers preferred BARI hybrid maize 5 for attractive colour and taste.
3. Stover was used as fodder and fuel.

Conclusion

From one year study it may be concluded that Pacific 11 followed by BARI hybrid maize 3 would be suitable for cultivation after harvest of T.aman rice in the Satkhira and BARI hybrid maize 3 in the Kuakata coastal area. The experiment should be repeated in next season for final confirmation



Fif. 1. Soil salinity level at Banerpota, Satkhira during the crop growing season

Table 1. Yield and yield attributing characters of maize at Banerpota Farm, Satkhira, 2007-08

Variety/line	Plant ht (cm)	Cob length (cm)	Cob diameter (cm)	Seed/cob (no.)	1000 grain wt. (g)	Grain yield (t/ha)
BARI hybrid maize 2	171.33	19.33	2.19	451.66	296.66	6.67
BARI hybrid maize 3	178.33	18.66a	2.25	484.33	255.00	6.89
BARI hybrid maize 5	180.00	17.33	2.11	491.66	215.00	4.61
Pacific 11	177.66	18.33	2.36	425.66	276.66	7.91
Pacific 60	173.00	18.00	2.36	491.33	270.00b	6.63
Pacific 983	174.00	17.66	2.33	492.00	250.00	5.64
Pacific 984	175.33	19.66	2.16	489.33	253.33	6.77
$LSD_{(.05)}$	23.23	1.65	0.16	45.90	17.36	0.82
CV(%)	7.60	5.23	4.32	5.61	3.93	7.60

Table 2. Yield and contributing characters of hybrid maize in rabi, 2007-08 at Kuakata, Potuakhali

Variety	Population /10 m^2	Plant ht. (cm)	No. of grains/cob	100-grain wt. (gm)	Grain yield (t/ha)
BARI hybrid maize 2	53	186	585	27.2	8.12
BARI hybrid maize 3	57	185	612	28.6	9.08
BARI hybrid maize 5	58	197	583	27.3	8.26
Pacific 11	55	186	602	27.6	7.69
Pacific 60	56	181	579	27.0	7.62
Pacific 983	56	178	578	26.9	7.59
Pacific 984	58	188	580	27.0	7.64
$LSD_{(.05)}$	NS	NS	NS	NS	0.56
CV(%)	5.61	10.35	6.32	3.12	9.68

Soil salinity level: 4.52 to 6.8 dS/m

PEFFORMANCE OF SALT TOLERANT MUNGBEAN VARIETIES/LINES IN THE COASTAL AREAS

M. A. Aziz, W. Sultana, F. Begum, R. R. Saha, M. Amin and S. M. Zaman

Abstract

The field trial was conducted at FSRD site of Noakhali and Benarpota Farm, Sathkhira during the rabi season of 2007-08, to assess whether salt tolerance in BM 01 and BM 08 under pot culture has relationship with that under field condition. Six mungbean varieties /lines were tested in a randomized block design with three replications. The salt tolerant line BM 08 at Noakhali and BM 01 at Benarpota showed better adaptability in the coastal area. Significantly the highest yield was obtained from BM 08 (1.44 t/ha) and BM 01 (0.71 t/ha) at Noakhali and Benarpota respectively. The results indicated that the salt tolerance in BM 08 and BM 01 made in pot culture showed consistence with that made under field condition.

Introduction

A vast coastal and offshore area (2.85 m/ha) in the southern part of Bangladesh exhibits soil salinity of various magnitudes due to onrush of salt water from the Bay. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the underground moves up by capillary forces. Thus a considerable amount of salt from the subsoil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. As a result, most of the areas remain fallow during dry months. To increase mungbean area and production these marginal lands may be considered as it is mostly grown in the southern part of Bangladesh. The variation in salinity tolerance between crops and/or varieties of crop is well known (Mass and Hoffman, 1977; Karim *et al*. 1994; Richards *et al*. 1987). A judicial choice to grow a crop under saline soils is, therefore, considered an important management option to minimize yield loss by salinity. Blum (1988) rightly pointed out that, for sustainable crop production in the saline soil is more important to select a salt tolerant crop rather than a relatively better yielding variety of susceptible crops. The present study was therefore, undertaken to assess whether salt tolerance in BM 01 and BM 08 under control condition (pot culture) has relationship with that under field condition.

Materials and Methods

The trial was conducted at FSRD site of Noakhali and Benarpota Farm, Satkhira during the late rabi season of 2007-2008. Six mungbean varieties /lines viz. BM 01, BM 08, BARI mug 5, BARI mug 6, BU 02 and BU 4 at Noakhali and BM 01, BM 08, BARI mug 2, BARI mug 5, BARI mug 6 and Local at Benarpota, Sathkhira were tested in the experiment. The unit plot size was 3m x 2m. Seeds were sown in 30cm x 10cm line following RCB design with three replications. Fertilizers @ of 20-16-15-10 kg/ha of N-P-K-S was applied as basal. Mungbean was sown on 2 February 2008 at Noakhali and 15 February 2008 at Benarpota. Weeding, thinning and all other intercultural operations were done as and when necessary. Soil salinity level was measured time to time. Data on yield and yield components were collected and analyzed statistically following 'MSTAT' programme.

Results and Discussion

Noakhali

The performance of mungbean varieties/line at FSRD site of Noakhali presented in (Table 1 & Table 2). The soil salinity level was 2.02 dS/m on 28 February. Soil salinity increased upto 9 April and it was 4.88 dS/m and than declined (Table 3). The plant population per unit area at 10 days after was more or less same for all the varieties except BM 08 (Table 1). At harvesting the plant population was maximum in BM 08 (27 plant/m^2) and the minimum was in BU 04 (14 plants/m^2). The highest mortality (%) was in BU 04 (39.13) followed by BU 02 (30.43) and the lowest mortality was in BM 08 (6.89) followed BM 01 (8.33).

Soil salinity significantly influenced the yield and yield components of mungbean varieties (Table 2). The plant height varied significantly among the varieties. The highest plant height (53.3cm4) was recorded in BM 08. BU 04 gave significantly the lowest plant height. The number of pods per plant were significantly lower in BU 02 (10.10) followed BU 04 (11.23). Significantly the highest number of pods per plant was obtained in BM 08 (16.43) followed by BM 01 (14.36). Similar results were obtained by Raptan (2001). Aziz *et al.* (2002) and Faruquei (2002). The influence of salt stress on reduction of number of seed per pod was insignificant. Significantly the highest individual grain weight was obtained from BARI mug 6 (38.59 g/ha1000 seed) followed by BARI mug 5 (35.52 g/1000 seed). BU 04, BM 08 and BU 02 gave identical individual grain weight. The lowest grain weight was recorded from BM 01 (25.46 g/1000 seed). Grain yield is the function of pods per plant, seeds per pod and individual seed weight. The effects of soil salinity on grain yield closely matched its effects on number of plants per unit area and pods per plant. Grain yields were decreased by soil salinity and the decrease differed among the varieties. Significantly the highest grain yield was obtained from BM 08 (1.44 t/ha) which was identical with BARI mug 6 (1.26 t/ha) and BM 01 (1.06 t/ha). The lowest yield was recorded from BU 04 (0.49 t/ha) followed by BU 02 (0.52 t/ha).

Benarpota

The performance of mungbean varieties/line at Benarpota, Shathkhira presented in (Table 4). The soil salinity level was 4.45-6.97 dS/m through out the crop growing period. BM 08 took 75 days for maturity followed by BM 01 (68 days) and BARI mug 6 took 59 days for maturity. Soil salinity at Benarpota significantly influenced the yield and yield contributing characters of mungbean except pod per plant and seed per pod. Significantly the highest population was recorded in BM 01 (55.33) followed by BARI mug 6 and BM 08. The lowest population was recorded in BARI mug 2 (33.66). The highest plant height was obtained from Local variety (68.00cm) followed by BM 01 (60.33cm). Significantly the lowest plant height was obtained from BARI mug 6 (53.00cm) which was identical with BARI mug 5, BARI mug 2 and BM 08.

Although insignificant BARI mug 6 gave maximum number of pod per plant (8.00) and the Local variety gave minimum of pod per plant (6.33). The influence of salt stress on reduction of number of seed per pod was insignificant. Significantly the highest individual grain weight was obtained from BARI mug 6 (48.33 g/ha1000 seed) followed by BM 01 (41.66). BARI mug 5 (39.66 g/1000 seed) and Local (39.00 g/1000 seed) gave identical individual grain weight. The lowest grain weight was recorded from BM 08 (34.00 g/1000 seed). Grain yield is the function of pods per plant, seeds per pod and individual seed weight. Grain yields were decreased by soil salinity and the decrease differed among the varieties. Significantly the highest grain yield was obtained from BM 01 (0.71 t/ha) followed by Local variety (0.67 t/ha). The lowest yield was recorded from BM 08 (0.57 t/ha) followed by BARI mug 6 (0.59 t/ha). Under salt stress condition in pot culture at about 10 dS/m the observations are in line with the results obtained by Raptan (2001), Aziz *et al.,* (2002), Faruque (2002) and Aziz (2003). They obtained the highest grain yield per plant from BM 01 followed by BM 08.

Conclusion

The salt tolerance in BM 08 followed by BM 01 made in pot culture showed consistence with that observed under field condition. The salt tolerant line BM 08 showed better adaptability in coastal area. Further investigation may be continued to evaluate the performance of the above-mentioned line for more saline areas and confirmation.

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Table 1. Yield and yield attributes of mungbean varieties at FSRD site of Noakhali during 2007-08

Varieties/lines	Plant ht. (cm)	Branch/ plant	Pod/plant	Pod length (cm)	Seed/pod	1000 seed wt. (g)	Grain yield (t/ha)
BM 01	40.32	3.37	14.36	6.81	10.17	25.46	1.06
BM 08	53.34	4.12	16.43	7.84	10.57	30.10	1.44
BARI mug 5	34.70	3.42	12.53	8.71	10.03	35.52	0.98
BARI mug 6	40.26	3.62	13.10	9.58	11.57	38.59	1.26
BU 02	33.13	3.07	10.10	6.92	8.27	29.87	0.52
BU 04	32.36	3.22	11.23	6.41	9.93	30.03	0.49
LSD $_{(0.05)}$	4.332	NS	2.531	NS	NS	6.822	0.467
CV(%)	6.10	19.09	15.94	4.04	13.79	11.87	26.67

Table 2. Plant population per m^2 at different stage and mortality % of different mungbean varieties at FSRD site of Noakhali during 2007-08

Varieties/lines	Plant population at 10 DAS)	Plant population at harvest	Mortality (%)
BM 01	24	22	8.33
BM 08	29	27	6.89
BARI mug 5	23	20	13.04
BARI mug 6	26	23	11.53
BU 02	23	16	30.43
BU 04	23	14	39.13

Table 3. Soil salinity (dS/m) of the experimental plot of mungbean varieties at FSRD site of Noakhali during 2007-08

Sampling date	Soil salinity level (dS/m)						
	BM 01	BM 08	BARI mug 5	BARI mug 6	BU 02	BU 04	Mean
28 February	1.89	1.85	1.65	1.85	2.35	2.55	2.02
10 March	3.20	2.90	2.87	3.22	4.92	3.95	3.53
19 March	3.69	4.85	3.14	4.82	4.59	4.30	4.20
30 March	4.50	4.10	4.90	5.50	4.60	5.20	4.80
09 April	4.60	5.15	3.20	5.20	5.90	5.20	4.88
22 April	4.60	5.35	3.90	4.50	4.30	5.20	4.54

Table 4. Yield and yield attributes of mungbean varieties at Benarpota, Sathkhira FSRD site of Noakhali during 2007-08

Varieties/lines	Days to maturity	Plant population/m^2	Plant ht. (cm)	Pod/plant	Seed/pod	1000 seed wt. (g)	Grain yield (t/ha)
BM 01	68	55.33	60.33	7.33	8.33	41.66	0.71
BM 08	75	49.00	57.33	6.66	8.33	34.00	0.57
BARI mug 2	64	38.66	53.66	7.00	8.66	37.66	0.62
BARI mug 5	60	42.00	53.66	6.66	8.66	39.66	0.65
BARI mug 6	59	51.33	53.00	8.00	8.33	48.33	0.59
Local	65	45.66	68.00	6.33	8.66	39.00	0.67
LSD $_{(0.05)}$	-	6.39	9.511	1.69	1.37	1.135	5.38
CV(%)	-	7.48	9.07	13.30	8.86	1.56	

Soil salinity level : 4.45-6.97 dS/m

EFFECT OF DATE OF SOWING ON YIELD AND YIELD COMPONENTS OF MUNGBEAN IN THE COASTAL AREAS

M. A. Aziz, W. Sultana, F. Begum, R. R. Saha, M. Amin and S. M. Zaman

Abstract

The experiment was conducted at MLT site Kuakata, Patuakhali during the rabi season of 2007-2008. To investigate the influence of sowing date on the performance of munbean varieties as well as to avoid moisture stress caused due to late sowing after 15 January. Three varieties/line of mungbean such as BM 01, BARI mug 2 and BARI mug 5 were sown on three different dates viz. 01 January, 10 January and 21 January under rainfed situation in a split-plot design. Among the mungbean varieties BM 01 performed better and gave maximum yield on 10 January to 21 January. It might be concluded that BM 01 would be suitable for north-western non saline region provided that the sowing could be completed with 3rd week of January to avoid moisture stress. The experiment should be repeated in the next season for final conformation.

Introduction

Mungbean (*Vigna radiata*) is the fifth important pulse crop of Bangladesh and contributes about 1.53% of total production. Its area and production are decreasing day by day. About 65% of mungbean is grown in the southern region. In the coastal area of Potuakhali where soil salinity is minimum, farmers are growing local mungbean cultivars with poor yield potential. In the farmers' field of Kuakata MLT site it was observed that BARI mung 2 perform better than local varieties. Farmers are growing local variety in the middle of January. During the reproductive phase of the crop soil moisture dries up and the crops suffer from drought. Early sowing in December could save the crop from drought. Moreover, increasing soil dryness caused increased soil salinity. Therefore, early sowing in December could be able to escape the crop from drought and high salinity. With this objective the experiment was conducted to find out optimum date of sowing for maximum growth and yield of mungbean and to save the crop from drought and high salinity.

Materials and Methods

The experiment was conducted at the MLT site Kuakata, Patuakhali during the late rabi season of 2007-2008. Three sowing dates such as 01 January, 10 January and 21 January 2008 with three mungbean varieties viz. BM 01, BARI mug 2 and BARI mug 5 were used in the study. The experiment was conducted in a Factorial RCB design with three dispersed replications under rainfed condition. The unit plot size was 5 m × 2 m. Seeds were sown in line with a spacing of 30cm x 5cm. Fertilizers @ 50-85-35 kg/ha Urea, TSP and MP were applied as basal during final land preparation. All other intercultural operations were done as and when necessary. Harvesting of pods was done two times. Data for yield components were taken from five randomly selected plants of each plot. Collected data were analyzed statistically and the mean differences were adjusted by DMRT.

Results and Discussion

Date of sowing

The performance of mungbean variety at different date of sowing in the coastal area is presented in Table 1. Date of sowing affect significantly on all the parameters studied except plant population, pod/plant and seed/pod. The maximum population was recorded from 10 January sowing (40 plants/m^2) followed by 01 January sowing (39 plants/m^2). 21 January sowing gave the minimum plant population. Significantly the highest plant height was recorded from 10 January sowing (29.42 cm) which was identical with 01 January sowing (28.01 cm). 21 January gave significantly the lowest plant height (26.04 cm). Although insignificant 10 January sowing gave maximum number of pods per plant and seed per pod. Significantly the highest yield was obtained from 10 January sowing (877 kg/ha) which was identical with 21 January sowing (809 kg/ha). The lowest yield was obtained from 01 January sowing (724 kg/ha). The highest yield form 10 January sowing followed by 21 January sowing might be attributed for maximum population/m^2, maximum pod/plant and maximum number seed/pod.

Variety

Yield and yield contributing characters except plant population and pods per plant of mungbean significantly affect by variety studied in the coastal area. All though insignificant BARI mug 5 gave the maximum plant population followed by BARI mug 2. Plant height varied insignificantly among the varieties. Significantly the highest plant height was recorded from BM 01 (30.50 cm)

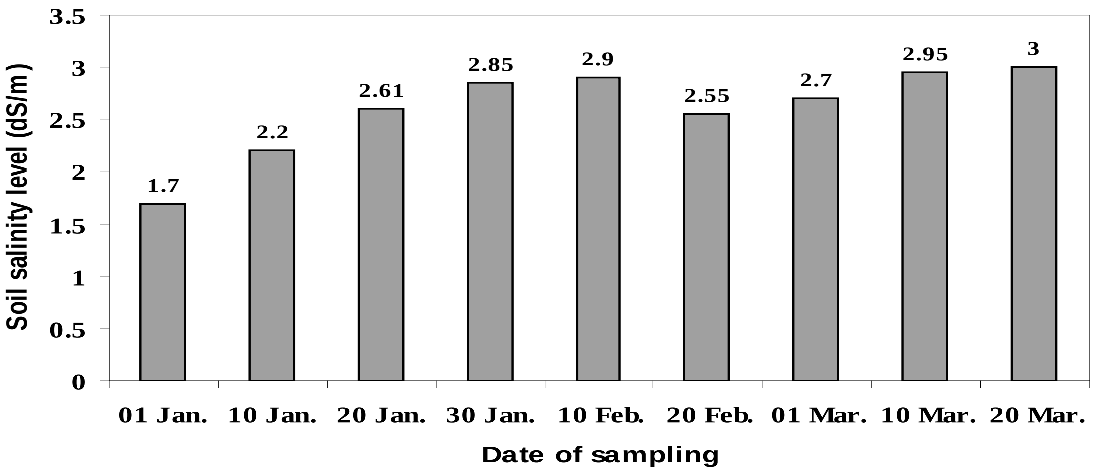

Fig. 1. Soil salinity level at MLT site Kuakata during the crop growing season

followed by BARI mug 2 (28.02cm). The lowest plant height was obtained from BARI mug 5 (26.30cm). The highest number of pod per plant was recorded from BM 01 (9). The highest number of seed per pod was found in BARI mug 5 (12). BARI mug 2 gave the lowest number of seed per pod followed BM 01. The yield of mungbean varied significantly among the varieties. Significantly the highest yield was obtained from BM 01 (880 kg/ha). BARI mug 5 gave the lowest yield (710 kg/ha) followed by BARI mug 2 (786 kg/ha).

Farmers' Reaction

1. Farmers are interested to grow mungbean after harvest of T.aman.
2. Farmers are satisfied with the yield obtained from the experiment.

Conclusion

It was revealed from the study that maximum yield was obtained from 10 January sowing followed by 21 January sowing. At 21 January sowing the yield reduction was 21 percent compared to 10 January sowing. It may be concluded that upto 3rd week of January would be optimum time of sowing for mungbean in the coastal area. In the last year upto 3rd week of December gave the maximum yield. Therefore, the experiment should be repeated in the next year for final confirmation.

Table 1. Performance of mungbean varieties at different date of sowing in the saline area of Kuakata, Potuakhali in 2006-07

Sowing date	Plant population /m^2	Plant height (cm)	pods/plant	Seeds/pod	Yield (kg/ha)
01 January	39	28.01 a	8	9	724 b
10 January	40	29.42 a	9	10	877 a
21 January	37	26.04 b	8	10	809 a
Variety					
BM 01	36	30.50 a	9	9 b	880 a
BARI mug 2	39	28.02 b	8	8 b	786 b
BARI mug 5	41	26.30 c	8	12 a	710 b
CV (%)	10.26	8.03	7.05	4.50	12.04

PERFORMANCE OF DIFFERENT CROPS AND CROP CULTIVARS IN THE COASTAL SALINE AREA OF DACOPE, KHULNA

M. A. Aziz, W. Sultana, F. Begum, R. R. Saha and S. M. Zaman

Abstract

The experiment was conducted at testing site of Laudove, Dacope 2007-08 with different crop and crops cultivars viz. mungbean, soybean and sesame. Among the crops sesame perform better and the rest of crops were damaged by salinity stress. In sesame out of four varieties Aatshira gave the highest yield (970 kg/ha) with maximum strover yield (2555 kg/ha). From years study it might be concluded that sesame could grown in coastal saline area of Dacope, Khulna. Aatshira would be suitable for cultivation after harvest of T.aman rice in saline area of Dacope. The experiment should repeated in next season for final confirmation.

Introduction

There are 49 Upazilas of 13 districts under the coastal zone of Bangladesh. Among them Khulna, Satkhira, Bagerhat are included. Recently the Scientist of Agronomy Division vished the coastal area of Khulna, Satkhira, Patuakhlai and Noakhali for survey and monitoring of existing crops growing in saline area. It was reported that 71 to 96% land remain fellow after harvest of T.aman rice in those survey areas (Begum et al., 2006). From the constraints of crop cultivation in the coastal areas and lack of adequate knowledge about salinity management the land remains fellow after T.aman harvest. Even though some farmers of that area especially Dacope Upazila of Khulna till growing some crops with own innovative practices. There have a great scope of growing BARI released varieties in that area using farmers innovative practice. With this view, the present study will be conducted to variety the suitability of BARI released varieties of different crops during rabi and kharif I seasons at Dacope Upazial under Khulna District.

Materials and Methods

The experiments were conducted at testing site of Laudove, Dacope, Khulna during 2007-08. Three different crops were sown on 25 February 2008. Five mungbean varieties/lines (BARI mug 2 and BARI mug 6, BM 01, BM 08 and Local), three soybean varieties (Shohag, Bangladesh soybean 4 and BARI soybean 5) and four sesame varieties (BARI til-2, BARI til 3, Aatshira and Local) were included in the study. All the crop varieties except sesame were damaged due to higher degree of soil salinity. Mungbean and soybean varieties/cultivars were damaged within 20 March 08 and 30 March 08 respectively. For sesame crop the unit plot size was 4 m x 3 m. The crop was fertilized with 100-130-40-100-5-80 kg/ha of Urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid respectively. Seeds were sown continuously in line keeping a distance of 30cm spacing. The experiment was laid out in RCB design with three replications. Weeding and all other intercultural operations were done as and when necessary. The crop was harvested on 25, May 2008. During the crop growing period the soil salinity level was 4.32 to 6.50 dS/m in sesame, 5.15 to 7.50 dS/m in mungbean and 5.02 to 7.15 dS/m in soybean. The yield and yield contributing data were collected form five randomly selected plants in each plot, analyzed statistically by MSTAT program and the means are adjusted following LSD.

Results and Discussion

The performance of sesame varieties at Dacope, Khulna presented in (Table 1). The soil salinity level was 4.32 to 6.50 dS/m through out the crop growing period. The yield and yield contributing characters of sesame as influence by natural soil salinity varied significantly among the varieties. Significantly the highest population (61.5) was recorded in BARI til 2 followed BARI til 3 and

Aatshira. The lowest population was recorded in Local variety (57.00). The highest plant height was obtained from Aatshira (61.7cm) which was identical with BARI til 3 (66.1cm). Local variety gave significantly the lowest plant height (49.7cm). Significantly the highest number of branches per plant was recorded in BARI til 3 (2.17) which was identical with Aatshira (2.03). Local variety gave significantly the lowest number of branch per plant (1.18).

Significantly the maximum number of pod per plant was obtained from Aatshira (32.3) followed by BARI til 2 (30.0). Local variety gave significantly the lowest number of pod per plant (25.38). Pod length was maximum in BARI til 3 (1.83cm) followed by Aatshira and BARI til 2. Significantly the minimum pod length was recorded in Local variety. The influence of salt stress on the number of seed per pod was significant. Significantly the highest number of seed per pod was recorded in Aatshira (64.66) followed BARI til 3 (53.66). BARI til 2 gave significantly the lowest number of seed per pod (45.06) which was identical with Local variety (45.11). Significantly the highest individual seed weight was obtained from Aatshira (2.21 g/1000 seed) which was identical with BARI til 2 (2.15 g/1000 seed) followed by BARI til 3 (2.08 g/1000 seed). The lowest seed weight was recorded from Local variety (1.94 g/1000 seed). Grain yield is the function of pods per plant, seeds per pod and individual seed weight. Grain yields were decreased by soil salinity and the decrease differed among the varieties. Significantly the highest grain yield was obtained from Aatshira (970 kg/ha). The lowest yield was recorded from Local (805 kg/ha) which was identical with BARI til 2 (821 kg/ha) and BARI til 3 (828 kg/ha). The highest stover yield was obtained from Aatshira (2555 kg/ha) followed BARI til 3 (2436 kg/ha). Significantly the lowest stover yield was obtained from BARI til 2 (2038 kg/ha).

Farmers reaction

The farmers of Dacope, Khulna like Aatshira variety of sesame due to its high yield potential and more stover yield which could be used as fuel.

Conclusion

From one year study it might be concluded that sesame could grown in coastal saline area of Dacope, Khulna. Aatshira would be suitable for cultivation after harvest of T.aman rice in saline area of Dacope. The experiment should be repeated in next season for final confirmation.

Table 1. Yield and yield contributing of sesame at Dacope, Khulna, 2007-2008

Variety	Plant popu./ m^2	Plant height. (cm)	Branch/ plant (no.)	Pod/ plant (no.)	Length /pod (cm)	Seed/ pod (no.)	1000 seed wt. (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
BARI til-2	64.5	55.7	1.70	30.00	1.71	45.06	2.15	822	2038
BARI til 3	61.0	66.1	2.17	28.00	1.83	53.66	2.08	829	2437
Aatshira	59.0	61.7	2.03	32.33	1.74	64.66	2.21	970	2555
Local	57.0	49.8	1.18	25.38	1.62	45.11	1.94	805	2303
$LSD_{(.05)}$	3.99	3.85	1.06	3.32	0.06	4.75	0.18	81	209
$CV_{(\%)}$	3.35	3.31	4.77	5.78	2.11	4.57	4.63	4.71	4.48

PERFORMANCE OF MUSTARD VARIETIES RELAYING WITH T.AMAN IN COASTAL REGION OF BANGLADESH

M. A. Aziz, P. K. Sardar, S.M. Zaman and M.M. Hossain

Abstract

The experiment was carried out in the coastal area of the MLT site Shatkhira during the rabi season of 2008-09 to find out suitable variety of mustard for relay cropping with T.aman in the coastal saline areas. Five mustard varieties viz. BARI Sarisha-9, BARI Sarisha-11, BARI Sarisha-15, Tori-7 and BINA Sarisha-5 were sown on 20 October, 2008 in a randomized complete design with three replications. The highest yield (583 kg/ha) was obtained from BARI sarisha-9 followed by BINA sarisha-5 (567 kg/ha).

Introduction

A vast coastal and offshore area (2.85m ha) in the Southern part of Bangladesh exhibit soil salinity of various magnitudes due to onrush of salt water from the Bay. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the under ground moves up by capillary forces. Thus a considerable amount of salt from the subsoil is carries to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. As a result, most of the areas remain fallow during dry months. To increase mustard area and production especially under relay condition marginal lands should be considered. It was observed that salinity rises from first week of March. A judicial choice to grow a crop under saline soil is, therefore considered an important management option to minimize yield loss by salinity. Blum (1998) rightly pointed out that, for sustainable crop production in the saline soils, it is more important to select a salt tolerant crop rather than a relatively better yielding variety of susceptible crops. The present study will be under taken to find out suitable variety of mustard to be grown under relay condition in the coastal areas of Bangladesh.

Materials and Methods

The experiment was conducted in coastal of the Shatkhira, MLT site during the rabi season of 2008-09. The design of the experiment was RCB with 3 replications. Five mustard varieties viz. BARI Sarisha-9, BARI Sarisha-11, BARI Sarisha-15, Tori-7 and BINA Sarisha-5 were tested under relay condition with T.aman rice. The mustard seed was broadcast in T.aman paddy field 15 days before T.aman (var. BINA Dhan-4) harvest. The seed rate was 10 kg/ha and was sowing on 20 October, 2008. Initially the experimental plots were fertilized with 250-170-85-150-15 kg/ha Urea, TSP, MP, Gypsum, Zinc Sulphate and Borax respectively. All the fertilizers were applied as basal except urea. Urea was applied as top dress on 20 and 35 days after relaying of mustard. The crop was harvest recording to their maturity. Intercultural operation and plant protection measures were taken as and when necessary. The data on different plant characters were collected from 10 randomly selected plants from each plot and yield was recorded plot wise. All necessary data were collected and analyzed statistically. During this period salinity level was 2.56 to 8.62 dS/m.

Results and Discussion

The performance of different mustard varieties under relay condition with T.aman rice presented in Table 1. The salinity range of the experimental plot was 2.56 to 8.62 dS/m during the crop growing period. The variety Tori-7 and BARI sarisha-9 was the short duration variety and took 75 days for maturity. BARI sarisha-11 was the long duration variety and took 92 days for maturity.

Significantly the highest yield of 583 kg/ha was obtained from BARI sarisha-9 followed by BINA sarisha-5 (567 kg/ha). BARI sarisha-14 gave significantly the lowest yield (433 kg/ha). The highest yield in BARI sarisha-9 was due to maximum number of population per unit area and siliqua/plant all though seed/siliqua was maximum in BARI sarisha-14 and BINA sarisha-5. BINA sarisha-5 was bold seeded (5.17 g/1000 seed) followed by BARI sarisha-11 (4.33 g/1000 seed). Significantly the highest straw yield obtained from BARI sarisha-14 (2050 kg/ha) which was identical with BARI sarisha-11 (2033 kg/ha).

Table 1. Yield and yield attributing characters of mustard relaying with T.aman at Satkhira MLT site during rabi season of 2007-08

Variety	Days to maturity	Plant popu./m	Plant height (cm)	Siliqua/ plant (no.)	Seed/ siliqua (no.)	1000 seed wt. (g)	Seed yield (kg/ha)	Straw yield (kg/ha)
BINA sarisha-5	84	134	40.87	14.07	10.67	5.17	567	1600
Tor-7	75	146	62.67	21.30	8.57	4.10	450	1416
BARI sarisha-9	75	149	73.23	26.83	10.27	4.10	583	186
BARI sarisha-11	92	98	91.73	30.43	9.07	4.33	553	2033
BARI sarisha-14	82	136	79.63	24.23	11.30	3.90	433	2050
LSD(.05)	-	24.07	7.591	4.46	1.539	0.3904	236	261
CV (%)	-	9.08	5.78	10.13	8.20	4.78	25.37	7.75

Salinity level: 2.56 to 8.62 dS/m.

Farmer's Reaction

Farmers of Satkhira area are interested to grow mustard as relay cropping with T.aman rice because of timely sowing, less cultivation cost under relay condition using residual moisture and avoid salinity stress.

The farmers those cultivate boro rice preferred BARI sarisha-9 and Tori-7 because of short duration variety.Cultivation of early maturing T.aman rice (BRRI Dhan-33/BINA Dhan-4) can also extrapolate the technology in the coastal area.

Conclusion

BARI sarisha-9 could be grown under relay condition with T.aman rice in the coastal area of south-west Bangladesh in T.aman-fallow-fallow cropping pattern. But in the previous year BARI sarisha-11 perform better. Therefore, the experiment should be repeated in the next season over locations for final conclusion.

EFFECT OF DATE OF SOWING ON YIELD AND YIELD COMPONENTS OF MUNGBEAN IN COASTAL AREAS

M. A. Aziz, A.K.M. Rahman and M. K. Basher

Abstract

The experiment was conducted at ARS, BARI, Benarpota, Satkhira and Kuakata, Potuakhali MLT site during the Rabi season of 2008-09 to investigate the influence of sowing date on the performance of mungbean variety as well as to avoid moisture stress caused due to late sowing after 15 January. Seeds were sown at four different dates viz. 20 December, 30 December, 10 January and 20 January under rainfed situation in a RCB design. Maximum yield was obtained from 10 January it might be for saline region provided that the sowing could be completed with 3^{rd} week of January to avoid moisture stress.

Introduction

Mungbean is the fifth important pulse crop in Bangladesh and contributes 11-53% of total pulse production. About 63% of mungbean grow in the southern areas. Saline soil in coastal region where farmers are growing local mungbean cultivar with poor yield potential. Farmer normally grow local variety in the early February. During the reproductive phase of the crop soil moisture dries up and the crop suffers from troth drought and salinity. On the other hand salinity may be avoided by December sowing. So, the study was undertaken to find out the optimum date of sowing for maximum yield of mungbean.

Materials and Methods

The experiment was conducted at the ARS, BARI, Benarpota, Satkhira and Kuakata, Potuakhali MLT site during the late Rabi season of 2008-09. Four sowing dates such as 20 December, 30 December, 10 January and 20 January 2009 with BARI mungbean vareity-2 was used in the study. The experiment was conducted in a Randomized complete block design with six applications. The unit plot size 5 m x 2 m. Seeds were sown in line with a spacing of 30 cm × 5 cm. Fertilizers and 50-85-35 kg/ha Urea, TSP and MP were applied as basal during final land preparation. All other intercultural operations were done as and when necessary. Harvesting of pods was done two times. Data for yield components were taken from five randomly selected plants of each plot. Collected data were analyzed statistically and the mean differences were adjusted by DMRT.

Results and Discussion

The performance of mungbean variety at different date of sowing in the coastal area Banerpota and Potuakhali are presented in Table 1. The salinity level at Banerpota varied from 20 to 6.31 dS/m and it was 2.61 to 4.45 dS/m at Potuakhali. Date of sowing affect significantly on all the parameters studied except plant population, pods/plant and seeds/pod at Potuakhali. At Banerpota significantly the highest population per unit area was recorded from 20 January sowing (67) which was identical with 10 January sowing (56). The lowest population was recorded from 20 December sowing (12) which was identical with 30 December sowing (14). Significantly the highest number of pods/plant was obtained from 20 December and 30 December sowing (12.5) at Banerpota which was identical with 10 January sowing (12.3). 20 January sowing gave the lowest number of pods/plant (11.8). At Poulakhali the number of pods/plant due to different dates of sowing was insignificant however 20 December sowing gave maximum number of pods/plant

(11.2). At Banerpota significantly the highest number seeds/pod was recorded from 20 January sowing (7.8) which was identical with 10 January sowing (7.1). The lowest number of seeds/pod was recorded from 20 December sowing (5.9). Although insignificant 20 December and 10 January sowing gave maximum number of seeds/pod (10.1) at Potuakhali. At Banerpota significantly the highest yield was obtained from 20 January sowing (1.50 t/ha) followed by 10 January sowing (1.35 t/ha). 20 December sowing gave the lowest yield (1.20 t/ha) which was identical with 30 December sowing (1.30 t/ha). At Potuakhali significantly the highest yield was obtained from 20 December sowing (1.12 t/ha) which was identical with 30 December sowing (1.10 t/ha). The lowest yield was obtained from 10 January sowing (1.08 t/ha).

Table 1. Yield and yield components of mungbean as affected by date of sowing in the saline area of Benarpota and Potuakhali

Treats.	Plant population/m^2		Pods/plant		Seed/pod		Grain yield (t/ha)	
	Baner.	Potua.	Baner.	Potua.	Baner.	Potua.	Baner.	Potua.
20 December	12 b	50	12.5 a	11.2	5.9 c	10.1	1.20 c	1.12 a
30 December	14 b	49	12.5 a	10.9	6.6 bc	9.8	1.30 c	1.10 a
10 January	56 a	49	12.3 ab	11.1	7.1 ab	10.1	1.35 b	1.08 b
20 January	67 a	-	11.8 b	-	7.8 a	-	1.50 a	-
CV(%)	24	10.26	8.7	7.05	7.4	4.50	20	12.04

Salinity level: Banerpota, 2.00 to 6.31 dS/m Potuakhali: 2.61 to 4.45 dS/m Baner- Banerpota, Potua.- Potuakhali,

Conclusion

It was revealed from the study that 20 to 30 December sowing gave maximum yield at Potuakhali but 20 January sowing gave maximum yield at Banerpota. The experiment should be repeated in the next season for final confirmation.

Farmer's Reaction

1. Farmers are interested to grow mungbean after harvest of T.aman.
2. Farmers are satisfied with the yield obtained from the experiment.

EFFECT OF DATE OF SOWING ON YIELD AND YIELD COMPONENTS OF SESAME AT COASTAL AREA

M. A. Aziz, F. Begum, R. R. Saha and A. K. M. H. Rahman

Abstract

The experiment was conducted at ARS, BARI, Benarpota, Satkhira during the Rabi season of 2008-09 to investigate the influence of sowing date on the performance of sesame (BARI til-3) under saline condition as well as to avoid moisture stress caused due to late sowing after 15 January in the coastal area. Five different dates viz. 02 January, 10 January, 20 January, 30 January and 10 February were included and the trial was conducted under rainfed situation in a RCB design. The highest yield (0.80 t/ha) was obtained from 10 February which was identical with 30 January sowing. January 02 sowing gave the lowest yield (0.17 t/ha).

Introduction

Sesame is the second most important oil seed crop in Bangladesh. It is mainly grown in kharif-1 season which is the dry wet transition period at the start of monsoon rain. Salinity is one of the major impediments to Agriculture in the southern coastal areas of Bangladesh. It was observed that salinity rises from 1st week of March. A biotic approach to over come the salinity problem has been considered the most feasible and economic path and it has recently received much attention. The different strategies that have adopted by various crop scientists in employing biological approach to overcoming the salinity problem have been listed. One of the procedures which are of prime importance is the avoidance of salinity stress of a crop for salt tolerance. Sesame is growing successfully in the none saline coastal area of Noakhali, Feni, Bhola and Khulna area in the month of January. To avoid salinity stress in the coastal saline area early sowing in the month of December may be of optimum date of sowing for successfully sesame production. The present study was therefore, undertaken to find out optimum date of sowing for maximum growth and yield of sesame to avoid salinity stress in the coastal saline area.

Materials and Methods

The experiment was conducted at the ARS, Benarpota, Satkhira during the late Rabi season of 2008-09. Five sowing dates such as 02 January, 10 January, 20 January, 30 January and 10 February were included in the trial. The experiment was conducted in a randomized complete block design with four applications. The unit plot size 5 m x 2 m. Seeds of BARI Till-3 was sown in line with a spacing of 30 cm x 5 cm. Fertilizers at the rate of 50-85-35 kg/ha Urea, TSP and MP were applied as basal during final land preparation. All other intercultural operations were done as and when necessary. Data for yield and yield components were taken from five randomly selected plants of each plot. Collected data were analyzed statistically and the mean differences were adjusted by DMRT.

Results and Discussion

The salinity level in field of sesame at Banerpota varied from 4.56 to 13.58 dS/m. The performance of Sesame at different date of sowing in the coastal area of Banerpota presented in Table 1. Date of sowing affect significantly on all the parameters studied.. Significantly the highest population per unit area was recorded from 10 January sowing (62.00 plants/m^2) which was identical with 20 January, 30 January and 10 February sowing. 02 January sowing gave the minimum plant population per unit area (8.33 plants/m^2). Minimum population on 02 January sowing was due to maximum soil moisture that cause poor plant establishment. Significantly the highest plant height was recorded from 10 January sowing (82.33 cm) which was identical with 20 January, 30 January and 10 February. 02 January sowing gave the lowest plant height (50.67 cm). The maximum number of branches was obtained from 10 January sowing (6.0) which was identical with 20 January and 30 January sowing. Significantly the lowest number of branches per plant was obtained 02 January sowing (4.0) which was identical with 10 February sowing (.4.3). Pods per plant varied significantly due to different dates of sowing. 20 January sowing gave the highest number of pods/plant (100.0) followed by 10 January sowing (89.67). 02 January sowing gave the lowest number of pods/plant (45.33). Significantly the highest number of seeds/pod was recorded from 10 January and 20 January sowing (71.0) which was identical with 30 January sowing (70.0). The lowest number of seed per pod was recorded from 02 January sowing (56.3). Significantly the highest yield was obtained from 10 February sowing (0.80 t/ha) which was identical with 30 January sowing (0.75 t/ha). The lowest yield was obtained from 02 January sowing (0.17 t/ha).

Conclusion

It was revealed from the study that maximum yield was obtained from 30 January to 10 February sowing. The results also suggested that upto Mid February would be the optimum time of sowing for sesame in the coastal area. The experiment should be repeated in the next year for final confirmation.

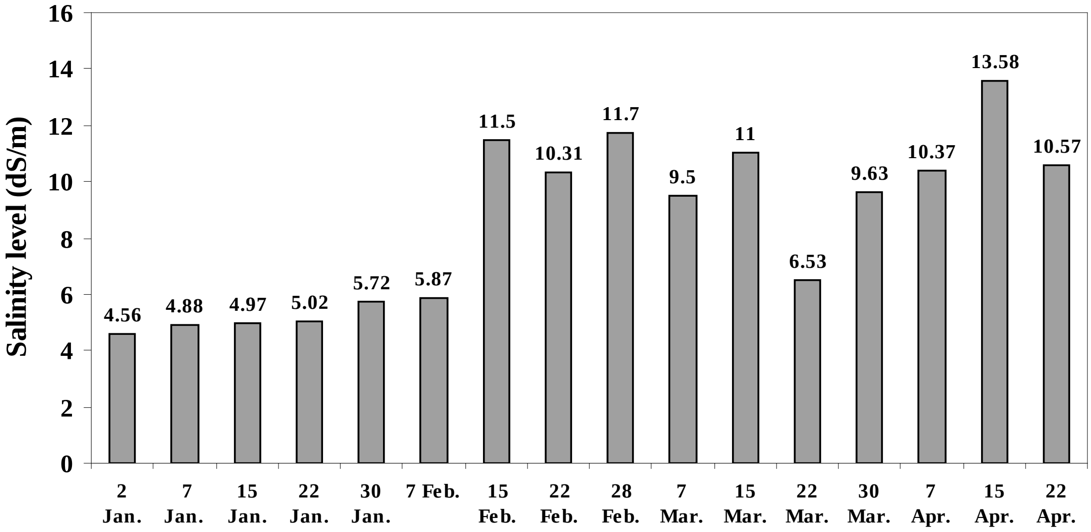

Fig.1. Soil salinity leverl in sesame field at Banerpota

Table 1. Yield and yield components of sesame as influenced by date of sowing in the saline area of Banerpota, Satkhira during 2008-09

Treatment	Plant population/ m^2 (no.)	Plant height (cm)	Branches /plant (no.)	Pods/ plant (no.)	Seeds/ pod (no.)	Grain yield/(t/ha)
02 January	8.33 b	50.67 b	4.0 b	45.33 d	56.33 c	0.17 c
10 January	62.00 a	82.33 a	6.0 a	89.67 b	71.0 a	0.53 b
20 January	61.33 a	80.00 a	5.0 ab	100.0 a	71.0 a	0.65 b
30 January	61.67 a	79.00 a	5.0 ab	86.0 bc	70.0 a	0.75 a
10 February	61.67 a	78.00 a	4.3 b	82.33 c	67.0 b	0.80 a
CV(%)	1.44	5.02	5.3	10.23	12.37	7.6

EFFECT OF DATE OF SOWING ON YIELD AND YIELD COMPONENTS OF SOYBEAN AT COASTAL AREA

M. A. Aziz, M. Idrish, R. R. Saha and A. K. M. H. Rahman

Abstract

The experiment was conducted at ARS, BARI, Banerpota, Satkhira and Kuakata, Potuakhali during the rabi season of 2008-09 to investigate the influence of sowing date on the performance of Soybean. Six dates of sowing viz. 10 December, 20 December, 30 December, 10 January, 20 January and 30 January were included in the trial under rainfed situation in a RCB design. It was observed that 20 December to 30 December sowing gave maximum yield at Potuakhali and at Banerpota 10 January to 10 February gave the maximum yield. Influence of date of sowing on the performance of soybean varied in both the locations.

Introduction

Salinity is one of the major impediments to Agriculture in the southern coastal areas of Bangladesh. It was observed that salinity rises from 1st week of March. A judicial choice to grow a crop under saline soils is therefore considered an important management option in minimize yield loss by salinity. A biotic approach to over come the salinity problem has been considered the most feasible and economic path and it has recently received much attention. The different strategies that have adopted by various crop scientists in employing biological approach to overcoming the salinity problem have been listed (Orcuit and Nelson, 2002. One of the procedures which are of prime importance is the avoidance of salinity stress of a crop for salt tolerance (Epstain, 2004, Ashraf and Meneilly, 2001). Soybean is growing successfully in none saline coastal area of Noakhali, Feni, Bhola area in the month of January. To avoid salinity stress in the coastal saline area early sowing in the month of December may be of optimum date of sowing for successful soybean production. The present study was therefore undertaken to find out the optimum date of sowing for maximum growth and yield of soybean to avoid salinity stress in the coastal saline area.

Materials and Methods

The experiment was conducted at ARS, BARI, Banerpota, Satkhira and Kuakata, Potuakhali during the rabi season of 2008-09. Six dates of sowing viz. 10 December, 20 December, 30 December, 10 January, 20 January and 30 January were included in the trial The experiment was conducted in a randomized complete block design with 3 applications. The unit plot size 5 m × 2 m. Seeds were sown in line with a spacing of 30 cm x 5 cm. The variety Shohag was used in the trial. Fertilizers at the rate of 50-85-35 kg/ha Urea, TSP and MP were applied as basal during final land preparation. All other intercultural operations were done as and when necessary. Harvesting of pods was done two times. Data for yield components were taken from five randomly selected plants froim each plot. Collected data were analyzed statistically and the mean differences were adjusted by DMRT.

Results and Discussion

Potuakhali

The influence date of sowing on the performance of mungbean in the coastal area of Potuakhali presented in Table 1. Date of sowing affect significantly on all the parameters studied except plant population, pod/plant and seed/pod. The maximum population was recorded from 30 December sowing (31 plants/m^2) followed by 12 January sowing (29 plants/m^2). January 20 sowing gave the minimum plant population. Significantly the highest plant height was recorded from 20 December sowing (43.2 cm) which was identical with 30 December sowing (42.5 cm). 12 January gave significantly the lowest plant height (39.8 cm). Although insignificant 20 December sowing gave maximum number of pods per plant (29.5) followed by 30 December sowing (27.7). 12 January sowing gave minimum number of pods/plant (26.6). Seed/pod varied insignificantly due to different dates of sowing. Significantly the highest yield was obtained from 20 December sowing (1.45 t/ha) which was identical with 30 December sowing (1.40 t/ha). The lowest yield was obtained from 12 January sowing (1.20 t/ha). The highest yield form 20 December sowing followed by 30 December sowing might be attributed for maximum population/m^2 and maximum pods/plant.

Banerpota

The salinity level in soybean field at Banerpota Farm varied from 4.63 to 13.63 dS/m. Minimum salinity level was in month of January and maximum was in April. The performance of mungbean at different date of sowing in the coastal area of Banerpota presented in Table 2. Date of sowing affect significantly on all the parameters studied. The maximum plant height was recorded from 20 January sowing (49.3 cm). Sowing on 10 January, 30 January and 10 February gave identical plant height. Significantly the lowest plant height (30.7 cm) was recorded from 2 January sowing. Branch per plant varied significantly due to different date of sowing. Maximum number of branches was obtained from 20 January sowing and 30 January sowing (4.3) which was identical 10 January and 10 February sowing (4.0). 02 January sowing gave significantly the lowest number of branches per plant (2.7).Significantly the highest number of pods/plant was recorded from 20 January sowing (96.0). 10 February sowing gave 91.7 number of pods/plant which was identical with 30 January sowing.(88.3 pods/plant).The lowest number of pods/plant was obtained from 02 January sowing (62.0). Significantly the highest yield was obtained from 20 January and, 30 January sowing (1.99 t/ha) which was identical with 10 February (1.98 t/ha) and 10 January sowing (1.95 t/ha). January 2 sowing gave significantly the lowest grain yield (0.67 t/ha). The highest yield form 20 January sowing followed by 30 January, 10 February and 10 January sowing might be attributed for maximum number of pod/plant. Total dry matter production per plant followed the same trend as observed in grain yield.

Farmer's reaction

1. It is a new crop to the farmers
2. Farmers are interested to cultivate soybean
3. But seed availability and marketing of soybean is a problem.

Conclusion

It was revealed from the study that maximum yield was obtained from 10 January to 10 February sowing at Banerpota and 20 December to 30 December sowing at Potuakhali. The experiment should be repeated in the next year for final confirmation.

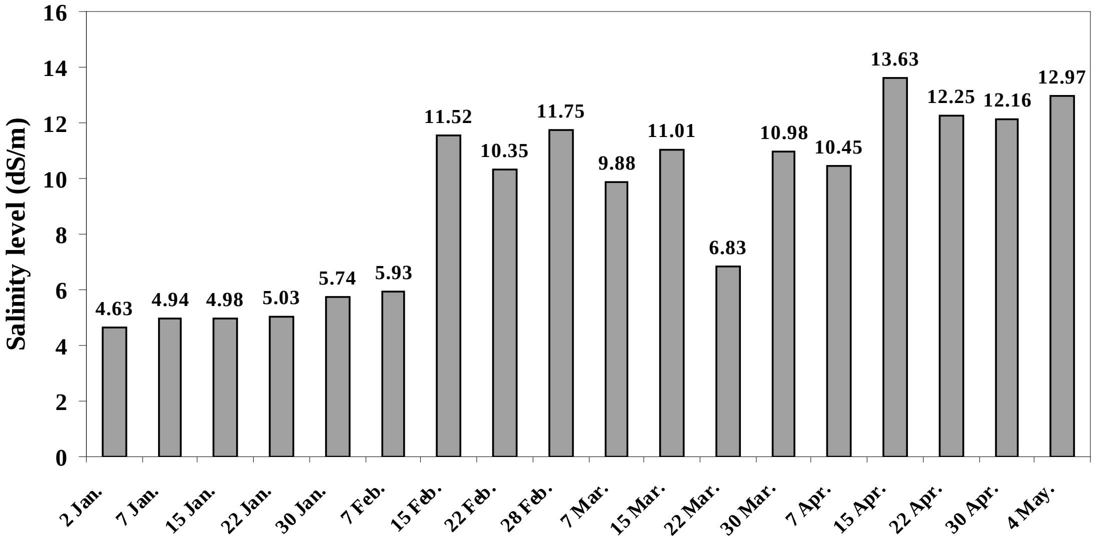

Fig.1. Soil salinity leverl in Soybean field at Banerpota

Table 1. Effect of time of sowing on yield and yield contributing characters of soybean in the saline area of Potuakhali

Treatment	Plant population/ m^2 (no.)	Plant height (cm)	Pods/ plant (no.)	Seeds/ pod (no.)	Seed yield (t/ha)
20 December	28	43.2 a	29.5	2.1	1.45 a
30 December	31	42.5 a	27.7	2.0	1.40 a
12 January	29	39.8 b	26.6	2.1	1.20 b
CV (%)	10.26	8.03	7.05	4.50	12.04

Table 2. Yield and yield components of soybean as influenced by date of sowing in the saline area of Benarpota, Satkhira during 2008-09

Treatment	Plant height (cm)	Branches/ plant (no.)	Pods/ plant (no.)	Grain yield (t/ha)	TDM at harvest (g/plant)
02 January	30.7 c	2.7 b	62.0 d	0.67 b	54.0 b
10 January.	44.7 b	4.0 a	80.7 c	1.95 a	54.7 a
20 January	49.3 a	4.3 a	96.0 a	1.99 a	55.0 a
30 January	44.3 b	4.3 a	88.3 b	1.99 a	55.0 a
10 February	44.7 b	4.0 a	91.7 b	1.98 a	55.0 a
CV(%)	5.6	12.5	20.5	4.01	.47

PERFORMANCE OF SALT TOLERENT SOYBEAN GENOTYPES IN THE COASTAL AREA OF BANGLADESH

M. A. Aziz, F. Begum, M. I. Ali and A. K. M. H. Rahman

Abstract

The experiment was conducted at ARS, BARI, Banerpota, Satkhira and Kuakata, Potuakhali during the rabi season of 2008-09 to select the salt tolerant soybean variety. At Banerpota Shohag and BARI soybean-5 (1.99 t/ha) and at Potuakhali Shohag (1.78 t/ha) produced the highest seed yield. 1.99 (t/ha), Amber produced the lowest seed yield (1.19 t/ha) at Banerpota and BGM-2026 produced the lowest yield at Potuakhali.

Introduction

Salinity is one of the major impediments to agriculture in the southern coastal areas of Bangladesh. A biotic approach to overcoming the salinity problem has been considered the most feasible and economic path and it has recently received much attention (Ashraf *et al.* 1994). The different strategies that have been adopted by various crop scientists, in employing and biological approach to overcoming the salinity problem, have been listed by Ashraf and MeNeilly, 1988. One of the procedures, which are of prime importance, is the screening of available germplasm of a crop for salt tolerance, (Epstain, 1984; Ashraf and MeNeilly 1987). Soybean is growing successfully in the non-saline coastal area of Noakhali, Feni, Bhola area. Salt tolerant soybean genotypes identified the last the season under Hoagland culture solution could be potential and economic for growing in the coastal area. Therefore, the experiment was undertaken weather salt tolerance in soybean performed under control condition has consistence with natural field condition.

Materials and Methods

The trial was conducted at ARS, BARI, Benarpota, Satkhira and Kuakata, Potuakhali during the rabi season of 2008-09. Eight soybean varieties/genotypes such as (Shohag, Amber, BGM-2026, BGM-2093, GC-84051, BARI soybean-5, ASSET-95 and GMOT-17) were included in the study. The unit plot size was 4 cm × 3 cm. Seeds were sown following RCB design with three replications. Soybean was sown on 29 January 2009 at Benarpota and 13 January at Potuakhali. The seeds were sown in line with a spacing of 30 cm x 5 cm. Fertilizers @ 25-30-60-16-02-0.9 kg/ha of N-P-K-S-Zn-B was used. Two irrigations were applied at initial stage for crop establishment. Intercultural operations were followed as and when necessary. Data were taken from 5 randomly selected plants from each plot. The collected data were analyzed and the means were separated following DMRT.

Results and Discussion

Banerpota

The salinity level at Banerpota varied from 4.93 to 9.27 dS/m. The performance of soybean varieties/genotypes is presented in Table 1.Plant population was optimum for all the varieties except Amber which was due to poor vigour. Plant height varied significantly among all the varieties. The highest plant height was obtained from BGM-2026 (66.7 cm) which was identical with BC-84051 (66.0 cm) and BGM-20903 (63.0 cm). Amber gave significantly the lowest plant height (34.3 cm). Significantly the maximum branches/plant was recorded from BC-84051 (5.0) which was identical with BGM-2026 (4.7). Shohag, Amber and BARI soybean-5 gave significantly the lowest branches/plant (3.0). Pods/plant varied significantly among the varieties.

BGM-2026 gave the maximum number of pods/plant (108.7) which was identical with Amber (106.7) and BC-84051 (100.0). BARI soybean-5 gave significantly the lowest number pods/plant (65.3). The highest seed weight was recorded BARI soybean-5 (12.52 g/100 seed) followed Amber (12.24 g/100 seed). Significantly the lowest seed weight was recorded from BGM-2026 (9.8 g/100 seed). All the yield contributing characters affect finally the grain yield. Significantly the highest grain yield was obtained from Shohag and BARI soybean-5 (1.99 t/ha). BGM-2026 (1.69 t/ha, BGM-20903 (1.67 t/ha) and BC-84051 (1.64 t/ha) gave identical grain yield. The variety Amber gave significantly the lowest grain yield (1.19 t/ha). The lowest yield in Amber might be due to the poor plant stand. BARI soyeban-5 gave significantly the highest straw yield (1.66 t/ha) followed by Shohag (1.50 t/ha).

Potuakhali

The salinity level at Potuakhali varied from 0.84 to 5.50 dS/m. The natural soil salinity influenced insignificantly among the varieties in all the characters studied except grain yield. Significantly the highest grain yield was obtained from Shohag (1.78 t/ha) followed by BARI soybean-5 (1.66 t/ha). GMOT-17 (1.63 t/ha), AGS-95 (1.58 t/ha) and BC-84051 (1.55 t/ha) gave identical grain yield. BGM-2026 gave significantly the lowest grain yield (1.20 t/ha) which was identical with BGM-20903 (1.28 t/ha).

Farmer's reaction

1. It is a new crop to the farmers
2. Farmers are interested to cultivate soybean
3. But seed availability and marketing of soybean is a problem.

Conclusion

It was observed that at Banerpota, Shohag and BARI soybean-5 (1.99 t/ha) and at Potuakhali Shohag (1.78 t/ha) produced the highest seed yield. Shohag showed better adaptability in the coastal saline area. The experiment should be repeated in next season for final conclusion.

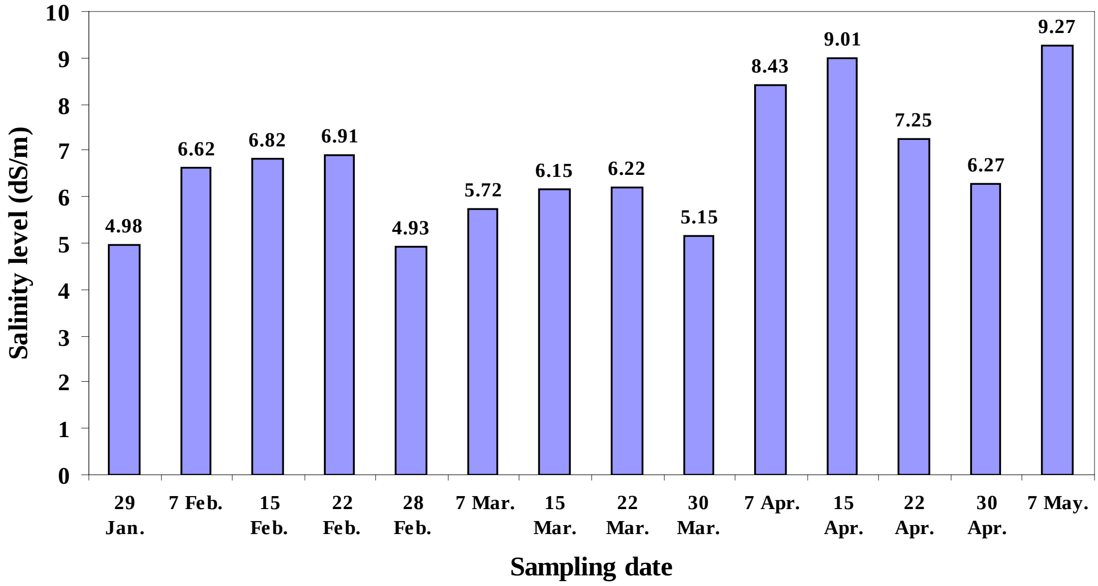

Fig.1. Soil salinity leverl in Soybean field at Banerpota

Table 1. Yield and yield attributes of soybean varieties at Benarpota Farm, Satkhira during rabi season, 2008-09

Variety	Plant population / m^2	Plant height (cm)	Branches /plant (no.)	Pods/ plant (no.)	100-seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
Shohag	61.0 a	50.0 b	3.0 c	81.0 b	12.06 c	1.99 a	1.50 b
Amber	12.3 b	34.3 c	3.0 c	106.7 a	12.24 b	1.19 c	0.56 d
BARI soy.-5	61.3 a	54.7 b	3.0 c	65.3 c	12.52 a	1.99 a	1.66 a
BGM-2026	62.0 a	66.7 a	4.7 a	108.7 a	9.8 f	1.69 b	1.00 c
BGM-20903	61.3 a	63.0 a	4.0 b	69.3 c	9.88 e	1.67 b	1.02 c
BC-84051	62.0 a	66.0a	5.0 a	100.0 a	9.98 d	1.64 b	1.00 c
CV(%)	1.8	4.7	6.2	5.7	10.05	10.9	10.7

Table 2. Yield and yield contributing characters of soybean varieties at MLT site Kuakata, Patuakhali, 2008-09

Variety	Plant height (cm)	Pods/plant (no.)	Seeds/pod (no.)	100-seed weight (g)	Grain yield (t/ha)
Shohag	42.7	28.6	2.2	8.7	1.78 a
BARI Soybean-5	36.1	26.9	2.1	8.5	1.66 b
BGM-2026	50.6	32.0	2.1	5.7	1.20 e
BGM-20903	46.6	33.7	1.9	6.2	1.28 e
BC-84051	42.5	27.2	2.2	7.8	1.55 c
AGS-95	35.6	28.9	2.1	9.0	1.58 c
ASSET-95	48.6	29.1	2.0	7.1	1.40 d
GMOT-17	50.8	34.2	1.8	8.2	1.63 bc
CV (%)	-	-	-	-	9.25

Salinity level: 0.84 to 5.50 dS/m

PERFORMANCE OF HYBRID MAIZE VARIETIES IN THE COASTAL CYCLONE PRONE AREAS OF BANGLADESH

M. A. Aziz, F. Begum, R. R. Saha, M. Amin, A.K.M. H. Rahman and M. I. Ali

Abstract

The experiment was conducted in the coastal saline area of Banerpota Farm, Shatkhira, FSRD site Noakhali and MLT site Kuakata, Potuakhali during the rabi season of 2008-09 after T.aman harvest to select suitable hybrid maize variety adaptive for coastal cyclone prone area of Bangladesh. It was observed that Pacific-60 perform better in the coastal cyclone prone areas and among the BARI released varieties BARI hybrid maize-5 perform better. But in the last year BARI hybrid maize-3 perform better.

Introduction

The last devastating cyclone in the coastal areas of Bangladesh especially Potuakhali and Khulna has broken the backbone of all most all farmers. T.aman crop in those areas in completely damaged. Maize could be grown as cyclone rehabilitation program in the cyclone affected areas. Among the popular hybrid maize varieties which one will be most suitable for those areas is not yet studied. The present study have been undertaken to find out suitable hybrid maize variety for the cyclone prone area of Bangladesh.

Materials and Methods

The experiment was conducted in the coastal saline area of Banerpota Farm, Shatkhira, FSRD site Noakhali and MLT site Kuakata, Patuakhali during the rabi season of 2008-09 after the harvest of T.aman rice. Six hybrid maize. Varieties viz BARI hybrid maize-2, BARI hybrid maize-5, Pacific-11, Pacific-60, Pacific-555 and Pacfic-984 were tested in a randomized complete block design with three replications. Seeds of different varieties were sown on 19 January 2009 at Banerpota and 01 January 2009 at Kuakata with a spacing of 75cm x 25cm. The trial was fertilized with 253-52-110-46-5-1.2 kg/ha of N-P-K-S-Zn-B+CD respectively. All fertilizer along with 6 t/ha cowdung/ha and $^1/_3$ N were applied as basal during final land preparation. The rest of urea was applied in two equal split at 35 and 65 DAS. Two irrigations were given following the urea top dressing. Earthing up was done after 2nd top dress of urea. There times weeding and necessary plant protection measures were taken. The crop was harvested on 13 May, 2009 at Satkhria and 6 May 2006 at Kuakata. The salinity level at satkhira during the crop growth period presented in Fig.1. Data on different plant characters and yield were record and analyzed statistically.

Results and Discussion

The salinity level at Banerpota varied from 4.30 to 16.57 dS/m and at Noakhali it was 2.03 to 5.21 dS/m. The performance of hybrid maize varieties under natural saline condition in the coastal area of Banerpota, Noakhali and Potuakhali presented in Table 1 and Table 2. Soil salinity influenced insignificantly to the characters studied in all three locations except grain yield at Potuakhali. Although insignificant at Banerpota highest plant height was observed in BARI hybrid maize-2 (200 cm) followed by Pacific-555 (199 cm). BARI hybrid maize-5 gave the lowest plant height (172 cm). At Noakhali Pacific-11 gave the highest plant height (199 cm) and at Potuakhali BARI hybrid maize-2 gave the highest plant height (103 cm). Number of grains/cob was significant at all the locations. At Banerpota Pacific-984 gave maximum number of grains/cob (603) and BARI hybrid maize-5 gave the lowest (453). At Potuakhli Pacific-60 gave the highest grains/cob (396). At Banerpota maximum individual grain weight was recorded from Pacific-984 (363.0 g/1000 seed) and Pacific-555 gave the lowest grain weight (290 g/1000 seed) but at Noakhali Pacific-555 gave the highest individual grain weight (328.3 g/1000 seed). At Potuakhali Pacific-11 gave the maximum individual grain weight (183.0 g/1000 seed) and Pacific-984 gave the minimum (142.0 g/1000 seed). Grain yield influenced significantly only at Potuakhali. At Banerpota the highest yield was recorded from Pacific-984 (11.5 t/ha) followed be Pacific-60 (11.02 t/ha). Pacific-555 gave the lowest yield (8.57 t/ha). At Noakhali the highest yield was recorded from Pacific-60 (7.70 t/ha) followed by BARI hybrid maize-5 and Pacific-11 gave the lowest yield (6.55 t/ha). At Potuakhali significantly the highest yield was obtained form Pacific-11 (5.90 t/ha) which was identical with Pacific-60 (5.6 t/ha) followed by BARI hybrid maize-2 (4.9t/ha) and Pacific-555 (4.8 t/ha). Pacific-984 gave the lowest yield (4.5 t/ha). From mean grain yield it was observed that Pacific-60 perform better in the coastal cyclone prone areas and among the BARI released varieties BARI hybrid maize-5 perform better. But in the last year BARI hybrid maize-3 perform better.

Farmer's reaction

1. Yield of hybrid maize was satisfactory, so farmers are interested to grow hybrid maize.
2. Farmers preferred BARI hybrid maize 5 for attractive colour and taste.
3. Stover was used as fodder and fuel.

Conclusion

From the study it was revealed that Pacific-60 followed by Pacific-11 performed better in the coastal cyclone area after harvest of T.aman rice. But in the last year Pacific-11 followed by BARI hybrid maize-3 performed better. The experiment should be repeated in the next year with BARI hybrid maize-3 for final conclusion.

Table 1. Plant height and number of grains/cob of hybrid maize varieties at Benarpota Noakhali and Patuakhali as influenced by natural soil salinity

Variety	Plant height (cm)			No. of grains/cob		
	Banerpota	Noakhali	Patuakhali	Banerpota	Noakhali	Patuakhali
BHM-2	200	192	103.0	492	-	364
BHM-5	172	183	81.3	453	-	364
Pacific- 11	190	199	102.0	454	-	347
Pacific-60	192	191	96.0	581	-	396
Pacific-555	199	194	92.0	521	-	349
Pacific-984	185	190	84.0	603	-	374
LDS $_{(0.05)}$	NS	NS	NS	NS	-	NS
CV (%)	10.35		-	6.32	-	-

NS= Not significant

Table 2. 1000- grain wt. and Grain yield of hybrid maize varieties at Banerpota, Noakhali and Patuakhali as influenced by natural soil salinity

Variety	1000- grain wt. (gm)			Grain yield (t/ha)			Mean
	Banerpota	Noakhali	Patuakhali	Banerpota	Noakhali	Patuakhali	
BHM-2	357.0	296.0	156.0	9.04	6.78	4.9 b	6.91
BHM-5	334.0	279.0	152.2	9.43	7.27	4.6 bc	7.0
Pacific- 11	295.0	277.7	183.0	10.30	6.55	5.9 a	7.58
Pacific-60	274.0	316.3	159.0	11.02	7.70	5.6 a	8.17
Pacific-555	290.0	328.3	157.0	8.57	6.92	4.8 b	6.76
Pacific-984	363.0	292.7	142.0	11.5	6.98	4.5 c	7.66
LSD $_{(0.05)}$	NS	NS	NS	NS	NS	NS	-
CV (%)	10.12	-	-	9.68	-	8.35	-

PERFORMANCE OF SALT TOLERANT MUNGBEAN VARIETIES/LINES IN THE COASTAL AREAS

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Abstract

The field trial was conducted at Benarpota Farm, Sathkhira, FSRD site Noakhali and Kuakata, Potuakhali during the rabi season of 2008-09, to assess whether salt tolerance in BM 01 and BM 08 under pot culture has relationship with that under field condition. Five mungbean varieties/lines viz. BM- 01, BM-08, BARI mug-2, BARI mug -5 and local were tested in a randomized block design with three replications. The salt tolerant line BM 08 and BM 01 showed better adaptability at all three locations in the coastal area. Significantly the highest yield was obtained from BM 08 (1.44 t/ha) and BM 01 (0.71 t/ha) at Noakhali and Benarpota, respectively. The results indicated that the salt tolerance in BM 08 and BM 01 made in pot culture showed consistence with that made under field condition.

Introduction

A vast coastal and offshore area (2.85 m/ha) in the southern part of Bangladesh exhibits soil salinity of various magnitudes due to onrush of salt water from the Bay. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the underground moves up by capillary forces. Thus a considerable amount of salt from the subsoil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. As a result, most of the areas remain fallow during dry months. To increase mungbean area and production these marginal lands may be considered as it is mostly grown in the southern part of Bangladesh. The variation in salinity tolerance between crops and/or varieties of crop is well known (Mass and Hoffman, 1977; Karim *et al.* 1994; Richards *et al*. 1987). A judicial choice to grow a crop under saline soils is, therefore, considered an important management option to minimize yield loss by salinity. Blum (1988) rightly pointed out that, for sustainable crop production in the saline soil is more important to select a salt tolerant crop rather than a relatively better yielding variety of susceptible crops. The present study was therefore, undertaken to assess whether salt tolerance in BM 01 and BM 08 under control condition (pot culture) has relationship with that under field condition.

Materials and Methods

The field trial was conducted at Benarpota Farm, Sathkhira, FSRD site Noakhali and Kuakata, Potuakhali during the rabi season of 2008-09. Five mungbean varieties /lines viz. BM- 01, BM-08, BARI mug-2, BARI mug -5 and local were tested in the experiment. The unit plot size was 3 m x 2 m. Seeds were sown in 30 cm x 5 cm line following RCB design with three replications. Fertilizers @ of 20-16-15-10 kg/ha of N-P-K-S was applied as basal. Mungbean was sown on 10 February 2009 at Noakhali, 20 December at Potuakhali and 26 January 2009 at Benarpota. Weeding, thinning and all other intercultural operations were done as and when necessary. Soil salinity level was measured 15 days interval from sowing harvesting of the crop.. Data on yield and yield components were collected from five randomly selected plants from each plot. The collected data were analyzed statistically following 'MSTAT' programme.

Results and Discussion

Benarpota

The performance of mungbean varieties/lines at Benarpota, Shathkhira presented in (Table 1). The soil salinity level was 4.85 to 7.65 dS/m through out the crop growing period. Soil salinity at Benarpota significantly influenced the yield and yield contributing characters of mungbean except seed per pod. Significantly the highest population was recorded in Local (64.7) followed by BM-01

(6.07). The lowest population was recorded in BARI mug-2 (24.3). The highest plant height was obtained from BM-01 (35.6 cm) followed by Local (29.3 cm). Significantly the lowest plant height was obtained from BARI mug-2 (23.6 cm) which was identical with BM-08. Significantly the highest number of pods per plant was recorded from Local (11.40) followed by BM-01 (9.13). The lowest number pods per plant was recorded from BARI mug-5 (6.13) The influence of salt stress on reduction of number of seed per pod was insignificant. Significantly the highest individual grain weight was obtained from BARI mug-5 (43.2 g/1000 seed) followed by BARI Mung-2 (35.1 g/1000 seed). The lowest grain weight was recorded from Local (24.5 g/1000 seed) which was identical with BM-08 (25.1 g/1000 seed). Grain yield is the function of pods per plant, seeds per pod and individual seed weight. Grain yields were decreased by soil salinity and the decrease differed among the varieties. Significantly the highest grain yield was obtained from BM 01 (0.71 t/ha) followed by Local variety (0.67 t/ha). The lowest yield was recorded from BM-01 (1.46 t/ha) which was identical with BM-08 (1.29 t/ha). BARI Mung-2 and BARI Mung-5 gave identical grain yield. The lowest grain yield was recorded from Local (0.58 t/ha). Under salt stress condition in pot culture at about 10 dS/m the observations are in line with the results obtained by Raptan (2001), Aziz *et al.*, (2002), Faruque (2002) and Aziz (2003). They obtained the highest grain yield per plant from BM 01 followed by BM 08.

Noakhali

The performance of mungbean varieties/line at FSRD site of Noakhali presented in (Table 2). The soil salinity level was 1.6 to 5.9 dS/. Soil salinity significantly influenced the yield and yield components of mungbean varieties. Significantly the highest number of pods per plant was obtained in BM-08 (14.34) which was identical with BM-01 (14.12). BARI mug-2 and BARI mug- gave identical number of pods/plant. The lowest number pods/plant was obtained from Local (8.80). Significantly the highest number of seeds per pod was recorded from BM-08 (9.80) which was identical with BM-01 (9.71). The lowest number of seeds/pod was recorded from Local (8.82). Significantly the highest individual grain weight was obtained from BARI mug-5 (33.99 g/1000 seed) which was identical with BARI mug-2 (33.50 g/1000 seed) followed by BM-01 (24.22 g/1000 seed) and BM-08 (33.17 g/1000 seed). Local (19.59 g/1000 seed) Local variety gave the lowest individual grain weight. The effects of soil salinity on grain yield closely matched its effects on number of pods per plant. Grain yields were decreased by soil salinity and the decrease differed among the varieties. Significantly the highest grain yield was obtained from BM -08 (1.10 t/ha) followed by BM-01.The lowest yield was recorded from Local (0.51 t/ha)

Potuakhali

The salinity level at Noakhali during the crop growing period varied from 2.80 to 7.04 dS/m. The performance of mungbean varieties/lines in the famer's field of Potuakhali presented in Table 3. Soil salinity influenced insignificantly the mungbean varieties for all the characters studied except grain yield. Significantly the highest grain yield was obtained from BM-01 (0.52 t/ha) which was identical with BM-08 (0.49 t/ha). BARI mung-5 gave significantly the lowest grain yield (0.15 t/ha).

Farmers' Reaction

1. Farmers are interested to grow mungbean after harvest of T.aman.
2. Farmers are satisfied with the yield obtained from the experiment.
3. Farmers like BM-01 and BM-08 as the lines are salt tolerant.

Conclusion

The salt tolerance in BM-08 followed by BM-01 made in pot culture showed consistence with that observed under field condition. The salt tolerant line BM-08 and BM-01 showed better adaptability in coastal area. The results should similarity for the last three years. Pilot production programme should be taken in the next season for large scale demonstration.

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Table 1. Yield and yield attributes of mungbean varieties at Banerpota, Satkhira during 2008-09

Varieties/ lines	Plant populations/m^2 (no.)	Plant height (cm)	Pod/plant (no.)	Seed /pod (no.)	1000 seed wt. (g)	Grain yield (t/ ha)
BM-01	60.7 ab	35.6 a	9.13 b	8.6	28.1 c	1.46 a
BM-08	57.0 b	24.6 c	8.53b c	8.3	25.1 d	1.29 a
BARI mug-2	42.3 c	23.6 c	7.73 c	8.5	35.1 b	0.96 b
BARI mug-5	23.0 d	26.6 bc	6.13 d	9.1	43.2 a	0.92 b
Local	64.7 a	29.3 b	11.40 a	8.1	24.5 d	0.58 c
CV (%)	7.52	9.8	7.66	5.6	4.8	10.2

Soil salinity level: 4.85 to 7.65 dS/m.

Table 2 Yield and yield attributes of mungbean as influenced by different varieties at FSRD, Hazirhat site of Noakhali during 2008-09

Varieties/lines	Pods/plant(no.)	Seed / pod(no.)	1000 seed wt. (g)	Grain yield(t/ha)
BM-01	14.12 a	9.71 a	24.22 b	0.82 b
BM-08	14.34 a	9.80 a	23.17 b	1.10 a
BARI mung-2	10.54 b	7.81 c	32.50 a	0.69
BARI mung-5	1058 b	7.07 c	33.99 a	0.79
Local	8.80 c	8.82 b	19.59 c	0.51
CV (%)	5.84	6.09	4.18	7.20

Soil salinity level: 1.6 to 5.9 dS/m

Table 3. Yield and yield attributes of mungbean varieties at Kuakata, Potuakhali during 2007-08

Varieties/lines	Plant population/m^2 (no.)	Plant ht. (cm)	Pod/plant (no.)	Seed/pod (no.)	1000 seed wt. (g)	Seed yield (t/ha)
BM 01	19.5	21.8	4.5	8.3	23.15	0.52 a
BM 08	18.0	28.8	6.4	8.4	32.0	0.49 a
BARI mug-2	21.0	22.1	5.0	8.4	25.9	0.20 b
BARI mug-5	18.5	27.5	6.2	8.5	35.7	0.15 c
CV (%)	-	-	-	-	-	9.85

Soil salinity level: 2.80 to 7.04 dS/m

PERFORMANCE OF SALT TOLERANCE BARLEY GENOTYPES IN THE COASTAL REGION OF BANGLADESH

F. Begum, M.A.Aziz, M.I.A. Howlader and A. K. M. H. Rahman

Abstract

The experiment was conducted at two different locations of coastal areas (Potuakhali and Khulna) to find out the performance of salt tolerant barley lines namely BHL-15, BHL-18 and BHL-19 screened under laboratory.BHL-15 performed better at Potuakhali and also Satkhira. The line BHL-15 could be selected for cultivation in the coastal saline area of Bangladesh.

Introduction

Barley (*Hordium vulgare* L.) is the world's 4th most important cereal crops and it has the potential to become one of the important crops in Bangladesh. Barley though a minor crop of the country can play an important role in enhancing the food security of the country and in reducing the drainage of foreign currency. It is nutritionally comparable to wheat and rice, which are the traditional foods of this subcontinent. Barley is popular for home consumption of rural people. This has several industrial uses also for which import is unavoidable. Further of all cereals barley is well known for its high resistance to salinity and thus has a great potentiality for expansion is the coastal saline area which mostly remains fallow in the rabi season. Therefore, development of high yielding and salt tolerant superior quality barley varieties is very much necessary for reducing the drainage of foreign currency and for enhancing the over all food security of the country.

Materials and Methods

The experiment was conducted at Satkhira, Khulna and Kuakata, Potuakhali during rabi season of 2008-09. Three varieties/lines namely BHL-15, BHL-18 and BHL-19 were used in this experiment. The crop was sown on 15th December'08 in Satkhira, 20th December in Potuakhali. Seeds were sown continuously and line to line spacing was 30 cm. Fertilizer was applied at the rate of 100-60-40 kg/ha of NPK respectively in the form of urea, TSP and MP and were applied as basal. Data on yield and yield attributes were collected and analyzed statistically.

Results and Discussion

The salinity levels of Satkhira and Potuakhali are presented in Table1. The salinity level during the crop growing period was ranged from 2.01 dS^{-m} to 7.43 dS^{-m} in Banerpota, Satkhira.. The soil salinity was ranged from 2.93 dS^{-m} to 9.51 dS^{-m} in Kuakata, Potuakhali. Yield and yield contributing characters were presented in Table 2. At Potuakhali BHL-15 gave the highest yield. The higher yield may be due to higher number of grains/spike and higher 1000 grain weight. BHL 18 gave the lowest yield which might be due to higher salinity in the experimental plot. At Satkhira significant difference was found in grains/spike, 1000 grain wt. and grain yield. The highest grain yield (0.98 t/ha) was obtained from BHL-18 grown in Potuakhali which was statistically identical with grain yield obtained from BHL-15 (0.96 t/ha). A decrease in yield due to salinity was also observed in other crops viz. Wheat (Begum and Karmoker, 1997), green grass (Patil *et al* 1992) and also in finger millet (Onkware, 1993).From this observation it is clear that BHL 15 showed better performance both in Banerpota , Satkhira and Kuakata, Potuakhali.

Farmer's reaction

1. Post harvest processing was not easy.
2. Marketing was a problem.
3. Farmers are not interested to cultivate barley.
4. If it is sown within 15 November the grain yield would be satisfactory.

Conclusion

It may be concluded that salt tolerance made in laboratory condition showed consistent under field condition in the coastal area. BHL-15 showed better adaptability in the coastal saline area and would be suitable for cultivation. Pilot production programme should be taken in the next season for large scale demonstration.

Table 1. Salinity levels in the experiment plots

Date	Soil Salinity level (dS/m)	
	Banerpota	Kuakata
25-12-2008	2.93	2.01
09-1-2009	3.81	3.82
21-1-2009	4.91	4.77
31-1-2009	5.53	5.42
12-2-2009	6.98	6.54
27-2-2009	7.80	4.63
15-3-2009	9.51	7.43
30-3-2009	-	6.44

Table 2. Yield and yield attributing characters of salt tolerant Barley varieties during rabi season, 2008-2009

Variety	Plant height (cm)		Grains/spike (no.)		1000 grain weight (g)		Grain yield (t/ha)	
	Sat.	Pot.	Sat.	Pot.	Sat.	Pot.	Sat.	Pot.
BHL 19	70	55	42.3 a	43	31.0 b	27.55 b	0.83 b	1.32 b
BHL 18	75	53	28.0 b	41	32.33 b	27.33 b	0.98 a	1.20 c
BHL 15	75	55	26.3 b	43	34.01 a	29.0 a	0.96 a	1.61 a
CV(%)	NS	NS		NS				

Sat. = Satkhira, Pot. = Potuakhali

EVALUATION OF SELECTED COWPEA GENOTYPES AGAINST SALINITY STRESS UNDER POT CULTURE

A.K.M.M. Rahman, M.A. Aziz, M.T. Rahman and S. Akhter

Abstract

In this study, five cowpea (BD-1604, BD-8337, BD-8338, BD-8345 and BD-8346) cultivars (*Vigna unguiculata* L. Walp.) were tested for their salt tolerance at different degrees of salinity; 0, 5, 10 and 15 dS/m of NaCl, in vinyl house. Growth and yield decreased by increasing soil salinity. Selected lines greatly varied with respect to salinity in root dry weight, shoot dry weight, plant height and yield as per control. In respect to growth, yield components and yield selected cowpea genotypes performed in Hoagland solution culture showed consistent with that under pot culture. Among the five genotypes BD-8338 performed better.

Introduction

Cowpea (*Vigna unguiculata* L. Walp.) is an important food crop in coastal area of Bangladesh. The high protein content of cowpea (20 to 28%) makes it an important supply to the diet of many people (Giami *et al*., 2001). Apart from their nutritional value cowpeas contribute to the soil nitrogen status through symbiotic N_2 fixation, thereby enhancing soil fertility. In addition, cowpea is considered to be less prone to drought damage and has a high yield potential especially when P fertilizers are applied (Jemo *et al*., 2006).In Bangladesh about 52.8 percent of the net cultivable land in the coastal area is affected by varying degrees of soil salinity. This vast land remains mostly uncultivated except some selected areas where *T.aman* crop is cultivated. So, introduction of salt tolerant crops is the most acceptable way of intensifying crop production in these areas. It was reported that germination is the most sensitive stage of plant growth and development in the saline environment (Onkare *et al.*,1993). Seedling development of different crops is also affected by varying level of salinity (Islam *et al*., 1989). For successful cultivation of crops/vegetable in coastal areas salt tolerant varieties /lines needed to be identified. 5 cowpea genotypes out of 20 genotypes selected from Hoagland nutrient solution culture have been undertaken for evaluation against salinity tolerance under pot culture. The present study was done to find out salt tolerance in cowpea genotypes grown in Hoagland solution culture had consistence with pot culture.

Materials and Methods

The experiment was carried out in plastic pots under vinyl house in the research area of Agronomy Division at Bangladesh Agricultural research Institute, Gazipur during late Rabi season of 2009-2010. Five selected cowpea genotypes viz. BD 1604, BD 8337, BD 8338, BD 8345 and BD 8346 screened in laboratory under Hoagland nutrient solution culture were used in the study at 0, 5, 10 and 15dS/m of NaCl solution. Pots were filled with soil and cow dung in 4: 1 volume ratio and final wt. of pot was 13kg. The soil used consisting of sandy loam. $N_{12}P_8K_{12.5}$ kg/ha in the form of Urea, TSP and MOP was given in the soil of pot. Seeds of selected lines were sown on 21 January, 2010 in plastic pots (76 cm on top dia., 74 cm on bottom dia. and 30cm on height). Seeds were dibbled in soil at a depth of 1cm. At germination (3-4 days after sowing) three seedlings were left in each pot by removing rest of the seedlings along with their roots. The study was evaluated under two factor completely randomized design with four replications. At early vegetative stage (3 weeks after planting) the plants were treated by adding NaCl solution. For achieving optimum salinity, solution @ 2.5 dS/m was added in each pot with 1 day interval. In 5 dS/m salinity level solution @ 2.5 dS/m was given twice and then stopped. In 10 & 15 dS/m salinity level solution @ 2.5 dS/m was given four times and six times respectively. The root and shoot sample were collected at 50 days after sowing. The collected sample was oven dried at 80 ^{0}c until constant weight. For root sampling, plastic pots were soaked in water, soil was washed with water and the roots were recovered by passing the soil water suspension through a 2mm wire mesh sieve. The yield component data were collected from ten randomly selected plants from each treatment at prior to harvest. Data were analyzed following MSTAT program and means were compared using LSD test.

Results and Discussion

Root Dry weight

The result presented in Fig-1.A indicated that there was variation in root dry weight among the genotypes under control condition. The genotype BD-8338 gave the highest root dry weight (0.71 g/plant) followed by BD-8337 (0.61 g/plant) in control condition. The genotype BD-1604 gave the lowest root dry weight (0.37 g/plant). At 5 dS/m salinity level reduction in root dry weight was observed and BD-8338 gave 97% relative root dry weight (RRDW) followed by BD-8346 (95% RRDW) and BD-8345 (94% RRDW). The lowest relative root dry weight (67% RRDW) was found from BD-1604 followed by BD-8337 (73% RRDW). At 10 dS/m salinity level relative root dry weight deceased sharply and it was below 80% in all the genotypes. BD-8338 gave higher relative root dry weight (78%) followed by BD-8345 (76%) and BD-8337 (70%). At 15 dS/m salinity level the genotype BD-8345 produced higher relative root dry weight (70%) followed by BD-8337 (68% RRDW). BD 1604 produced the lowest relative root dry weight (51%).

Shoot Dry weight

The genotypes varied in shoot dry weight under control condition but the variation was inconsistent compared to root dry weight except BD-8338 (Fig-1.**B**). The genotype BD-8338 gave the highest shoot dry weight (2.25 g/plant) followed by BD-8337 (2.02 g/plant) under control condition. The genotype BD-8346 gave the lowest root dry weight (1.66g/plant). At 5dS/m salinity level reduction in shoot dry weight was also observed in all the genotypes and BD-8337 gave 98% relative shoot dry weight (RSDW) followed by BD-8338 (94% RSDW) and BD-8345 (93% RSDW). The lowest relative shoot dry weight was found in BD 1604 (77% RSDW). At 10 dS/m salinity level BD-8345 produced the highest relative shoot dry weight (93%) followed by BD-8337 (86% RSDW). The lowest relative shoot dry weight was produced by BD-1604 (72% RSDW). At 15 dS/m salinity level relative shoot dry weight was higher in BD-8345 (86% RSDW) followed by BD-8337 (83% RSDW) and BD-8338 (80% RSDW). BD-1604 gave the lowest relative shoot dry weight (70%). Alam *et al*., 2004 and Taffouo *et al*., 2004 also reported reduction in root and shoot dry weight under higher salinity level.

Plant height

The result showed in Fig-1.C indicated that there was variation in plant height among the genotypes under control condition. The genotype BD-8338 gave the highest plant height (75.36 cm) followed by BD-8337 (68.22cm). The genotype BD-8346 gave the lowestest plant height (41.25 cm) followed by BD-8345 (42.35 cm). At 5 dS/m salinity level relative plant height (RPH) was found highest in BD-8346 (92%) followed by BD-8338 (90% RPH), BD-8345 (90% RPH) and BD 8337 (89% RPH). The lowest RPH was found in BD-1604 (74%). At 10 and 15 dS/m salinity level relative plant height followed the same trend as observed in 5 dS/m except BD-8345 at 15 dS/m. The results revealed that salinity greatly reduced the plant height of all the genotypes. Similar results were reported earlier by Greenway and Munns (1980) and Khadri *et al.* (2001). They cited that salinity affect plant growth and reduced plant height. The genotype BD-8338 performed better at all levels of salinity.

Yield components

The yield components of cowpea like no. of pods / plant, no. of seed/ plant and 100 seed weight did not differ significantly among the genotype both control and saline condition (Table 1). Although the genotype BD-8338 gave higher relative pods/plant, seeds/pod and 100-seed weight at all levels of salinity compared to other genotypes except 100-seed weight at 15 dS/m.

Yield

The results presented in Fig-2 indicated that there was variation in yield among the genotypes both control and saline condition. The genotype BD-8338 gave the highest yield (15.55 g/plant) followed by BD-8337 (13.98 g/plant) in control condition. The genotype BD-1604 gave the lowest yield (7.67 g/plant). At 5 dS/m salinity level the relative yield (RY) was found highest in BD-8345 (93% RY) followed by BD-8338 (88% RY), BD-8337 (87% RY) and BD-8346 (86% RY). The lowest yield was found in the genotype BD-1604 (75% RY). At 10 dS/m salinity level BD-8345 gave the highest RY (85%) followed by BD-8337 (81%), BD 8338 (79%) and BD-8346 (76% RY) and lowest in BD-1604 (71% RY). At 15 dS-m salinity level yield was decreased destructively in all the genotypes but the genotype BD-8338 performed better than others. In the present study it was observed that salinity greatly reduced yield of all the genotypes at higher salinity level. Similar result was also observed by Khan *et al*., 2007. They reported that the salinity may reduce the crop yield by upsetting water and nutritional balance of plant .Water availability and nutrient uptake by plant roots is limited because of high osmotic potential and toxicity of Na^+ and Cl^- ions although these are not yet measured in the experiment. Thus, excessive uptake of Na^+ and Cl^- may lead to ion toxicity and reduced plant growth and yield (Munns, 2002).

Conclusion

The salt tolerance in cowpea genotypes performed in Hoagland solution culture showed consistent with that done under pot culture. Among the five genotypes BD-8338 performed better. The experiment should be repeated in the next season with special care for final.

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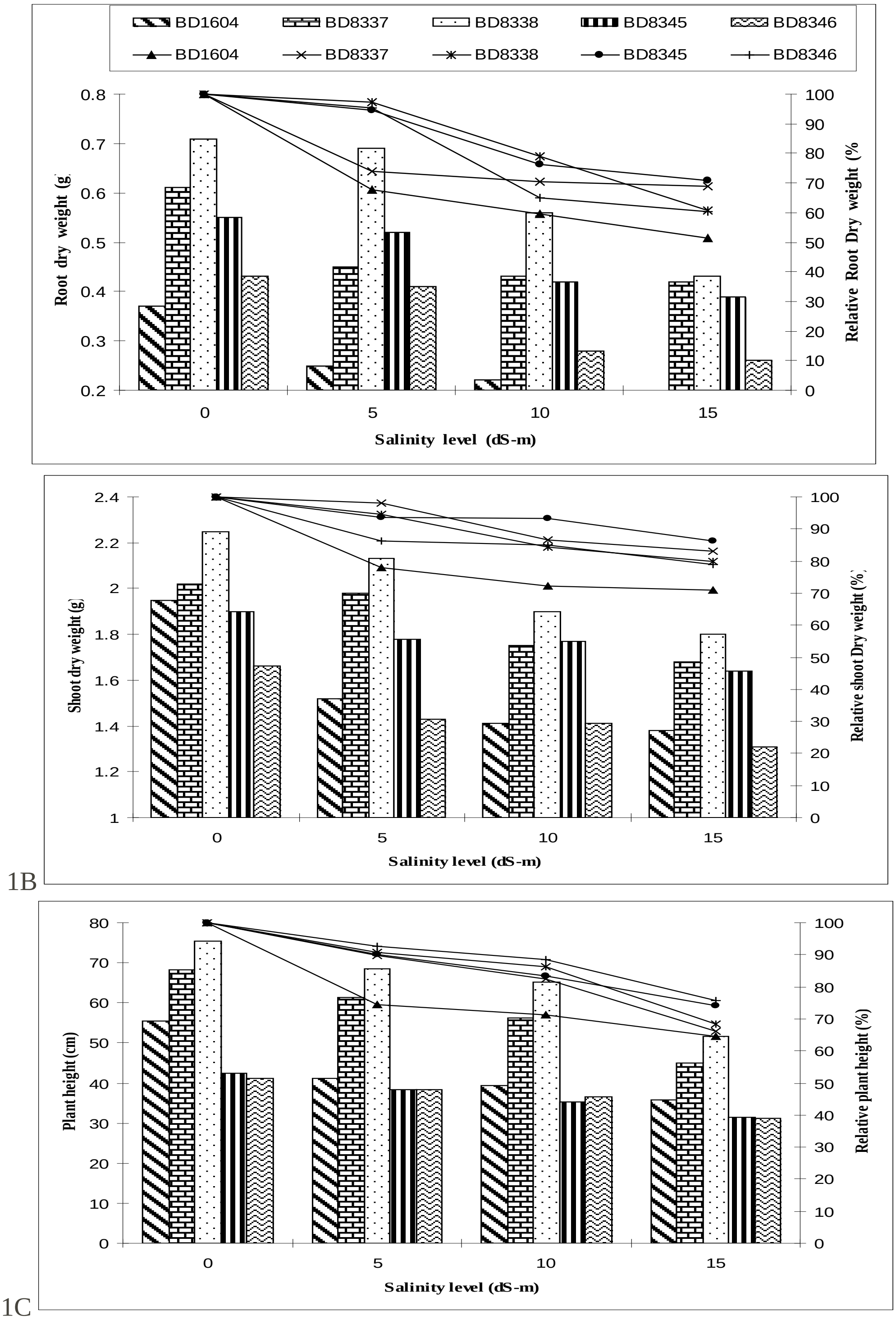

Fig.1: Effect of salinity on root dry weight (1A), shoot dry weight (1B) and plant height (1C) of selected cowpea lines

Table 1. Effect of salinity on yield components of selected cowpea lines

	No. of pods/plant				No. of seeds/plant				100-Seed weight (gm)			
	Salinity level (dS/m)											
	Control	5	10	15	Control	5	10	15	Control	5	10	15
BD1604	17.89	14.46 (80)	11.25 (62)	8.49 (47)	6.08	5.89 (96)	5.59 (91)	5.53 (90)	13.57	13.33 (98)	13.06 (96)	11.83 (88)
BD8337	16.53	13.88 (83)	11.4 (68)	7.46 (45)	6.47	6.02 (93)	5.56 (85)	5.63 (87)	13.8	12.91 (94)	12.73 (92)	11.81 (91)
BD8338	21.44	19.06 (88)	15.01 (70)	10.44 (48)	7.16	6.95 (97)	6.75 (94)	6.44 (89)	13.81	13.76 (100)	13.54 (98)	11.25 (81)
BD8345	17.06	14.03 (82)	10.75 (63)	7.51 (44)	6.19	5.88 (94)	5.51 (89)	5.39 (87)	13.82	13.29 (96)	12.9 (93)	11.38 (85)
BD8346	17.35	14.05 (80)	9.54 (54)	6.76 (38)	6.48	6.03 (93)	5.77 (89)	5.24 (80)	13.83	13.54 (96)	12.95 (93)	11.33 (83)
CV (%)	8.05				9.33				5.19			
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Values in parenthesis show relative value over control calculated as [(value of parameter / value of control) ×100]

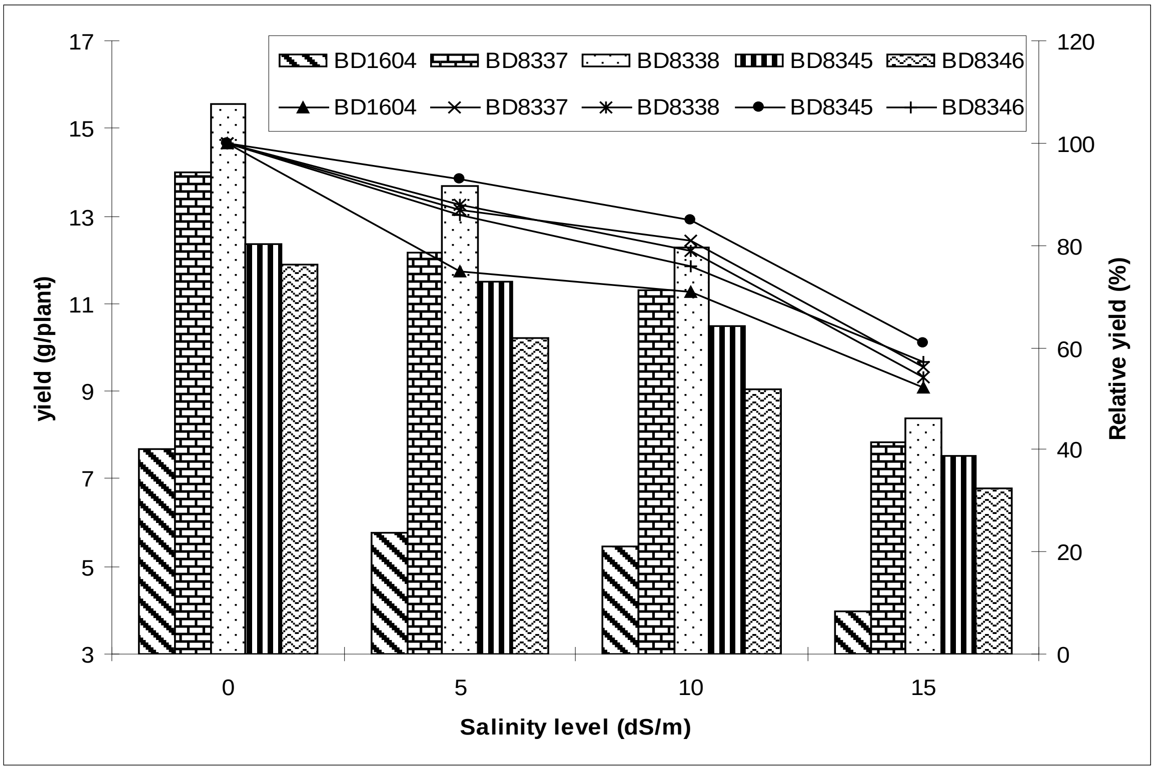

Fig.2: Effect of salinity on relative yield of selected cowpea lines

PERFORMANCE OF MUSTARD VARIETIES RELAYING WITH T.AMAN IN COASTAL REGION OF BANGLADESH

M. A. Aziz, F. Begum, R.R. Saha and A.K.M.H Rahman

Abstract

The experiment was carried out at the Agricultural Research Station, Banarpota, Shatkhira during the rabi season of 2009-10 to find out suitable variety of mustard for relay cropping with T.aman in the coastal saline areas. Six mustard varieties viz. BARI Sarisha-9, BARI Sarisha-11, BARI Sarisha-14, BARI Sarisha-15, Tori-7 and BINA Sarisha-5 were sown on 20 October, 2008 in a randomized complete design with three replications. The highest yield (1002 kg/ha) was obtained from BARI sarisha-11 followed by BINA sarisha-5 (880 kg/ha).

Introduction

A vast coastal and offshore area (2.85m ha) in the Southern part of Bangladesh exhibit soil salinity of various magnitudes due to onrush of salt water from the Bay. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the under ground moves up by capillary forces. Thus a considerable amount of salt from the subsoil is carries to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. As a result, most of the areas remain fallow during dry months. To increase mustard area and production especially under relay condition marginal lands should be considered. It was observed that salinity rises from first week of March. A judicial choice to grow a crop under saline soil is, therefore considered an important management option to minimize yield loss by salinity. Blum (1998) rightly pointed out that, for sustainable crop production in the saline soils, it is more important to select a salt tolerant crop rather than a relatively better yielding variety of susceptible crops. The present study will be under taken to find out suitable variety of mustard to be grown under relay condition in the coastal areas of Bangladesh.

Materials and Methods

The experiment was conducted in at the Agricultural Research Station, Banarpota, Shatkhira during the rabi season of 2009-10. The design of the experiment was RCB with 3 replications. Six mustard varieties viz. BARI Sarisha-9, BARI Sarisha-11, BARI Sarisha-14, BARI Sarisha-15, Tori-7 and BINA Sarisha-5 were tested under relay condition with T.aman rice. The mustard seed was broadcast in T.aman paddy field 15 days before T.aman (var. BINA Dhan-7) harvest. The seed rate was 10 kg/ha and was sowing on 20 October, 2008. Initially the experimental plots were fertilized with 250-170-85-150-15 kg/ha Urea, TSP, MP, Gypsum, Zinc Sulphate and Borax respectively. All the fertilizers were applied as basal except urea. Urea was applied as top dress on 20 and 35 days after relaying of mustard. The crop was harvest recording to their maturity. Intercultural operation and plant protection measures were taken as and when necessary. The data on different plant characters were collected from 10 randomly selected plants from each plot and yield was recorded plot wise. All necessary data were collected and analyzed statistically. During this period salinity level was 3.70 to 8.67 dS/m.

Results and Discussion

The performance of different mustard varieties under relay condition with T.aman rice presented in Table 1. The salinity range of the experimental plot was 3.70 to 8.67 dS/m during the crop growing period (Fig.1.). The variety Tori-7 and BARI sarisha-9 was the short duration variety and took 72 and 76 days respectively for maturity. BARI sarisha-11 was the long duration variety and took 92 days for maturity. Significantly the highest yield of 1002 kg/ha was obtained from BARI sarisha-11 followed by BINA sarisha-5 (880 kg/ha). BARI sarisha-15 gave significantly the lowest yield (433 kg/ha). The highest yield in BARI sarisha-11was due to maximum number of population per unit area, siliqua/plant and 1000-seed weight although seed/siliqua was maximum in BARI sarisha-14 and BINA sarisha-5. BARI sarisha-11 was bold seeded (4.03 g/1000 seed) followed by BINA sarisha-5 (3.67 g/1000 seed). Significantly the highest straw yield obtained from BARI sarisha-11 (2056 kg/ha) which was identical with BINA sarisha-5 (1980 kg/ha). The lowest straw yield was recorded from BARI sarisha-15 (1450kg/ha).

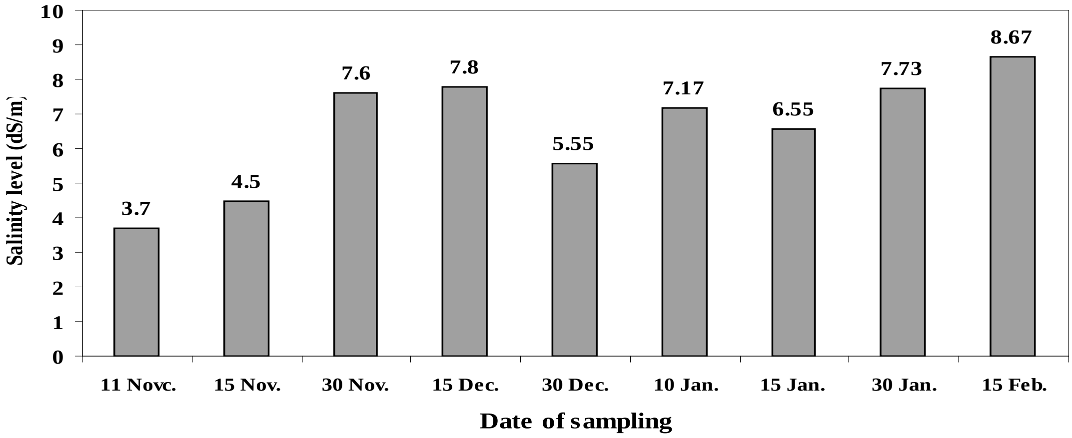

Fig.1. Soil salinity level in mustard field (relay) at Benarpota, Sathkira during crop growing period 2009-2010

Table 1. Yield and yield attributing characters of mustard relaying with T.aman at Satkhira MLT site during rabi season of 2007-08

Variety	Days to maturity	Plant popu./m	Plant height (cm)	Siliqua/plant (no.)	Seed/ siliqua (no.)	1000 seed wt. (g)	Seed yield (kg/ha)	Straw yield (kg/ha)
BARI sarisha-9	76	76	65.0c	66.67b	16.00d	3.10d	701bc	1620
BARI sarisha-11	91	80	100.0a	80.33a	13.00e	4.03a	1002a	2056
BARI sarisha-14	80	70	66.0c	38.33e	26.33a	3.80b	593c	1860
BARI sarisha-15	85	68	83.0b	45.00d	20.67c	3.50c	370e	1450
Tor-7	72	74	46.7e	53.00c	12.67e	2.70e	420d	1590
BINA sarisha-5	84	79	56.0d	53.67c	25.33b	3.67b	880b	1980
LSD(.05)	-	NS						270
CV (%)	-	10.25	5.56	9.23	7.85	5.26	12.37	8.25

Conclusion

BARI sarisha-11 performed better under relay condition with T.aman rice. In the previous year BARI sarisha-11 also performed better at the satkhira MLT site. It might be concluded that BARI sarisha-11 could be grown under relay condition with T.aman rice in the coastal area of south-west Bangladesh in T.aman-fallow-fallow cropping pattern.

EFFECT OF DATE OF SOWING ON YIELD AND YIELD COMPONENTS OF MUNGBEAN IN COASTAL AREAS

M. A. Aziz, F. Begum, R.R.Saha, A.K.M.H Rahman and M.K.Basher

Abstract

The experiment was conducted at ARS, BARI, Benarpota, Satkhira and Kuakata, Potuakhali MLT site during the Rabi season of 2009-10 to investigate the influence of sowing date on the performance of mungbean variety as well as to avoid moisture stress caused due to late sowing after 15 January. Seeds were sown at four different dates viz. 20 December, 30 December, 10 January and 20 January under rainfed situation in a RCB design. It was revealed from two years study that 20 to 30 December sowing gave maximum yield at Potuakhali but 20 January sowing gave maximum yield at Banerpota. It might be concluded that 20 to 30 December would be the optimum time of sowing for mungbean at Patuakhali area and up to 3rd week of January would be the optimum time of sowing at Satkhira area.

Introduction

Mungbean is the fifth important pulse crop in Bangladesh and contributes 11-53% of total pulse production. About 63% of mungbean grow in the southern areas. Saline soil in coastal region where farmers are growing local mungbean cultivar with poor yield potential. Farmer normally grow local variety in the early February. During the reproductive phase of the crop soil moisture dries up and the crop suffers from troth drought and salinity. On the other hand salinity may be avoided by December sowing. So, the study was undertaken to find out the optimum date of sowing for maximum yield of mungbean.

Materials and Methods

The experiment was conducted at the ARS, BARI, Benarpota, Satkhira and Kuakata, Potuakhali MLT site during the late Rabi season of 2008-09. Four sowing dates such as 20 December, 30 December, 10 January and 20 January 2009 with BARI mungbean vareity-2 was used in the study. The experiment was conducted in a Randomized complete block design with six applications. The unit plot size 5 m x 2 m. Seeds were sown in line with a spacing of 30 cm x 5 cm. Fertilizers and 50-85-35 kg/ha Urea, TSP and MP were applied as basal during final land preparation. All other intercultural operations were done as and when necessary. Harvesting of pods was done two times. Data for yield components were taken from five randomly selected plants of each plot. Collected data were analyzed statistically and the mean differences were adjusted by DMRT.

Results and Discussion

The performance of mungbean variety at different date of sowing in the coastal area Banerpota and Potuakhali are presented in Table 1 and Table 2. The salinity level at Banerpota varied from 4.96 to 10.37 dS/m and it was 0.49 to 2.40 dS/m at Potuakhali. Date of sowing affect significantly on all the parameters studied except plant population at Potuakhali. At Banerpota significantly the highest population per unit area was recorded from 20 January sowing (67) which was identical with 10 January sowing (56) (Table 1). The lowest population was recorded from 20 December sowing (12) which was identical with 30 December sowing (14). At Benarpota the the highest plant height was obtained from 10 January sowing which was identical with 20 January sowing. 20 December sowing gave significantly the lowest plant height. At patuakhali the result was reverse. Tthe highest number of pods/plant was obtained from 20 December and 30 December sowing (12.5) at

Banerpota which was identical with 10 January sowing (12.1). 20 January sowing gave the lowest number of pods/plant (11.9). At Poulakhali significantly the highest number of pods/plant was recorded from 20 December sowing (13.2). 20 January sowing gave the lowest number of pods/plant (10.8). At Banerpota significantly the highest number seeds/pod was recorded from 20 January sowing (7.8) which was identical with 10 January sowing (7.1) (Table 2). The lowest number of seeds/pod was recorded from 20 December sowing (5.9). 10 January sowing gave significantly the maximum number of seeds/pod (10.7) at Potuakhali. Individual seed weight varied significantly due to different date of sowing at both the locations. At Benarpota higher 1000-seed weight was found in 20 December sowing (23.7 g) which was atper with 30 December and 10 January. 20 January gave significantly the lowest 1000-seed weight (22.3 g). Similar results were also obtained at Patuakhali. At Banerpota significantly the highest yield was obtained from 20 January sowing (1.50 t/ha) followed by 10 January sowing (1.45 t/ha). 20 December sowing gave the lowest yield (1.21 t/ha) which was identical with 30 December sowing (1.32 t/ha). At Potuakhali significantly the highest yield was obtained from 20 December sowing (1.37 t/ha). 30 December sowing gave identical yie4ld with 10 January sowing. The lowest yield was obtained from 20 January sowing (0.93 t/ha). Similar trend of grain yield was also obtained during 2008-09.

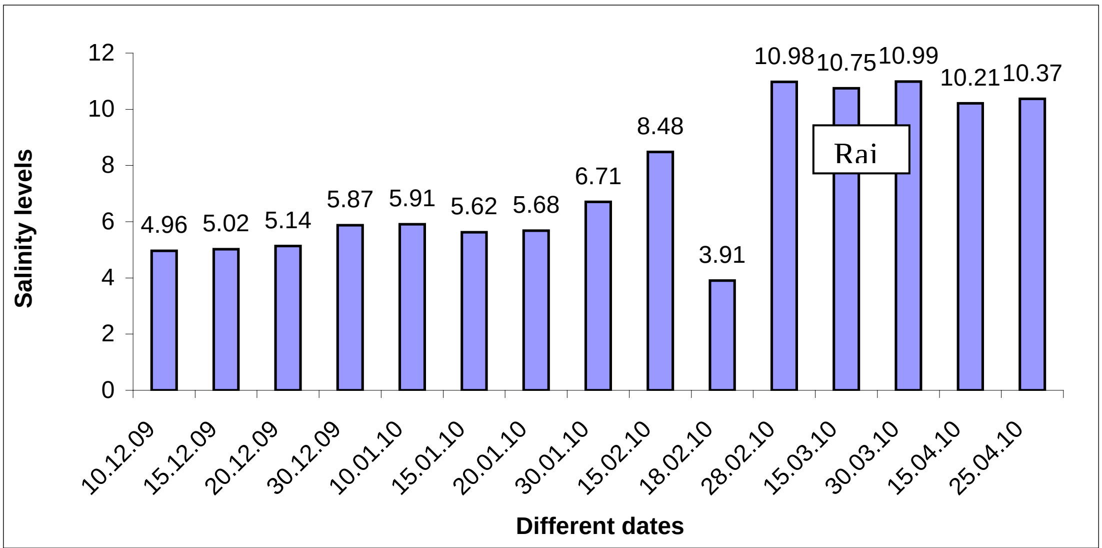

Fig. 1. Salinity levels in mungbean field at Benarpota at different dates

Table 1. Plant population, plant height and pods/plant of mungbean as affected by date of sowing in the saline area of Benarpota and Potuakhali

Treats.	Plant population/m^2		Plant height (cm)		Pods/ plant	
	Baner.	Potua.	Baner.	Potua.	Baner.	Potua.
20 December	11.8 b	44.2	18.3 c	34.33 a	12.6 a	13.2 a
30 December	13.8 b	43.1	27.5 b	32.43 b	12.3 a	12.2 b
10 January	55.8 a	43.2	35.5 a	31.13 c	12.1 ab	12.0 b
20 January	66.8 a	43.0	35.0 a	30.79 c	11.9 b	10.8 c
CV(%)	14.2	10.25	10.2	7.98	8.25	6.05

Salinity level: Potuakhali: 0.49 to 2.40 dS/m Baner- Banerpota, Potua.- Potuakhali,

Table 2. Seed/pod, 1000-seed weight and grain yield of mungbean as affected by date of sowing in the saline area of Benarpota and Potuakhali

Treats.	Seed/pod		1000-seed weight (g)		Grain yield (t/ha)			
					2009-10		2008-09	
	Baner.	Potua.	Baner.	Potua.	Baner.	Potua.	Baner.	Potua.
20 December	5.9 c	10.2 b	23.7 a	24.7 a	1.21 c	1.37 a	1.20 c	1.12 a
30 December	6.6 bc	10.2 b	23.5 a	24.6 a	1.32 c	1.30 b	1.30 c	1.10 a
10 January	7.1 ab	10.7 a	23.2 a	24.7 a	1.45 b	1.28 b	1.35 b	1.08 b
20 January	7.8 a	9.7 c	22.3 b	23.0 b	1.59 a	0.93 c	1.50 a	-
CV(%)	7.4	4.65	5.26	5.12	12.0	10.04	20	12.04

Farmer's Reaction

1. Farmers are interested to grow mungbean after harvest of T.aman.
2. Farmers are satisfied with the yield obtained from the experiment.

Conclusion

It was revealed from two years study that 20 to 30 December sowing gave maximum yield at Potuakhali but 20 January sowing gave maximum yield at Banerpota. It might be concluded that 20 to 30 December would be the optimum time of sowing for mungbean at Patuakhali area. At satkhira region up to 3rd week of January would be the optimum time of sowing.

EFFECT OF DATE OF SOWING ON YIELD AND YIELD COMPONENTS OF SESAME AT COASTAL AREA

M. A. Aziz, F. Begum, R.R. Saha, A.K.M.H Rahman and M.K. Basher

Abstract

The experiment was conducted at ARS, BARI, Benarpota, Satkhira and Poutuakhaly during the Rabi season of 2009-10 to investigate the influence of sowing date on the performance of sesame (BARI til-3) under saline condition as well as to avoid moisture stress caused due to late sowing after 15 January in the coastal area. Four different dates viz. 20 December, 30 December, 10 January and 20 January were included in the stady. The trial was conducted under rainfed situation in a RCB design. At Banerpota significantly the highest yield was obtained from 20 January sowing (0.75 t/ha) which was identical with 10 January sowing (0.70 t/ha) followed by 30 December sowing (0.60 t/ha). 20 December sowing gave the lowest yield (0.46 t/ha). At Potuakhali significantly the higher yield was obtained from 10 January sowing (0.93 t/ha). Which was similar with 20 January sowing (0.92 t/ha). The lowest yield was obtained from 20 December sowing (0.83 t/ha).

It was revealed from the study that maximum yield was obtained from 10 January to 20 January sowing at both the locations. The results also suggested that upto 20 January would be the optimum time of sowing for sesame in the coastal area

Introduction

Sesame is the second most important oil seed crop in Bangladesh. It is mainly grown in kharif-1 season which is the dry wet transition period at the start of monsoon rain. Salinity is one of the major impediments to Agriculture in the southern coastal areas of Bangladesh. It was observed that salinity rises from 1st week of March. A biotic approach to over come the salinity problem has been considered the most feasible and economic path and it has recently received much attention. The different strategies that have adopted by various crop scientists in employing biological approach to overcoming the salinity problem have been listed. One of the procedures which are of prime importance is the avoidance of salinity stress of a crop for salt tolerance. Sesame is growing successfully in the none saline coastal area of Noakhali, Feni, Bhola and Khulna area in the month of January. To avoid salinity stress in the coastal saline area early sowing in the month of December may be of optimum date of sowing for successfully sesame production. The present study was therefore, undertaken to find out optimum date of sowing for maximum growth and yield of sesame to avoid salinity stress in the coastal saline area.

Materials and Methods

The experiment was conducted at the ARS, Benarpota, Satkhira during the late Rabi season of 2008-09. Five sowing dates such as 02 January, 10 January, 20 January, 30 January and 10 February were included in the trial. The experiment was conducted in a randomized complete block design with four applications. The unit plot size 5 m x 2 m. Seeds of BARI Till-3 was sown in line with a spacing of 30 cm x 5 cm. Fertilizers at the rate of 50-85-35 kg/ha Urea, TSP and MP were applied as basal during final land preparation. All other intercultural operations were done as and when necessary. Data for yield and yield components were taken from five randomly selected plants of each plot. Collected data were analyzed statistically and the mean differences were adjusted by DMRT.

Results and Discussion

The salinity level in the field of sesame at Banerpota varied from 4.91 to 13.58 dS/m and at Patuakhali 0.48 to 3.40 dS/m respectively. The performance of sesame at different date of sowing in the coastal area of Banerpota and Potuakhali are presented in Table 1 and Table 2. Date of sowing affect significantly on all the parameters studied except plant population at Banerpota and 1000-seed weight at both the locations. At Patuakhali the height population was recorded from 20 January sowing (40.2) which was identical with 20 January sowing (40.0) (Table 1). The lowest population was recorded from 30 December sowing (36). Plant height vried singificantly due to drefferent date sowing at both the locations.

At Benarpota the the highest plant height was obtained from 10 December sowing which was identical with 10 January and 20 January sowing. 20 December sowing gave significantly the lowest plant height. At patuakhali the similaer result was of obtained. Singinacntly the highest number of capluse/plant was obtained from 20 January sowing (112.3) followed by 10 January sowing (106.0). 30 December sowing gave the lowest number of capsule/plant (100.0).At Potuakhali 10 January sowing gave the hither number of calsule/plant (46.07) which was identical with 20 January sowing (46.68). 20 December sowing gave significantly the lowest number of capsule/plant (32.25). At Banerpota the higher number seeds/capsule was recorded from 20 January sowing (77.0) which was identical with 10 January sowing (75.0) and 30 December sowing (73.0) (Table 2). The lowest number of seeds/capsule was recorded from 20 December sowing (71.0). 10 January sowing gave significantly the highest number of seeds/capsule (87.3) at Potuakhali followed by 20 January sowing (85.6). The lowest number of seed/capsule was obtined from 30 December sowing (82.0) which was identical with 20 December sowing (82.1). Individual seed weight varied insignificantly due to different date of sowing at both the locations.

At Banerpota significantly the highest yield was obtained from 20 January sowing (0.75 t/ha) which was identcal with 10 January sowing (0.70 t/ha) followed by 30 December sowing (0.60 t/ha). 20 December sowing gave the lowest yield (0.46 t/ha). At Potuakhali significantly the higher yield was obtained from 10 January sowing (0.93 t/ha). Which was similar wiht 20 January sowing (0.92 t/ha). The lowest yield was obtained from 20 December sowing (0.83 t/ha).

Conclusion

It was revealed from the study that maximum yield was obtained from 10 January to 20 January sowing at both the locations. The results also suggested that upto 20 January would be the optimum time of sowing for sesame in the coastal area.

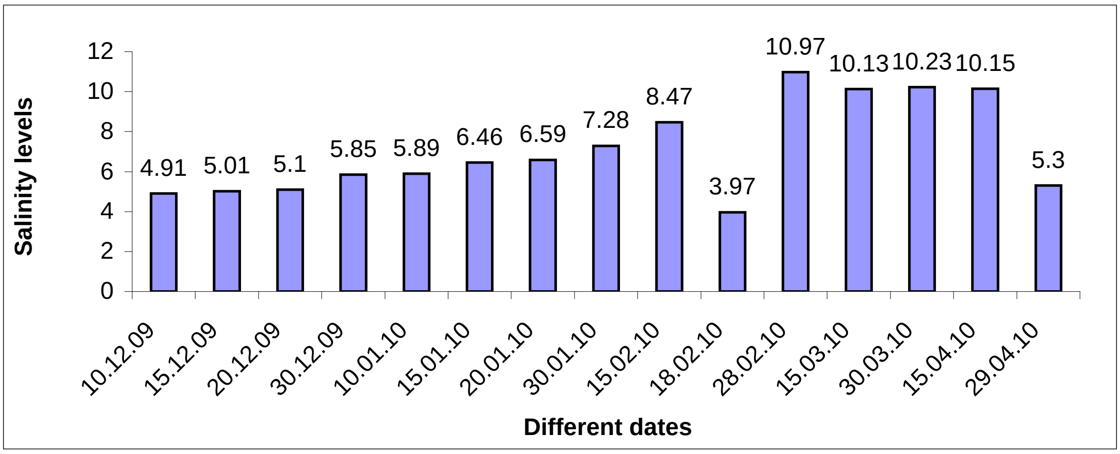

Fig. 1. Salinity levels in sesame field at Benarpota at different dates

Table 1. Plant population, plant height and capsule/plant of sesame as affected by date of sowing in the

saline area of Benarpota and Potuakhali

Treats.	Plant population/m^2		Plant height (cm)		Capsule/ plant	
	Baner.	Potua.	Baner.	Potua.	Baner.	Potua.
20 December	62.0	38.1 b	78.0 b	68.75 b	89.67 d	32.25 c
30 December	61.3	36.0 c	88.0 a	72.75 a	100.0 c	35.20b
10 January	61.7	40.2 a	81.0 a	72.66 a	106.0 b	46.70a
20 January	61.7	40.0 a	82.3 a	72.00 a	112.3 a	46.68 a
CV(%)	14.4	5.23	5.02	3.25	10.23	5.059

Salinity level: Potuakhali: 0.48 to 3.40 dS/m Baner- Banerpota, Potua.- Potuakhali,

Table 2. Seed/capsule, 100-seed weight and seed yield of sesme as affected by date of sowing in the saline area of Benarpota and Potuakhali

Treats.	Seed/capsule		100-seed weight (g)		Seed yield (t/ha)	
	Baner.	Potua.	Baner.	Potua.	Baner.	Potua.
20 December	71.0 b	82.1 c	2.21	2.45	0.46b	0.83c
30 December	73.0a	82.0c	2.23	2.55	0.60ab	0.88b
10 January	75.0 a	87.3a	2.20	2.55	0.70a	0.93a
20 January	77.0a	85.6b	2.19	2.54	0.75a	0.92a
CV(%)	2.37	2.56	1.12	2.12	7.6	9.85

EFFECT OF DATE OF SOWING ON YIELD AND YIELD COMPONENTS OF SOYBEAN AT COASTAL AREA

M. A. Aziz, A. K. M. H. Rahman, M.K.Basher and M.Amin

Abstract

The experiment was conducted at ARS, BARI, Banerpota, Satkhira, Kuakata, Potuakhali and Noakhali, during the rabi season of 2009-10 to investigate the influence of sowing date on the performance of Soybean. Six dates of sowing viz. 10 December, 20 December, 30 December, 10 January, 20 January and 30 January were included in the trial under rainfed situation in a RCB design. It was observed that 20 December sowing gave the highest yield at Potuakhali. At Banerpota 20 December to 20 January gave the maximum yield. At Noakhali 20 January produced the highest yield.

Introduction

Salinity is one of the major impediments to Agriculture in the southern coastal areas of Bangladesh. It was observed that salinity rises from 1st week of March. A judicial choice to grow a crop under saline soils is therefore considered an important management option in minimize yield loss by salinity. A biotic approach to over come the salinity problem has been considered the most feasible and economic path and it has recently received much attention. The different strategies that have adopted by various crop scientists in employing biological approach to overcoming the salinity problem have been listed (Orcuit and Nelson, 2002. One of the procedures which are of prime importance is the avoidance of salinity stress of a crop for salt tolerance (Epstain, 2004, Ashraf and Meneilly, 2001). Soybean is growing successfully in none saline coastal area of Noakhali, Feni, Bhola area in the month of January. To avoid salinity stress in the coastal saline area early sowing in the month of December may be of optimum date of sowing for successful soybean production. The present study was therefore undertaken to find out the optimum date of sowing for maximum growth and yield of soybean to avoid salinity stress in the coastal saline area.

Materials and Methods

The experiment was conducted at ARS, BARI, Banerpota, Satkhira, Kuakata, Potuakhali and Noakhali during the rabi season of 2009-10. Six dates of sowing viz. 10 December, 20 December, 30 December, 10 January, 20 January and 30 January were included in the trial The experiment was conducted in a randomized complete block design with 3 applications. The unit plot size 5 m x 2 m. Seeds were sown in line with a spacing of 30 cm x 5 cm. The variety Shohag was used in the trial. Fertilizers at the rate of 50-85-35 kg/ha Urea, TSP and MP were applied as basal during final land preparation. All other intercultural operations were done as and when necessary. Harvesting of pods was done two times. Data for yield components were taken from five randomly selected plants froim each plot. Collected data were analyzed statistically and the mean differences were adjusted by DMRT.

Results and Discussion

Potuakhali

The influence date of sowing on the performance of soybean in the coastal area of Potuakhali presented in Table 1. Date of sowing affect significantly on all the parameters studied. Significantly the maximum population was recorded from 20 December sowing (31.5 plants/m^2) followed by 30 December sowing (29 plants/m^2). January 10 sowing gave the minimum plant population (19.0). Significantly the higher plant height was recorded from 30 December sowing

(42.6 cm) which was identical with 20 December sowing (42.5 cm). 10 January gave significantly the lowest plant height (22.6 cm). 20 December sowing gave significantly the highest number of pods per plant (20.6) followed by 30 December sowing (19.7). 10 January sowing gave minimum number of pods/plant (13.5). Seed/pod varied significantly due to different dates of sowing. Significantly the higher number of seeds/pod was obtained from 10 December sowing (2.6) which was identical with 30 December and 10 January sowing. 20 December sowing gave the lowest of seed/pod. The highest 1000-seed weight was recorded from 20 December sowing (80.1gm). 10 January sowing gave the lowest 1000-seed weight (66.2gm). Significantly the highest yield was obtained from 20 December sowing (1.15 t/ha) followed by 30 December sowing (1.05 t/ha). The lowest yield was obtained from 10 January sowing (0.48 t/ha). The highest yield form 20 December sowing followed by 30 December sowing might be attributed for maximum population/m^2 and maximum pods/plant.

Banerpota

The salinity level in soybean field at Banerpota Farm varied from 4.95 to 11.53 dS/m. Minimum salinity level was in the month of December and maximum was in last February. The performance of soybean at different date of sowing at Banerpota presented in Table 2. Date of sowing affect significantly on all the parameters studied. The maximum plant height was recorded from 30 December sowing (49.3 cm). Sowing on 20 December, 10 January and 20 January gave identical plant height. Significantly the lowest plant height (30.7 cm) was recorded from 10 December sowing. Branch per plant varied significantly due to different date of sowing. Maximum number of branches was obtained from 30 December sowing and 10 January sowing (4.3) which was identical with 20 December and 20 January sowing (4.0). 10 December sowing gave significantly the lowest number of branches per plant (2.7). Significantly the highest number of pods/plant was recorded from 30 December sowing (96.0). 20 January sowing gave 91.7 number of pods/plant which was identical with 10 January sowing.(88.3 pods/plant).The lowest number of pods/plant was obtained from 10 December sowing (62.0). Significantly the higher yield was obtained from 30 December and 30 January sowing (2.00 t/ha) which was identical with 20 December (1.99 t/ha) and 20 January sowing (1.97 t/ha). 10 December sowing gave significantly the lowest grain yield (0.67 t/ha). Total dry matter production per plant followed the same trend as observed in grain yield.

Noakhali

The influence date of sowing on the performance of soybean in the coastal area of Nokhaly presented in Table 3. Date of sowing affect significantly on all the parameters studied. Significantly the maximum population was recorded from 20 January sowing (86 plants/m^2) followed by 10 January and 30 January sowing (75 plants/m^2). 30 December sowing gave the minimum plant population (50). Significantly the highest plant height was recorded from 20 January sowing (56.10 cm). 30 December gave significantly the lowest plant height (47.88 cm). 20 January sowing gave significantly the higher number of pods/plant (53.20) which was identical with 10 January sowing (52.40). January 30 sowing gave minimum number of pods/plant (45.60). Seed/pod varied significantly due to different dates of sowing. Significantly the highest number of seeds/pod was obtained from 20 January sowing (2.8) followed by 10 January sowing (2.4). 30 December and 30 January sowing gave the lowest number of seed/pod (2.2). The highest 1000-seed weight was recorded from 20 January sowing (130.0 g). December 30 sowing gave significantly the lowest 1000-seed weight (110.0 g). Significantly the highest yield was obtained from 20 January sowing (2.85 t/ha) followed by 10 January sowing (2.46 t/ha). The lowest yield was obtained from 30 December sowing (1.65 t/ha). The highest yield form 20 January sowing followed by 10 January sowing might be attributed for maximum population/m^2, pods/plant, seed/pod and 1000-seed weight.

Farmer's reaction

1. It is a new crop to the farmers
2. Farmers are interested to cultivate soybean
3. But seed availability and marketing of soybean is a problem.

Conclusion

It was revealed from the study that maximum yield was obtained from 20 December at Potuakhali, 20 December to 20 January at Benarpota and 20 January at Noakhali. The experiment should be repeated in the next year for final confirmation.

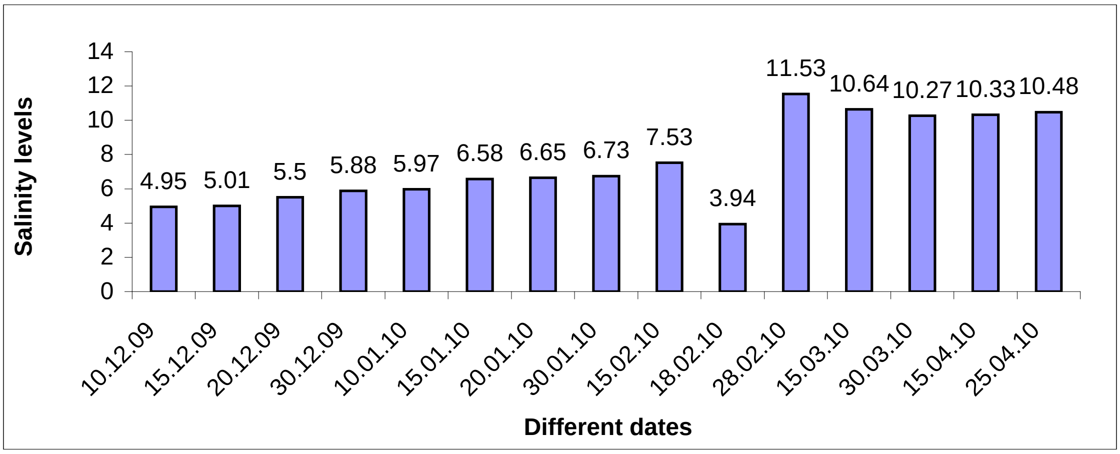

Fig. 1. Salinity levels in soybean field at Benarpota at different dates

Table 1. Effect of time of sowing on yield and yield contributing characters of soybean in the saline area of Potuakhali

Treatment	Plant population/ m^2 (no.)	Plant height (cm)	Pods/ plant	Seeds/pod	1000-seed weight	Yield (kg/ha)
10 December	28.0 c	42.2 b	18.4 c	2.6 a	72 .0 b	0.98 c
20 December	30.5 a	42.5 a	20.6 a	2.4 ab	80.1 a	1.15 a
30 December	29.0 b	42.6 a	19.7 b	2.5 a	71.0 b	1.05 b
10 January	19.0 d	22.6 c	13.5 d	2.6 a	66.2 c	0.48 d
CV(%)	9.26	7.24	6.58	4.50	6.18	10.4

Table 2. Yield and yield components of soybean as influenced by date of sowing in the saline area of Benarpota, Satkhira during 2009-10

Treatment	Plant height (cm)	Branches/ plant	Pod/plant	Grain yield (t/ha)	TDM at harvesting stage
10 December	30.7 c	2.7 b	62.0 d	0.67 b	54.0 b
20 December	44.7 b	4.0 a	80.7 c	1.99 a	54.7 a
30 December	49.3 a	4.3 a	96.0 a	2.00 a	54.7 a
10 January	44.3 b	4.3 a	88.3 b	2.00 a	55.0 a
20 January	44.7 b	4.0 a	91.7 b	1.97 a	55.0 a
CV(%)	5.6	12.5	20.5	4.01	.47

Table 3. Effect of time of sowing on yield and yield contributing characters of soybean in the saline area of Noakhali

Treatment	Plant population /m^2	Plant height (cm)	Pods /plant	Seeds/pod	1000-seed weight	Yield (kg/ha)
30 December	50 c	47.88 c	46.60 bc	2.2 c	110.0 d	1.65 d
10 January	75 b	51.40 b	52.40 a	2.4 b	123.9 b	2.46 b
20 January	86 a	56.10 a	53.20 a	2.8 a	130.0 a	2.85 a
30 January	75 b	41.33 d	45.60 c	2.2 c	117.3 c	2.26 c
CV(%)	10.25	7.57	6.78	7.84	6.14	20.10

PERFORMANCE OF SALT TOLERENT SOYBEAN GENOTYPES IN THE COASTAL AREA OF BANGLADESH

M. A. Aziz, A. K. M. H. Rahman, M.K.Basher

Abstract

The experiment was conducted at ARS, BARI, Banerpota, Satkhira and Kuakata, Potuakhali during the rabi season of 2009-10 to select the salt tolerant soybean variety. The results indicated that at Banerpota, BGM-2026 (1.91) and BARI soybean-5 (1.83 t/ha) and at Potuakhali BARI soybean-5 (1.85 t/ha) produced the highest seed yield. BARI soybean-5 showed better adaptability in the coastal saline area. In the last year Shohag performed better at both the locations. Therefore, the experiment should be repeated in next season for final conclusion.

Introduction

Salinity is one of the major impediments to agriculture in the southern coastal areas of Bangladesh. A biotic approach to overcoming the salinity problem has been considered the most feasible and economic path and it has recently received much attention (Ashraf *et al.* 1994). The different strategies that have been adopted by various crop scientists, in employing and biological approach to overcoming the salinity problem, have been listed by Ashraf and MeNeilly, 1988. One of the procedures, which are of prime importance, is the screening of available germplasm of a crop for salt tolerance, (Epstain, 1984; Ashraf and MeNeilly 1987). Soybean is growing successfully in the non-saline coastal area of Noakhali, Feni, Bhola area. Salt tolerant soybean genotypes identified the last the season under Hoagland culture solution could be potential and economic for growing in the coastal area. Therefore, the experiment was undertaken weather salt tolerance in soybean performed under control condition has consistence with natural field condition.

Materials and Methods

The trial was conducted at ARS, BARI, Benarpota, Satkhira and Kuakata, Potuakhali during the rabi season of 2009-10. Eight soybean varieties/genotypes such as (Shohag, BARI soybean-5, BARI soybean-6, BGM-2026, BGM-2093, BC-84051, , ASSET-95 and GMOT-17) were included in the study. The unit plot size was 4 cm ꞉ 3 cm. Seeds were sown following RCB design with three replications. Soybean was sown on 14 December 2009 at Benarpota and 12 January at Potuakhali. The seeds were sown in line with a spacing of 30 cm x 5 cm. Fertilizers @ 25-30-60-16-02-0.9 kg/ha of N-P-K-S-Zn-B was used. Two irrigations were applied at initial stage for crop establishment. Intercultural operations were followed as and when necessary. Data were taken from 5 randomly selected plants from each plot. The collected data were analyzed and the means were separated following DMRT.

Results and Discussion

Banerpota

The salinity level at Banerpota varied from 4.50 to 14.42 dS/m. The performance of soybean varieties/genotypes at Banerpota is presented in Table 1. Plant population varied significantly among the varieties. The highest plant population at harvest was found in BGM-2026 (33). BGM-2093 and BC-84051 gave identical plant population. Shohag gave the lowest plant population (10) which was identical with BARI soybean-6 (12) and BARI soybean-5 (13). Plant height varied significantly among all the varieties. The higher plant height was obtained from Shohag (82 cm) which was identical with BC-84051 (80 cm), BGM-2093 (79 cm) and BARI soybean 6(76 cm). BGM-2026 gave the lowest plant height (72 cm) which was identical with BARI soybean 5 (74 cm). Significantly the highest number of pods/plant was obtained from BARI soybean-6 (98) followed by Shohag (90). BC-84051 gave significantly the lowest number pods/plant (40). Significantly the higher grain yield was obtained from BGM-2026 (1.91 t/ha) which was identical with BARI soybean-5 (1.83 t/ha), BGM-2093 (1.64 t/ha) and BC-84051 (1.60 t/ha). Shohag gave significantly the lowest grain yield (1.16 t/ha). The lowest yield in Shohag might be due to the poor plant stand.

Potuakhali

The salinity level at Potuakhali varied from 3.30 to 6.20 dS/m during nthe crop growing period. The performance of soybean varieties/genotypes at Potuakhali is presented in Table 2. Soil salinity affect significantly all the plant characters studied. The highest population/m^2 was found in BGM-2026 (54) followed by GMOT-17 (52). AGS-95 gave the lowest population/m^2 (41). Plant height varied significantly among all the varieties. The highest plant height was obtained from BC-84051 (47 cm) followed by BGM-2026, ASSET-95 and GMOT-17 (45 cm). Shohag gave significantly the lowest plant height (37 cm). Pods/plant varied significantly among the varieties. GMOT-17 gave the maximum number of pods/plant (34.20) followed by AGS-95 (28.90) and BGM-20903 (27.13). BGM-2026 gave significantly the lowest number pods/plant (19.60). The higher number of seed/pod was obtained from BARI soybean-5, BARI soybean-6, BC-84051 (2.4) followed by Shohag and ASSET-95 (2.3). BGM-20903 gave significantly the lowest number of seed/pod (1.9). The highest seed weight was recorded BARI soybean-5 (62.66 g/1000 seed) followed BARI soybean-6 (58.50 g/1000 seed). Significantly the lowest seed weight was recorded from BGM-2026 (38.66 g/1000 seed) which was identical with BGM 20903 and ASSET-95. All the yield contributing characters affect finally the grain yield. Significantly the highest grain yield was obtained from BARI soybean-5 (1.85 t/ha). Shohag (1.57 t/ha) and BC-84051 (1.58 t/ha) gave identical grain yield. The genotype BGM-2026 gave significantly the lowest grain yield (0.78 t/ha).

Farmer's reaction

1. It is a new crop to the farmers
2. Farmers are interested to cultivate soybean
3. But seed availability and marketing of soybean is a problem.

Conclusion

It was observed that at Banerpota, BGM-2026 (1.91) and BARI soybean-5 (1.83 t/ha) and at Potuakhali BARI soybean-5 (1.85 t/ha) produced the highest seed yield. BARI soybean-5 showed better adaptability in the coastal saline area. In the last year Shohag performed better at both the locations. Therefore, the experiment should be repeated in next season for final conclusion.

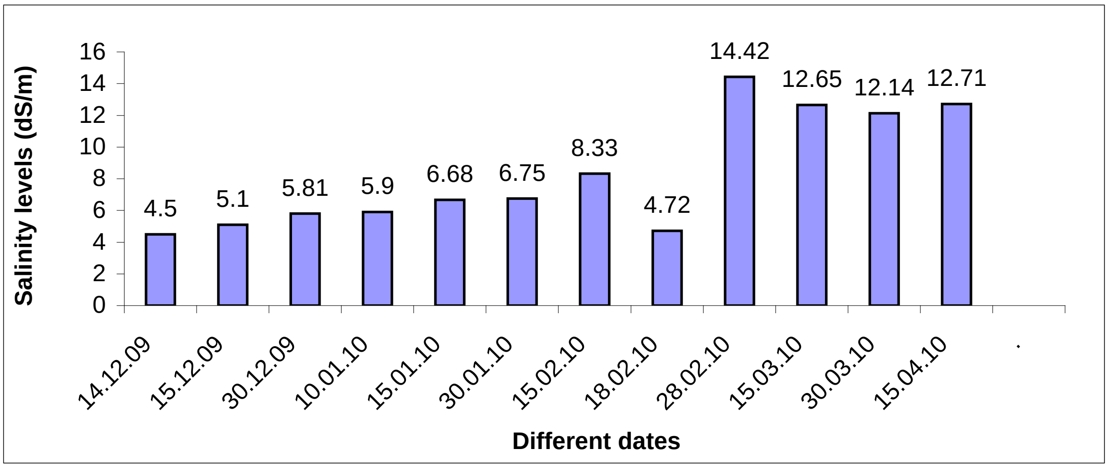

Fig. 1. Salinity levels in soybean field at Benarpota at different dates

Table 1. Yield and yield attributes of soybean varieties at Benarpota Farm, Satkhira during rabi season, 2009-10

Variety	Initial plant Population/m^2	Plant population / m^2	Plant height (cm)	No. of pod/ plant	Grains yield/ ha(ton)
Shohag	35 b	10 c	82 a	90 b	1.16 c
BARI soybean-5	26 c	13 c	74 b	78 c	1.83 a
BARI soybean-6	33 b	12 c	76 a	98 a	1.28 bc
BGM-2026	47 a	33 a	72 b	72 d	1.91 a
BGM-2093	37 b	26 b	79 a	53 e	1.64 a
BC-84051	28 c	25 b	80 a	40 f	1.60 a
CV (%)	4.2	2.50	8.6	5.5	0.48

Salinity level: 4.50 to 14.42 dS/m

Table 2.Yield and yield contributing characters of soybean varieties at MLT site Kuakata, Patuakhali, 2009-10

Variety	Plant population / m^2	Plant height (cm)	Pods/plant (no.)	Seeds/pod (no.)	100-seed weight (g)	Grain yield (t/ha)
Shohag	43 d	37 d	26.66 bc	2.3 ab	54.83 c	1.57 b
BARI Soybean-5	50 b	42 b	22.00 d	2.4 a	62.66 a	1.85 a
BARI Soybean-6	43 d	39 c	21.33 d	2.4 a	58.50 b	1.50 c
BGM-2026	54 a	45 ab	19.60 e	2.1 bc	38.66 e	0.78 g
BGM-20903	47 c	43 b	27.13 b	1.9 c	40.03 e	1.13 d
BC-84051	50 b	47 a	23.93 cd	2.4 a	59.33 b	1.58 b
AGS-95	41 e	42 b	28.90 b	2.2 b	47.33 d	1.13 d
ASSET-95	45 cd	45 ab	25.40 c	2.3 ab	40.00 e	0.98 f
GMOT-17	52 ab	45 ab	34.20 a	2.2 b	64.33 d	1.05 e
CV (%)	7.82	3.42	10.2	2.03	1.02	9.25

Salinity level: 3.30 to 6.20 dS/m

PERFORMANCE OF HYBRID MAIZE VARIETIES IN THE COASTAL CYCLONE PRONE AREAS OF BANGLADESH

M. A. Aziz, F. Begum, R. R. Saha, A.K.M. H. Rahman and M.K.Basher

Abstract

The experiment was conducted in the coastal saline area of Banerpota Farm, Shatkhira and MLT site Kuakata, Potuakhali during the rabi season of 2009-10 after T.aman harvest to select suitable hybrid maize variety adaptive for coastal cyclone prone area of Bangladesh. It was observed that Pacific-60 perform better in the coastal cyclone prone areas and among the BARI released varieties BARI hybrid maize-5 perform better. But in the last year BARI hybrid maize-3 perform better.

Introduction

The last devastating cyclone in the coastal areas of Bangladesh especially Potuakhali and Khulna has broken the backbone of all most all farmers. T.aman crop in those areas in completely damaged. Maize could be grown as cyclone rehabilitation program in the cyclone affected areas. Among the popular hybrid maize varieties which one will be most suitable for those areas is not yet studied. The present study have been undertaken to find out suitable hybrid maize variety for the cyclone prone area of Bangladesh.

Materials and Methods

The experiment was conducted in the coastal saline area of Banerpota Farm, Shatkhira and MLT site Kuakata, Patuakhali during the rabi season of 2009-10 after the harvest of T.aman rice. Six hybrid aize. Varieties viz BARI hybrid maize-2, BARI hybrid maize-5, Pacific-11, Pacific-60, Pacific-555 and Pacfic-984 were tested in a randomized complete block design with three replications. Seeds of different varieties were sown on 19 January 2009 at Banerpota and 01 January 2009 at Kuakata with a spacing of 75cm x 25cm. The trial was fertilized with 253-52-110-46-5-1.2 kg/ha of N-P-K-S-Zn-B+CD respectively. All fertilizer along with 6 t/ha cowdung/ha and $^{1}/_{3}$ N were applied as basal during final land preparation. The rest of urea was applied in two equal split at 35 and 65 DAS. Two irrigations were given following the urea top dressing. Earthing up was done after 2nd top dress of urea. There times weeding and necessary plant protection measures were taken. The crop was harvested on 13 May, 2010 at Satkhria and 6 May 2010 at Kuakata. The salinity level at satkhira during the crop growth period presented in Fig.1. Data on different plant characters and yield were record and analyzed statistically.

Results and Discussion

The salinity level at Banerpota varied from 4.80 to 15.83 dS/m and at Potuakhali it was 1.40 to 2.75 dS/m. The performance of hybrid maize varieties under natural saline condition in the coastal area of Banerpota and Potuakhali presented in Table 1 and Table 2. Soil salinity influenced insignificantly to the characters studied at both the locations. At Banerpota the highest plant height was observed in Pacific-11 (200.3 cm) which was identical with Pacific-555 (199.7 cm) and Pacific-60 (198.0). BARI hybrid maize-5 gave significantly the lowest plant height (175.0 cm). At Potuakhali BARI hybrid maize-7 gave the highest plant height (167.0 cm) which was identical with BARI hybrid maize-2 (166.1 cm). Pacific-60 and Pacific-984 gave the lowest plant height. Number of grains/cob was significant at all the locations. At Banerpota Pacific-11 gave maximum number of grains/cob (660) followed by Pacific-60 (646.3) and BARI hybrid maize-2 gave the lowest (534.0). At Potuakhli BARI hybrid maize-5 gave the highest grains/cob (498.6) which was identical with Pacific-984 (495.0). At Banerpota maximum individual grain weight was recorded from all the varieties except BARI hybrid maize-5. At Potuakhali BARI hybrid maize-5 gave the maximum individual grain weight (282.2 g/1000 seed) and Pacific-60 gave the minimum (267.8 g/1000 seed). Grain yield influenced significantly at both the locations. At Banerpota the highest yield was recorded from Pacific-11 (9.39 t/ha) followed be Pacific-60 (8.83 t/ha). BARI hybrid maize-2 gave the lowest yield (8.57 t/ha). At Potuakhali significantly the highest yield was obtained form BARI hybrid maize-5 (7.05 t/ha) followed by Pacific-555 (6.26 t/ha). Pacific-984 gave the lowest yield (5.32 t/ha). From mean grain yield it was observed that Pacific-60 perform better in the coastal cyclone prone areas and among the BARI released varieties BARI hybrid maize-5 perform better. But in the last year BARI hybrid maize-3 perform better.

Farmer's reaction

1. Yield of hybrid maize was satisfactory, so farmers are interested to grow hybrid maize.
2. Farmers preferred BARI hybrid maize 5 for attractive colour and taste.
3. Stover was used as fodder and fuel.

Conclusion

From the study it was revealed that among the BARI tested varieties BARI hybrid maize-5 performed better in the coastal cyclone area after harvest of T.aman rice. It mighe be concluded that BARI hybrid maize-5 would be suitable in the coastal cyclone area after harvest of T.aman rice

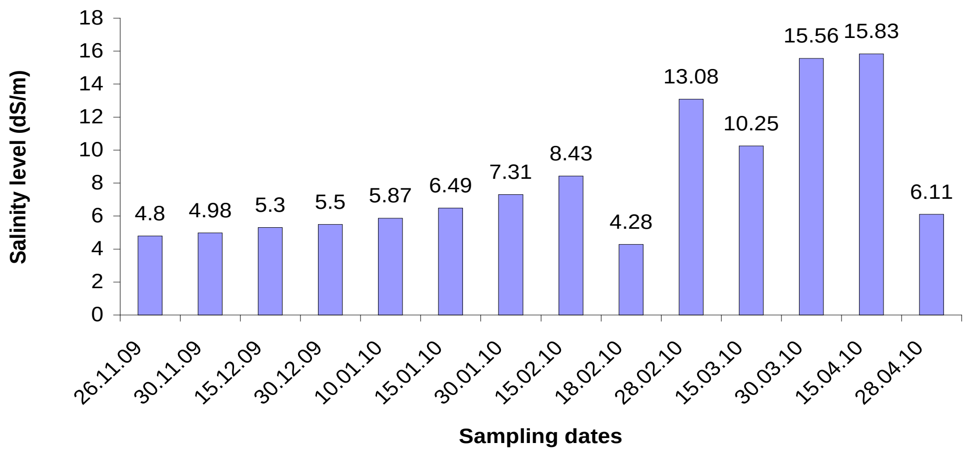

Fig. 1. Salinity levels in maize field at Benarpota at different dates

Table 1. Plant height and number of grains/cob of hybrid maize varieties at Benarpota and Patuakhali as influenced by natural soil salinity

Variety	Plant height (cm)		No. of grains/cob	
	Banerpota	Patuakhali	Banerpota	Patuakhali
BARI Hybrid maize-2	190.3 b	166.1a	534.0 g	434.2 c
BARI Hybrid maize-5	175.0 d	158.2 ab	597.0 d	498.6 a
BARI Hybrid maize-7	189.7 bc	167.0 a	589.2 e	464.0 b
Pacific- 11	200.3 a	155.2 b	660.0 a	414.2 d
Pacific-60	198.0 a	151.3 c	646.3 b	471.1 b
Pacific-555	199.7 a	156.0 b	614.0 c	424.2 cd
Pacific-984	185.6 c	152.2 c	645.2 b	495.0a
CV (%)	12.37	6.28	2.25	7.29

Table 2. 1000-grain wt. and grain yield of hybrid maize varieties at Banerpota and Patuakhali as influenced by natural soil salinity

	1000- grain wt. (gm)		Grain yield (t/ha)		
	Banerpota	Patuakhali	Banerpota	Patuakhali	Mean
BARI Hybrid maize-2	357.0 a	277.8 b	5.45 f	5.33 d	5.39
BARI Hybrid maize-5	330.2 b	282.2 a	7.25 d	7.05 a	7.15
BARI Hybrid maize-7	364.4 a	278.1 b	6.92 e	5.83 c	6.38
Pacific- 11	360.4 a	278.1 b	9.39 a	5.83 c	7.61
Pacific-60	358.0 a	267.8 d	8.83 b	5.78 c	7.30
Pacific-555	357.5 a	277.0 b	8.08 c	6.26 b	7.17
Pacific-984	358.0 a	269.8 c	8.01 c	5.32 d	6.67
CV (%)	2.12	1.05	8.64	10.25	-

PERFORMANCE OF SALT TOLERANT MUNGBEAN VARIETIES/LINES IN THE COASTAL AREAS

M. A. Aziz, A. H.M.A. Faisal and M. Amin

Abstract

The field trial was conducted at FSRD site Noakhali during the rabi season of 2009-10, to assess whether salt tolerance in BM 01 and BM 08 under pot culture has relationship with that under field condition. Six mungbean varieties /lines viz. BM- 01, BM-08, BARI mug-2, BARI mug -5, BARI mug-6 and local were tested in a randomized block design with three replications. The salt tolerant line BM 08 and BM 01 showed better adaptability at Noakhali coastal area. Significantly the highest yield was obtained from BM 08 (0.78 t/ha). The results indicated that the salt tolerance in BM 08 made in pot culture showed consistence with that made under field condition.

Introduction

A vast coastal and offshore area (2.85 m/ha) in the southern part of Bangladesh exhibits soil salinity of various magnitudes due to onrush of salt water from the Bay. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the underground moves up by capillary forces. Thus a considerable amount of salt from the subsoil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. As a result, most of the areas remain fallow during dry months. To increase mungbean area and production these marginal lands may be considered as it is mostly grown in the southern part of Bangladesh. The variation in salinity tolerance between crops and/or varieties of crop is well known (Mass and Hoffman, 1977; Karim *et al.* 1994; Richards *et al*. 1987). A judicial choice to grow a crop under saline soils is, therefore, considered an important management option to minimize yield loss by salinity. Blum (1988) rightly pointed out that, for sustainable crop production in the saline soil is more important to select a salt tolerant crop rather than a relatively better yielding variety of susceptible crops. The present study was therefore, undertaken to assess whether salt tolerance in BM 01 and BM 08 under control condition (pot culture) has relationship with that under field condition.

Materials and Methods

The field trial was conducted at FSRD site Noakhali and Kuakata, Potuakhali during the rabi season of 2009-10. Five mungbean varieties /lines viz. BM- 01, BM-08, BARI mug-2, BARI mug -5 and local were tested in the experiment. The unit plot size was 3 m x 2 m. Seeds were sown in 30 cm x 5 cm line following RCB design with three replications. Fertilizers @ of 20-16-15-10 kg/ha of N-P-K-S was applied as basal. Mungbean was sown on 10 February 2009 at Noakhali, 20 December at Potuakhali and 26 January 2009 at Benarpota. Weeding, thinning and all other intercultural operations were done as and when necessary. Soil salinity level was measured 15 days interval from sowing harvesting of the crop.. Data on yield and yield components were collected from five randomly selected plants from each plot. The collected data were analyzed statistically following 'MSTAT' programme.

Results and Discussion

The performance of mungbean varieties/line at FSRD site of Noakhali presented in (Table 1). The soil salinity level was 1.6 to 5.9 dS/. Soil salinity significantly influenced the yield and yield components of mungbean varieties. Significantly the highest number of pods per plant was obtained in BM-08 (19.2) which was identical with BM-01 (18.1). BARI mug-2, BARI mug-5 and BARI mug-6 gave identical number of pods/plant. The lowest number pods/plant was obtained from Local (15.2). Although insignificantly the higher number of seeds per pod was recorded from BM-08 (11.1) followed by BM-01 (10.2). The lowest number of seeds/pod was recorded from BARI mug-5 and BARI mug-6 (10.0). Significantly the highest individual grain weight was obtained from BM-01 (24.1 g/1000 seed) which was identical with BM-08 (23.0 g/1000 seed). Local variety gave the lowest individual grain weight (18.2 g/1000-seed). The effects of soil salinity on grain yield closely matched its effects on number of pods per plant.

Farmers' Reaction

1. Farmers are interested to grow mungbean after harvest of T.aman.
2. Farmers are satisfied with the yield obtained from the experiment.
3. Farmers like BM-01 and BM-08 as the lines are salt tolerant.

Conclusion

The salt tolerance in BM-08 followed by BM-01 made in pot culture showed consistence with that observed under field condition. The salt tolerant line BM-08 and BM-01 showed better adaptability in coastal area. The results should similarity for the last three years. Pilot production programme should be taken in the next season for large scale demonstration.

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Table 1 Yield and yield attributes of mungbean as influenced by different varieties at FSRD, Hazirhat site of Noakhali during 2008-09

Varieties/lines	Plant height (cm)	Pods/plant (no.)	Seed / pod (no.)	1000 seed wt. (g)	Grain yield (t/ha)
BM-01	45.20	18.1	10.2	24.1	0.75
BM-08	48.80	19.2	11.1	23.0	0.78
BARI mung-2	42.03	15.0	10.1	19.5	0.47
BARI mung-5	46.53	16.2	10.0	21.0	0.53
BARI mung-6	41.63	16.1	10.0	20.6	0.57
Local	38.27	15.2	10.2	18.2	0.46
LSD (0.05)	4.36	2.94	NS	3.17	0.18
CV (%)	9.25	15.57	7.79	8.56	14.58

Soil salinity leve: 120 to 11.69 dS/m

PERFORMANCE OF SALT TOLERANCE BARLEY GENOTYPES IN THE COASTAL REGION OF BANGLADESH

M. A. Aziz, F. Begum, M.K.Basher and A. K. M. H. Rahman

Abstract

The experiment was conducted at two different locations of coastal areas (Benarpota and Potuakhali) during 2009-10 to find out the performance of salt tolerant barley lines namely BHL-15, BHL-18 and BHL-19 screened under laboratory condition. BHL-15 performed better at Potuakhali and also Satkhira. The line BHL-15 could be selected for cultivation in the coastal saline area of Bangladesh.

Introduction

Barley (*Hordium vulgare* L.) is the world's 4th most important cereal crops and it has the potential to become one of the important crops in Bangladesh. Barley though a minor crop of the country can play an important role in enhancing the food security of the country and in reducing the drainage of foreign currency. It is nutritionally comparable to wheat and rice, which are the traditional foods of this subcontinent. Barley is popular for home consumption of rural people. This has several industrial uses also for which import is unavoidable. Further of all cereals barley is well known for its high resistance to salinity and thus has a great potentiality for expansion is the coastal saline area which mostly remains fallow in the rabi season. Therefore, development of high yielding and salt tolerant superior quality barley varieties is very much necessary for reducing the drainage of foreign currency and for enhancing the over all food security of the country.

Materials and Methods

The experiment was conducted at Benarpota and Kuakata, Potuakhali during rabi season of 2009-10. Three varieties/lines namely BHL-15, BHL-18 and BHL-19 were used in this experiment. The crop was sown on 15th December'08 in Satkhira, 12 December 2009 at Potuakhali. Seeds were sown continuously and line to line spacing was 30 cm. Fertilizer was applied at the rate of 100-60-40 kg/ha of NPK respectively in the form of urea, TSP and MP and were applied as basal. Data on yield and yield attributes were collected and analyzed statistically.

Results and Discussion

The salinity level during the crop growing period was ranged from 5.00 dS^{-m} to 13.97 dS^{-m} at Banerpota, Satkhira and 2.93 dS^{-m} to 6.51dS^{-m} at Kuakata, Potuakhali. Yield and yield contributing characters were presented in Table 1. At Potuakhali BHL-19 and BHL-15 gave the highest yield. The higher yield may be due to higher number of grains/spike and higher 1000 grain weight. BHL-18 gave the lowest yield which might be due to higher salinity in the experimental plot. At Benarpota significant difference was found in grains/spike, 1000 grain wt. and grain yield. Significantly the highest grain yield (2.41 t/ha) was obtained from BHL-18. BHL-19 and BHL-15 identical and lowest grain yield. A decrease in yield due to salinity was also observed in other crops viz. Wheat (Begum and Karmoker, 1997), green grass (Patil *et al* 1992) and also in finger millet (Onkware, 1993).From this observation it is clear that BHL In the last year BHL-15 performed at both the locations.

Farmer's reaction

1. Post harvest processing was not easy.
2. Marketing was a problem.

Conclusion

The salt tolerance in BM-08 followed by BM-01 made in pot culture showed consistence with that observed under field condition. The salt tolerant line BM-08 and BM-01 showed better adaptability in coastal area. The results should similarity for the last three years. Pilot production programme should be taken in the next season for large scale demonstration.

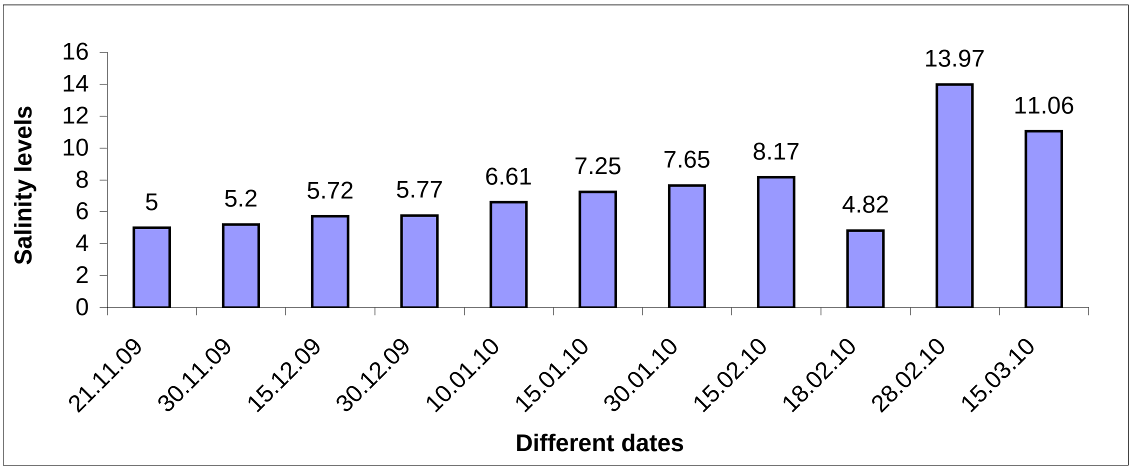

Fig. 1. Salinity levels in barley field at Benarpota at different dates

Table 1. Yield and yield attributing characters of salt tolerant Barley varieties during at benarpota and potuakhali during rabi season, 2009-2010

Variety	Plant height (cm)		Grains/spike (no.)		1000 grain weight (g)		Grain yield (t/ha)	
	Ben.	Pot.	Ben.	Pot.	Ben.	Pot.	Ben.	Pot.
BHL 19	74.2b	58.1	65.4c	49.2a	35.2c	36.6a	1.93b	1.65a
BHL 18	69.8c	57.2	77.4a	43.5b	38.4a	33.3b	2.41a	1.53b
BHL 15	80.4a	56.8	67.6b	45.0b	37.0b	35.0ab	2.00b	1.62a
CV(%)	1.26	9.23	1.22	4.12	1.93	1.02	2.77	10.12

Ben. = Satkhira, Pot. = Potuakhali

PILOT PRODUCTION OF HIGH VALUE CROPS THROUGH SUPPLEMENTAL IRRIGATION IN THE COASTAL AREAS

M. A. Aziz, K. Roy, A. K. M. H. Rahman, P.K.Sarker and M.Hossain

Abstract

The experiment was conducted at ARS, Benarpota, MLT site Satkhira and MLT site Dacope, during the rabi season of 2009-2010 to find out the performance of high value crops in the coastal saline area and to increase employment opportunity and economic return of farmers. High value crops such as knol khol, sweet gourd, tomato and cabbage, chilli, watermelon, okra, ribbed gourd, cucumber, yard long bean, bitter gourd were evaluated. At Benarpota, the yield of higth value crops knol kohl, sweet gourd, tomato and cabbage were 19.3, 14.71, 45.00 and 47.5 t/ha respectively. The highest gross return (2,70,000 Tk./ha) and benefit cost ratio (1.7) were recorded from Tomato. At Satkhira MLT site, the highest BCR was obtained from cabbage (3.32) because of its better yield. At Dacope MLT site, the highest BCR was recorded from sweet gourd. From one year study it may be concluded that tomato, cabbage and sweet gourd would suitable for cultivation in the coastal saline areas with supplemental irrigation.

Introduction

After harvest of T.aman rice in the southern part of Bangladesh a vast coastal and offshore areas remaining fallow. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation the saline water from the under ground moves up by capillary forces. Thus a considerable amount of salt from the sub soil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. During survey of existing crops and cropping in the coastal area it was observed that some farmer's use supplemental irrigation from reserve sources during the dry season. Growing of high value crops through suppleme4ntal irrigation in the coastal saline area would increase economic return of farmer's. Therefore, the experiment was undertaken to find out there performance of high value crops through supplemental irrigation in the coastal area of Bangladesh.

Materials and Methods

The experiment was conducted at the ARS, Benarpota, MLT site Satkhira and MLT site Dacope, during the rabi season of 2009-2010 from November 2009 to May 2010. The trial was laid out in a RCB design with four replications. Different high value crops were taken in the study. Those were tomato, cabbage, sweet gourd, knol khol, chilli, watermelon, ribbed gourd, cucumber, yard long bean, bitter gourd. Transplantation of these treatments was done on 5 15 November 2010. The unit plot size was 5 m × 4 m. Data of the variables were recorded. Recommended doses of fertilizers were applied respectively. Intercultural operations were done as and when necessary.

Result and Discussion

Benarpota

Data on yield and economics were given in Table 1. The yield of Knol kohl, Sweet gourd, Tomato and Cabbage were 19.3, 14.71, 45.00 and 47.5 t/ha respectively. Gross return 270000, 237500, 88260 and 135100 Tk./ha were recorded from Tomato, Cabbage, Sweet gourd and Knol khol respectively. Maximum benefit cost ratio (1.7) was obtained from Sweet gourd.

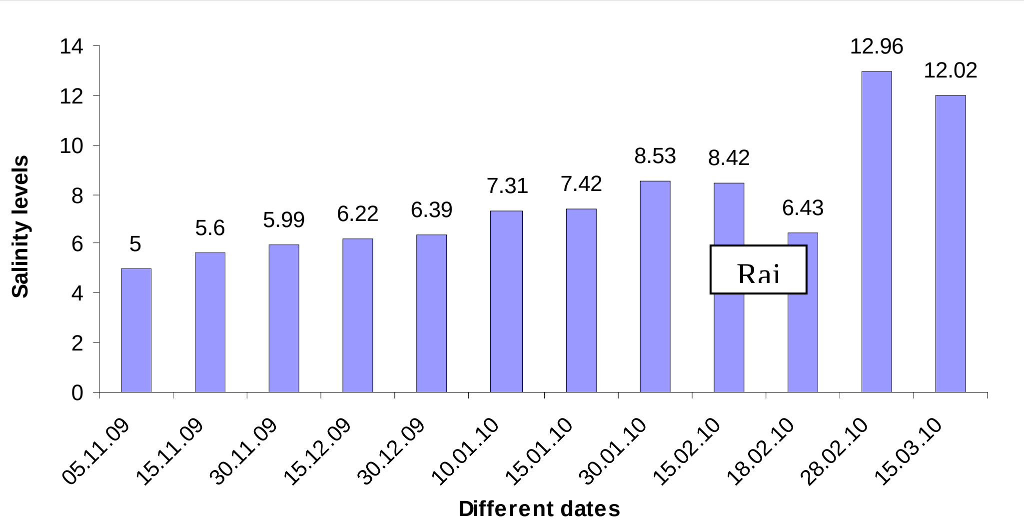

Fig. 1. Salinity levels in high value crops field at Benarpota at different dates

Table 1. Yield and Economics of high value crops as pilot production at ARS, Benarpota, Satkhira during 2009-2010.

Treatment	Yield (t/ha)	Gross return	Variable cost	BCR
Tomato	45.0	270000/-	104800/-	1.30
Cabbage	47.5	237500/-	82900/-	1.06
Sweet gourd	14.7	88260/-	161800/-	1.70
Knol khol	20.1	140700/-	131700/-	1.06

Market price (Tk/Kg): Tomato =6, Cabbage=5, Sweet gourd=6, Knol khol=7 MLT site, Satkhira

Among five vegetable crops the highest net return was found from cabbage (Tk.295136.00/ha) and the lowest from sweet gourd (Tk.35992.00/ha). The gross return was found negative in performance from chilli due to its low yield. Soil salinity along with severe mite infestation caused the growth of chilli plant stunted. The highest BCR was observed in cabbage (3.32) because of its better yield and good market price. The lowest BCR was recorded from chilli (0.65).

Table 3. Effect of supplemental irrigation on the yield and yield contributing characters of high value crops at MLT site, Satkhira, during 2009-10

Crops	Height/length of plant (cm)	Fruit/plant (no.)	Yield/plant (g)	Yield (t/ha)
Tomato	96.23	12.93	770.33	30.63
Cabbage	38.10	1.00	1405.00	52.76
Sweet gourd	180.80	1.00	1478.33	4.04
Chilli	36.93	20.13	39.57	1.32
Knolkhol	34.17	1.00	379.33	28.87
LSD (0.05)	10.74	0.87	204.00	8.91
CV (%)	7.39	6.46	13.30	20.10

Table 4.Yield and economic performance of high value crops at MLT site, Satkhira during 2009-10

Vegetable crops	Yield (t/ha)	Gross return (Tk/ha)	Total variable cost (Tk/ha)	Gross return (Tk/ha)	BCR
Tomato	30.63	214410	135555	78855	1.58
Cabbage	52.76	422080	126944	295136	3.32
Sweet gourd	4.03	60450	24458	35992	2.47
Chilli	1.32	52800	80888	(-) 28088	0.65
Knolkhol	28.82	230560	115294	115266	2.00

Price: Tomato: Tk. 7/kg, Cabbage: Tk 8/kg, Sweet gourd: Tk.15/kg, Chilli : Tk. 40/g, Knolkhol : Tk. 8/kg

MLT site, Dacope

Among eight high value vegetables, the highest gross return was recorded from watermelon (Tk. 153125.00/ha) and the lowest gross return was observed in cucumber (Tk. 3930.00/ha). The negative gross return was found from chilli. The highest BCR was recorded from sweet gourd (2.77) and the lowest was obtained from chilli (0.75).

Table 5. Effect of supplemental irrigation on the yield and yield contributing characters of high value crops at MLT site, Dacope, Khulna during 2009-10.

Crops	Height/length of the plant (m)	Yield/palnt (no.)	Fruit wt./plant (g)	Yield (t/ha)
Watermelon	2.50	1.90	6650	66.50
Sweet gourd	2.50	2.20	6050	60.50
Okra	1.50	55.50	1000	11.50
Chilli	1.00	75.00	750	3.00
Cucumber	3.00	9.90	1080	13.00
Ribbed gourd	3.10	20.00	1900	15.00
Yard long bean	3.15	29.00	1200	10.00
Bitter gourd	2.95	16.50	450	12.10
$LSD_{(0.05)}$	8.60	103.20	125.10	39.60
CV (%)	4.35	14.75	18.50	8.96

Table 6. Yield and economic performance of high value crops at MLT site, Dacope, Khulna during 2009-10

Vegetable crops	Yield (t/ha)	Gross net. (Tk/ha)	TVC. (Tk/ha)	Gross return (Tk/ha)	BCR
Watermelon	66.50	266000	112875	153125	2.36
Sweet gourd	60.50	226875	81900	144975	2.77
Okra	11.50	138000	80850	571510	1.71
Chilli	3.00	60000	79000	(-) 19000	0.75
cucumber	13.00	117000	113070	3930	1.03
Ribbed gourd	15.00	105000	95050	9950	1.10
Yard long bean	10.00	80000	55000	25000	1.45
Bitter gourd	12.10	84700	63250	21450	1.34

Price: Water melon: Tk. 4/kg, Sweet gourd: Tk 3.75/kg, Okra: Tk.12/kg, Chilli : Tk. 20/g,
Cucumber : Tk. 9/kg, Ribbed gourd: Tk. 7/kg, Yard long bean: Tk. 8/kg, Bitter gourd: Tk. 7/kg

Conclusion

At Benarpota, The highest gross return (2,70,000 Tk./ha) and benefit cost ratio (1.7) was recorded from Tomato. At Satkhira MLT site, the highest BCR was obtained from cabbage (3.32). At Dacope MLT site, the highest BCR was recorded from sweet gourd. From one year study it may be concluded that tomato, cabbage and sweet gourd would suitable for cultivation in the coastal saline areas with supplemental irrigation.

DEVELOPMENT OF ALTERNATE CROPPING PATTERN FOR COASTAL SALINE AREA OF BANGLADESH AGAINST FARMER EXISTING T.AMAN-FALLOW-FALLOW PATTERN

M. A. Aziz, A. K. M. H. Rahman and K. Roy

Abstract

An experiment was conducted at ARS, Benarpota, Satkhira during the rabi season of 2009-2010 to develop alternate cropping pattern against farmers T.aman-fallow-fallow pattern.. The tested crops after T.aman were cowpea, wheat and mustard. Salinity ranges from 4.41 dS/m to 15.23 ds/m. Grain yield of wheat, cowpea and mustard were 2.37 t/ha., 0.95 t/ha and 1.79 t/ha respectively. Gross return, and gross margin of cowpea were 27,000 and 6,400/- per ha. Gross return 53,700 Tk./ha and gross margin 27,800 Tk./ha were recorded from mustard. Gross return 28,440 Tk./ha and gross margin 8,370 Tk./ha were recorded from wheat. Benefit cost ratio of these three crops were 0.77, 2.07 and 1.42 respectively.

Introduction

After harvest of T.aman rice in the southern part of Bangladesh a vast coastal and offshore areas remaining fallow. However, during the dry season (November to March) surface layer of the soil dries up due to evaporation and the saline water from the under ground moves up by capillary forces. Thus a considerable amount of salt from the sub soil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. Previous study showed that mustard, mungbean, cowpea and wheat could be grown after harvest of T.aman rice if the land becomes free during the month of last November to early December. Cultivation of short duration T.aman rice would be the option to make the same. BRRI Dhan-33/BINA Dhan-7 a short duration T.aman variety matures 10-15 days earlier than any other T.aman varieties. Therefore the experiment wws carried out to develop alternate cropping pattern against farmers T.aman-fallow-fallow cropping pattern for the coastal saline area of Bangladesh.

Materials and Methods

The study was conducted at the ARS, Benarpota, Satkhira from November 2009 to May 2010. The trial was laid out in a RCB design with four replications. Three treatments were applied in the study. There are T.aman (BR 33) wheat (Prodip)-fallow, T.aman (BR 33)-mustard (BARI sarisha-11)-fallow, T.aman (BR 33)-cowpea (BARI falon 1)-fallow. Seeds of wheat, mustard and cowpea were sown on 23 November/09, 23 November/09 and January/2010 accordingly. The unit plot size was 1000 $m^{2.}$ Recommended doses of fertilizers were applied respectively. Intercultural operations were done as and when necessary. Data on initial plant population, plant height, branch/plant, pod/plant, seed/pod and grain yield were recorded and analyzed statistically.

Results and Discussion

Yield data of three crops were presented in Table 1. Lowest salinity was recorded 5 dS/m during sowing time and it increase 15.23 dS/m during harvesting period. Grain yield of wheat, cowpea and mustard were 2.37 t/ha., 0.95 t/ha and 1.79 t/ha respectively. Gross return, and gross margin of cowpea were 27,000 and 6,400/- per ha. Gross return 53,700 Tk./ha and gross margin 27,800 Tk./ha were recorded from Mustard. Gross return 28,440 Tk./ha and gross margin 8,370 Tk./ha were recorded from Wheat. Benefit cost ratio of these three crops were 0.77, 2.07 and 1.42 respectively. So. it was observed that the maximum gross return, net return and benefit cost ratio were recorded from the yield of mustard.

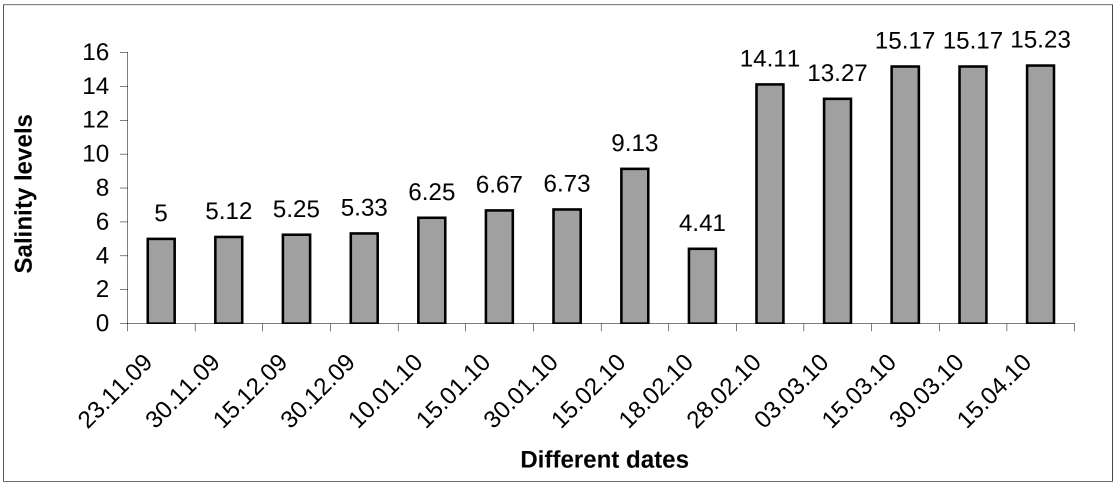

Fig. 1. Salinity levels in crop field at Benarpota at different dates

Table 1. Yield and economic analyzing result of three crops at ARS, Benarpota, Satkhira during 2009-2010.

Treatment	**Grain yield (t/ha)**	Gross return (Tk.ha)	TVC (Tk./ha)	Net return (Tk./ha)	BCR
	0.90	27000/=	20600/=	6400/=	0.77
	1.79	53700/=	25900/=	27800/=	2.07
	2.373	28440/=	20070/=	8370/=	1.42

Market price (Tk./Kg): **cowpea- 30/-, mustard-30/-, wheat-12/-**

Conclusion

From the results it may be concluded that T.aman–Mustard-Fallow cropping pattern may be suitable for the coastal area. It is the first year experiment and the experiment should be continued for the next year.

ESTABLISHMENT OF MINI FRUIT ORCHARD IN HOMESTEADS IN THE COASTAL AREA OF BANGLADESH

M. A. Aziz, P.K. Sardar and M.M. Hossain

Abstract

The program, establishment of mini fruit orchard was conducted at MLT site, Satkhira and MLT site, Dacope, Khulna during 2009-10 to see the performance of fruit trees at homestead of saline household and to increase income and employment opportunity of the devastating people. There were 13 fruit species namely Mango, Ber, Guava, Golden apple, Sapoto, Coconut, Jamun, Jambo, Indian olive, Pummetao, Jack fruit, Litchi and Lotkon. Farmer per homestead received 18 fruit seedling. The surviral of Mango (53.57%) and Ber (92.50%) were found highest in Dacope and Satkhira respectively. The growth of Mango, Guava, Golden apple, Wax jambo, Jack fruit, litchi were very good and growth of Sapota, Jamum and Pomelo were good.

Introduction

The importance of fruit is beyond explanation. Fruits are called the protective foods, rich in vitamins and minerals and are essential for the maintenance of human health. The minimum recommended dietary allowance of fruits per capita per day is 85 g. By the present availability is only 35 g. evidently; the present production of fruits in our country is far below than the requirements. Further, the production and consumption status of fruits in the coastal and charland area of the country is remarkably low. But there remains a scope to increase the production of fruits through establishing fruit orchard of high yielding varieties as well as taking proper management practices of the trees in these areas. An effort of fruit tree plantation in homesteads can also play an important role in this regard. Therefore, an attempt has been made to grow some high yielding quality fruits in the farmer’s homesteads in the coastal and charland area to see the growth, yield and quality of fruit.

Materials and Methods

The program was conducted at MLT site, Satkhira and MLT site, Dacope, Khulna during 2009-10. A total of 13 fruit species, major or minor, local or exotic were imcluded in the study. Most of the grafting seedlings were collected from Fruit Research Station, Jaintapur, Sylhet. Some seedlings of locally adapted fruit species were collected from reliable local nursery. The fruit seedlings were planted on August to September, 2009. Data in related to plant height, spreading and growth were recorded.

Results and Discussion

The trees of all the varieties were found good to very good except Lotkon and Indian alive; The highest survival (%) was found in Mongo and Ber and it was 53.57% and 92.50% at Dacope and Satkhira respectively. Survival (%) of Sapota (7.14%) and Jamun (7.14%) at Dacope and Indian olive (5%) at Satkhira were poor. The growth of Mango, Ber, Guava, Golded apple, Wax jambu, Jack fruits, Litchi were very good and the growth of Sapota, Jamun and Pummelo were good. No bearing was seen in any fruit tree. Because the trees are still at vegetative stage.

Table 1. Survival (%), plant height, Spreading and status of different fruit tree at MLT site, Satkhira and Dacope, Khulna.

Sl No	Name of fruit seedling	Survival (%)		Plant height (cm)		Spreading (m- NXS)		Status
		Satkhira	Dacope	Satkhira	Dacope	Satkhira	Dacope	
1.	Mango	48.75	53.57	65	160	70	62	Very good
2.	Ber	92.5	37.50	65	56	40	42	Very good
3.	Guava	30.00	41.01	120	112	55	58	Very good
4.	Golden apple	55.00	42.85	125	110	50	48	Very good
5.	Sapota	35.00	7.14	75	76	30	32	Good
6.	Coconut	80.00	46.42	65	60	45	44	Good
7.	Jamun	15.00	7.14	180	177	75	68	Good
8.	Wax jambu	30.00	25.00	50	50	25	28	Very good
9.	Indian olive	5.00	0.00	60	0.00	15	0.00	Medium
10.	Pummelo	5.00	28.57	32	35	20	15	Medium
11.	Jackfruit	10.00	28.57	135	130	25	25	Very good
12.	Litchi	10.00	42.85	100	80	70	68	Very good
13.	Lotkon	0.00	10.71	0.00	30	0.00	15	Bad

Conclusion

The plant growth of all the fruit trees were good and/or very good. However, final conclusion will be made after thorough evaluation of physiomorphological characters of 5/6 years.

SALINITY INDUCED CHANGES IN GROWTH AND ION UPTAKE OF SELECTED COWPEA GENOTYPES

A.K.M.M. Rahman and M.A. Aziz

Abstract

Five selected genotypes viz. cowpea (BD-1604, BD-8337, BD-8338, BD-8345 and BD-8346) along with BARI Felon-1were tested for their salt tolerance at different salinity levels viz, 0, 5, 10 and 15 dS $m^{-1}$of NaCl, in vinyl house of Agronomy Division, BARI, Gazipur during 2010-11. Results indicated that growth decreased by increasing soil salinity. Selected lines varied greatly with respect to root and shoot dry weight, plant height under different salinity. After 45 DAS, the tallest plant was observed in BD-1604 at 15 dS m^{-1}. Under saline condition, highest shoot dry weight was found in BD-1604 and it was lowest in BARI Felon-1. Root dry weight followed the same trend as shoot dry weight. Na^+ content was found minimum in BD-1604 and maximum in BARI Felon-1. K^+ contents in genotype BD-1604 was maximum than other genotypes. Ca^{2+} contents in plant decreased with the increase in salinity levels (0-15 dS m^{-1}). The Cl^{-1} contents in the shoot increased with increasing in salinity level from 0-15 dS m^{-1}. In respect to growth and ion accumulation all the selected genotypes except BARI Felon-1showed salt-tolerance. Selected cowpea genotypes performed in Hoagland solution culture showed consistent results with that under pot culture. Among the genotypes, BD-1604 performed better as salt tolerant genotype.

Introduction

Cowpea (*Vigna unguiculata* L. Walp.) is an important food crop in coastal area of Bangladesh. The high protein content of cowpea (20 to 28%) makes it an important supply to the diet of many people. Apart from their nutritional value, cowpea contribute to the soil nitrogen status through symbiotic N_2 fixation, thereby enhancing soil fertility. In addition, cowpea is considered to be less prone to drought damage and has a high yield potential especially when P fertilizers are applied. Salinity is a wide spread environmental stress for crop plants in arid and coastal regions. The salinity of the soil and irrigated water is a problem that restricts crop growth and yield. In Bangladesh, about 52.8 percent of the net cultivable land in the coastal area is affected by varying degrees of soil salinity. This vast land remains mostly uncultivated except some selected areas where *T.aman* crop is cultivated. So, introduction of salt tolerant crops is the most acceptable way of intensifying crop production in these areas. It was reported that germination is the most sensitive stage of plant growth and development in the saline environment. For successful cultivation of crops/vegetable in coastal areas salt tolerant varieties /lines needed to be identified. Generally the growth of plant is reduced by salinity but may vary from species to species in their tolerance. High levels of soil salinity can significantly inhibit seed germination and seedling growth, due to the combined effects of high osmotic potential and specific ion toxicity (Grieve and Suarez, 1997). Intolerance to salinity may result in physiological and biochemical disorders which prevent or delay germination or cause abnormal seedlings (Rehman *et al.*, 1996). Hence, introducing of salt tolerant plants is one of the ways to utilize the waste saline water and lands (Baccio *et al.*, 2004). Although extensive work has been carried out on the effects of salinity on cowpea (*Vigna unguiculata* L.) using NaCl as a source of salinity, tolerance against salinity at the germination stage is important in the establishment of cowpea in saline soils. Looking to the above fact, an investigation was undertaken to determine the effect of salinity levels on plant growth and nutrient accumulation in plants of selected genotypes of cowpea in pot culture.

Materials and Methods

The experiment was carried out in plastic pots under vinyl house of Agronomy Division at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during late Rabi season of 2010-

2011. Five selected cowpea genotypes viz. BD-1604, BD-8337, BD-8338, BD-8345 and BD-8346) out of 20 genotypes screened in laboratory under Hoagland nutrient solution culture along with BARI Felon-1 tested in the study at 0, 5, 10 and 15 dS/m of salinity. Pots were filled with soil and cow dung in 4: 1 volume ratio and final wt. of pot was 13kg. Soil used for the experiment was collected from the ploughed agriculture field. The salinity of the soil used in the present study gave an electrical conductivity (0.75 dS m^{-1}). The texture of the soil was sandy loam (sand 49.3%, silt 30.5% and clay 21.2%). Different salinity levels of 0, 5, 10, and 15 dS m-1 were prepared by mixing required amount of NaCl salt in water. For achieving optimum salinity level, salt solution @ 2.5 dS m^{-1} was added in respective pot with 1 day interval until the exact level reached. Eight seeds of each cultivar were sown in each pot (76 cm on top dia., 74 cm on bottom dia. and 30cm on height) at a depth of 1cm. Thinning was carried out 10 days after sowing, leaving three plants in each pot. The pots used during the present study had five small holes at the bottom. A randomized complete block design was used with three replications. The experiment was carried out during the period from of February to May 2011 and daily temperatures during the course of the experiment ranged from 21 - 30°C. Fertilizers @ $N_{12}P_8K_{12.5}$ kg/ha in the form of Urea, TSP and MoP were used in the soil of pot. Shoots and roots were collected after 45 days of seed sowing and separated after cleaning the roots of soil. Fresh weights were recorded immediately after harvest and were later placed in oven at 80°C for 72 hrs in order to determine the dry weight. Shoots were used for determination of mineral composition. Ash of plant samples was prepared by heating the samples to 550°C in a muffle furnace for 5 h and was later dissolved in dilute HCl with a few drops of Nitric acid and was used to determine Na^+, K^+ and Ca^{2+} using flame photometer, while Cl^- contents were determined by titration with AgNO3 (Richards, 1954).

Results and Discussion

Cowpea genotypes showed decrease in plant height with the increasing in salinity level (Fig. 1A). The highest plant height was observed in BD-1604 at 15 dSm^{-1} at 45 DAS. With the increase in salinity level (0 to 15 dS m^{-1}) reduction in plant height was observed and the relative plant heights were 77, 74, 80, 74, 74 and 43% for BD-1604, BD-8337, BD-8338, BD-8345, BD-8346 and BARI Felon-1, respectively (Fig. 1B). Similar result was reported by Bernardo *et al.*, (2006), who observed significant reduction in plant height with increasing salinity-induced stress in cowpea cultivars. This might be due to NaCl affects the permeability of the plasma membrane and increases influx of external ions and efflux of cytosolic solutes in plant cells (Allen *et al*., 1995). On the other hand, NaCl causes hardening of the cell wall (Nabil and Coudret, 1995) and a decrease in water conductance of the plasma membrane causing reduction in plant height (Cramer, 1992).

Reduction in shoot dry weight was also observed with increase in salinity levels. Under saline condition highest shoot dry weight was found in BD-1604 (Fig. 1B) and the lowest in BARI Felon-1. Relative shoot weight of selected cowpea lines viz., BD-1604, BD-8337, BD-8338, BD-8345 and BD-8346 were above 70% compared to non-saline condition, while it was 45% in BARI Felon-1. Root dry weight followed the same trend as shoot dry weight (Fig. 1C). The present result revealed that root growth was highly affected by salinity levels than shoot growth. Decrease in shoot biomass indicates an inverse relationship between salinity and biomass production (Gururaja Rao *et al*., 2005).

The Na^+ contents in the shoot increased with increasing salinity level from 0-15 dS m^{-1}. Na^+ content was found minimum in BD-1604 and maximum in BARI Felon-1(Table 1). K^+ contents in genotype BD-1604 was maximum than other genotypes. With increasing the salinity level from 0 to 15 dS m^{-1} decreased in K+ concentration. It was 5, 17 and 25% for BD-1604; 7,10 and 21% for BD-8337; 5,13 and 22% for BD-8338; 7,17 and 25% for BD-8345; 6,13 and 19% for BD-8346;

6,14 and 25% for BARI Felon-1at 5, 10, 15 dS m^{-1} respectively. K^+ content in plant tissues represents the main cation in plant cells, and is an important component of the cell osmotic potential (Reggiani *et al*., 1995).

Ca^{2+} contents in plant decreased with increased salinity levels (0-15 dS m^{-1}). The Ca^{2+} contents was 13, 18 and 26% for BD-1604; 12, 24 and 28% for BD-8337; 24, 34 and 40% for BD-8338; 18, 23 and 31% for BD-8345; 9, 27 and 42% for BD-8346; 19, 27 and 31% for BARI Felon-1at 5, 10, 15 dS/m^{-1} respectively (Table 2). The Cl^{-1} contents in the shoot increased with increase in salinity level from 0-15 dS m^{-1}. It has been reported that salt-tolerant species maintain high concentrations of Ca^{2+} and K^+; low concentrations of Na^+ and Cl^-. Essa (2002) reported that the main response of the plant to salt stress is a change in Ca^{2+} homeostasis and attributed that the salt tolerance of plants is their ability to avoid Na^+ toxicity and to maintain Ca^{2+} and K^+ concentrations. Also Na^+ is said to maintain turgor but it is unable to substitute for specific functions of Ca^{2+} and K^+. According to Ioneva (1988), increase in Na^+ contents, decrease in K^+ contents and K^+/ Na^+ ratios in plant leaves can be attributed to the effect of competition between Na^+ and K^+ ions on the absorptive sites of the plant roots. There was a substantial difference in Cl^- content and rate of accumulation between cultivars with increasing salinity level. Increasing the salinity level from 0 to 15 dS m^{-1} increased the Cl^- concentrations in the plant was observed. It has been reported that salt-tolerant species maintain high concentrations of Ca^{2+} and K^+ and low concentrations of Na^+ and Cl^-. Sodium is not considered an essential element for plants and plants accumulate Na+ at the expense of Ca^{2+} and K^+ in saline conditions (Kuiper, 1984). According to Greenway and Munns (1980), the reduction in K^+ concentration could inhibit growth by reducing the capacity for osmotic adjustment and turgor maintenance or by adversely affecting metabolic functions. Among the genotypes, BD-1604 maintained lower Na^+ and Cl^- ; higher Ca^{2+} and K^+ content under saline condition than the other genotypes.

Conclusion

The present study confirms that at all salinity levels, the variation in plant growth, dry matter accumulation and ionic content could be better explored in determining the tolerance capacity of the cowpea cultivars. In view of its better ion uptake and higher salt tolerance all the selected genotypes viz, BD-1604, BD-8337, BD-8338, BD-8345 and BD-8346 performed better. Among the genotypes, BD-1604 was the best. So, BD-1604 can be used as a salt tolerant cultivar. The experiment should be repeated in the next year for final conclusion.

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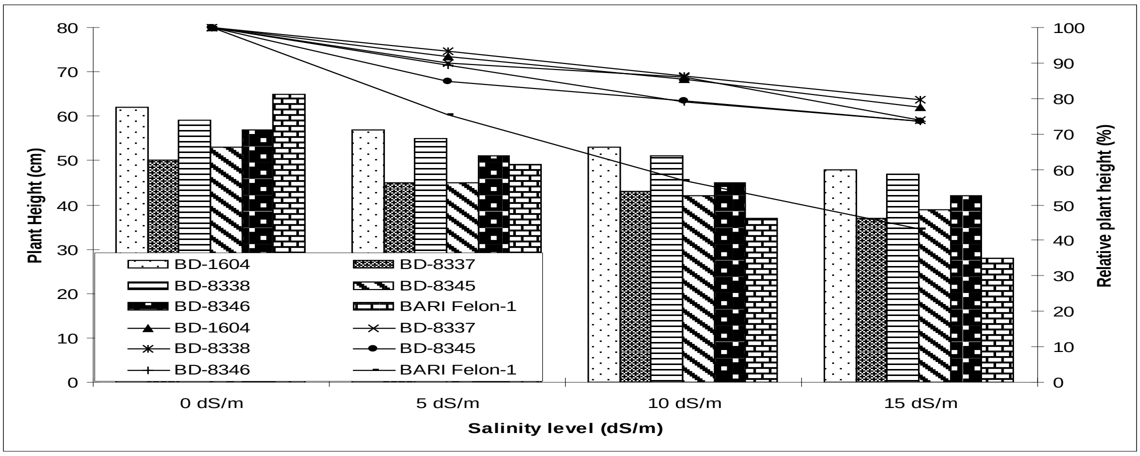
Table1. Accumulation of sodium and potassium content (mg g^{-1}) in shoots of cowpea genotypes after 45 days of seed sowing under different salinity levels

Genotypes	Na^+				K^+			
	Salinity level (dS m^{-1})				Salinity level (dS m^{-1})			
	0	5	10	15	0	5	10	15
BD-1604	1.98	3.14	5.4	6.34	33.64	31.03	28.07	25.18
BD-8337	2.11	3.34	5.56	7.32	29.78	27.71	26.85	23.64
BD-8338	2.34	3.42	5.48	7.11	31.27	29.64	27.31	24.27
BD-8345	2.45	3.52	5.94	7.95	31.33	29.18	26.03	23.35
BD-8346	2.64	3.92	6.33	8.33	29.21	27.33	25.45	23.78
BARI Felon-1	2.67	3.76	6.21	8.75	32.72	30.78	27.98	24.69

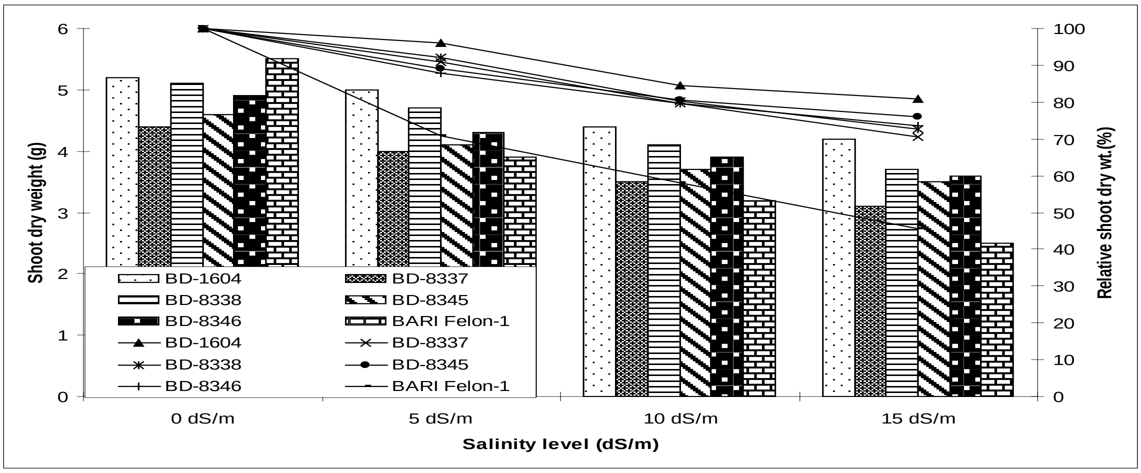
Table 2. Accumulation of calcium and chloride content (mg g^{-1}) in shoots of cowpea genotypes after 45 days of seed sowing under different salinity levels

Genotypes	Ca^{2+}				Cl^-			
	Salinity level (dS m^{-1})				Salinity level (dS m^{-1})			
	0	5	10	15	0	5	10	15
BD-1604	4.46	3.86	3.64	3.31	1.33	2.54	4.07	5.78
BD-8337	4.05	3.58	3.07	2.9	1.42	2.66	4.61	6.7
BD-8338	4.22	3.21	2.78	2.52	1.48	2.76	4.68	6.23
BD-8345	3.77	3.11	2.91	2.62	1.38	2.46	4.45	6.82
BD-8346	3.65	3.33	2.65	2.11	1.52	2.61	4.92	6.67
BARI Felon-1	3.98	3.21	2.92	2.73	1.52	2.54	4.76	6.97

Salinity Stress



1.A



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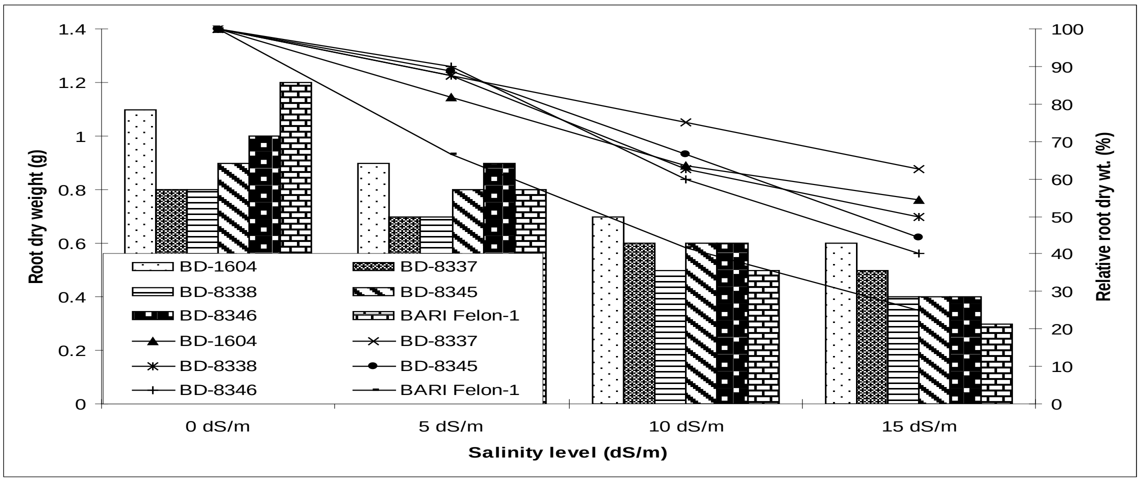

Figure1. Effect of different salinity levels on plant height (1A), shoot dry weight (1B) and root dry weight (1C) of six cowpea genotypes.

PERFORMANCE OF SELECTED MUSTARD GENOTYPES UNDER SALINITY IN POT CULTURE

S.N. Mahfuza and M. A. Aziz

Abstract

The experiment was carried out in vinyl house of Agronomy Division at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2010-2011 to examine the variation of salt tolerance of selected mustard genotypes up to maturity .Eight mustard genotypes (DB 9069, BD 9093, BD 9070, BD 9064, Daulat, BARI Sarisha 11, BARI Sarisha 13 and BARI Sarisha 14) were tested for their salt tolerance at different degrees of salinity (0, 5, 7.5 and 10 dS/m of NaCl). Selected genotypes were affected greatly by salinity with respect to root dry weight, shoot dry weight, plant height, days to flowering, days to maturity and yield over control. In respect of salt tolerance, selected mustard genotypes performed in Hoagland solution culture showed consistent results with that under pot culture. Among the eight genotypes, BD 9093 showed more salt tolerance at all the salinity levels in respect of root-shoot growth and yield performance.

Introduction

In Bangladesh coastal areas occupy almost thirty percent of the net cultivable land. Almost 1.06 million hectares of coastal land is affected by salinity of varying degrees. Mustard is one of the most important oil crops in Bangladesh which can be grown in the coastal area. The most common adverse effect of salinity on the crop of Brassica is the reduction in plant height, seed size and yield as well as deterioration of the quality of the product (Kumar, 1995). Fifty genotypes of mustard were collected from BARI gene bank and screened for their salt tolerance at early vegetative stage in Hoagland solution under laboratory condition. But salinity may affect mustard plants at any stage of growth. It has been reported by a number of workers that in some crops selection for salt tolerance at the early growth stages may not correlate with their tolerance at the later growth stages (Ashraf and McNeilly, 1988).Nevertheless, seed germination and seedling establishment are the most critical stages in life cycles of plants in a saline environment (Blum,1985) and are of importance in assessing the over all salt tolerance of a crop (Akbar and Yabuno 1974, Ashraf *et al*,.1990). However, Brassica has some potential to cope with the toxicity of salts (Francois, 1984). So it can be successfully grown on salt affected soils. Keeping this in mind, the experiment was undertaken to examine the variation in salt tolerance of selected mustard genotypes up to maturity.

Materials and Methods

The pot experiment was carried out in vinyl house of Agronomy Division at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2010-2011. Eight selected mustard genotypes viz. BD 9069, BD 9093, BD 9070, BD 9064, Daulat, BARI Sarisha 11, BARI Sarisha 13 and BARI Sarisha 14 which were screened in laboratory under Hoagland nutrient solution culture along with 0, 5, 7.5 and 10 dS/m of NaCl solution. Plastic pots (76 cm on top dia, 74 cm on bottom dia and 30 cm on height) were filled with soil and cowdung in 4:1 volume ratio and final weight of pot was 13 kg. Fertilizers were at the rate of N_{120} P_{35} K_{65} S_{25} Zn_2 B_1kg/ha in the form of urea, triple super phosphate , muriate of potash, zypsum, zinc sulphate and boric acid were incorporated in the soil. Ten seeds of each genotype were sown in each pot on 11 November 2011. Thinning of seedling was done by keeping four plants for each pot at 10 day after sowing. The pots were irrigated with tap water for growing crop without moisture stress. The study was evaluated under two factor completely randomized design with four replications. At early vegetative stage (2 weeks after sowing) of salt solutions were applied as per treatment. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 5.0, 7.5 and 10.0 dS/m solution. Tap water was used as control and that was 0.3 dS/m. The salt solution was applied with an increment of 2.5 dS/m in every alternate day till respective soil salinity level of 5, 7.5 and 10 dS/m were attained. The root and shoot sample were collected prior to harvest. For root sampling, plastic pots were soaked in water, soil was washed with water and the roots were recovered by passing the soil water suspension through a 2mm mesh sieve. The collected sample was oven dried at 80^0C, until constant weight. The yield and yield component data were collected from five randomly selected plants from each treatment at harvest. Data were analyzed following MSTAT program and means were compared using LSD test.

Results and Discussion

The days to first flowering was increased with the increaseing of salinity levels for all the eight genotypes of mustard (Fig. 1).BD 9064 took 25 days for flower initiation whereas BD 9093 took 44 days under control condition. All the genotypes flowered 2-4 days later at salinity level of 10 dS/m. Days to maturity (Fig. 2) showed the reverse trend as days to flowering in all the eight genotypes. However, the crop maturity period was shortened by environmental stress because of limited source for the sink due to leaf senescence (Levitt, 1972 and Hye, 2000).

There was variation in root dry weight among the genotypes under control condition (Fig.3). The genotype BD 9093 gave the highest root dry weight (4.53g/plant) followed by BD 9069 genotypes (3.04g/plant) and the genotype BD 9064 gave the lowest root dry weight (0.91g/plant) in control condition. Root dry weight decrease linearly with increasing the salinity level from 5.0 to 10.0 dS/m in all the genotypes. The reduction of root dry weight was minimum in genotype BD 9069 at salinity level up to 7.5 dS/m.

The genotype BD 9069 produced the highest shoot dry weight (21.73 g) followed by BD 9070 and the lowest shoot dry weight (12.77 g) was obtained from BARI Sarisha 13 in control condition(Fig.4). Shoot dry weight was significantly decreased with increasing salinity level up to 10 dS/m. The reduction in shoot dry weight might be due to decrease in CO_2 uptake in leaves (Fedina and popova, 1996) mainly because of sodium chloride treatment decreased stomata conductance and consequently less CO_2 available for carboxylation reaction in the photosynthetic apparatus (Yadav *et. al.*, 1996).

At control condition, BD 9093 showed the tallest plant (172.5cm) and BARI Sarisha 14(78cm) was the shortest one (Fig.5). This was due to the variation in genetic characteristic of the genotypes. At 10 dS/m salinity level, plant height decreased in all the genotypes. This result indicated that salinity affected the plant height at higher salinity level. The figure clearly showed that among the genotypes, BD 9093 was the best performer under different levels of salinity with the minimum reduction in plant height. Shannon *et al*. (1993) reported similar results regarding the decrease in plant height with the increase of salinity level in mustard.

Yield components

Number siliqua/plant, seeds/siliuqa and 1000-seed weight of mustard differed significantly among the genotypes irrespective of salinity levels (Table 1).

The heighest number of siliqua/plant recorded in BD 9093 (211) at control condition followed by BD 9070 (196.67). The lowest number of siliqua/plant (56.33) was found in genotype BARI Sarisha 13. Increasing salinity level led to a significant reduction in number of siliqua/ plant. At 5 dS/m salinity level, BD 9069 gave 93% siliqua/plant compared to control which was followed by

BARI Sarisha 11 and BD 9070, BD 9064 and BARI Sarisha 14. The lowest relative siliqua/plant was obtained from BARI Sarisha 13 (80%). At 7.5 dS/m salinity level relative siliqua/plant was heighest in BD 9069 (89%) and the lowest relative siliqua/plant was recorded in BARI Sarisha 14 (64%) which was followed by BD 9063 (69%). At 10 dS/m salinity level relative siliqua/plant decrease sharply and it was below 80% in all the genotypes. BD 9069 gave the highest (74%) relative siliqua/plant and the lowest was recorded in BD 9093 (58%) and it was at par with that of BARI Sarisha 13.

The number of seeds/siliqua was more or less affected by salinity in all the genotypes of mustard. The highest number of seeds/siliqua was obtained in BARI Sarisha 13 (28.33) which was followed by BARI Sarisha 14 (25.00) and the lowest number of seeds/siliqua was obtained from Daulat (15.33) and BARI Sarisha 11 (15.33) under control condition. At 5 dS/m salinity level reduction in seeds/siliqua was also observed in all the cultivars. The highest relative seeds/siliqua was 95% in BD 9064 and the lowest relative seed per siliqua was 81% in BD 9093. At 7.5 dS/m salinity level, Daulat produced the highest relative seed/siliqua (93%) and BARI Sarisha 13 produced the lowest relative seeds/siliqua (87%). At 10 dS/m BD 9043 performed best in producing relative seed/silliqua (75%) followed by BD 9064. The lowest relative seeds/siliqua was obtained from BARI Sarisha 13 (61%).

The 1000-seed weight under non saline condition was the highest in BD 9093 (4.05g) followed by BARI Sarisha 11(3.75g), BARI Sarisha 13 (3.75g) and BARI Sarisha 14 (3.75 g). The lowest 1000-seed weight under nonsaline condition was in BD 9064 (3.43 g). At 5 dS/m salinity level, relative 1000-seed weight was highest in BARI Sarisha 11 (97%) followed by BD 9064 (96%), BD 9070 (95%) and BD 9064 (95%). The lowest relative 1000-seed weight was in BD 9093 (92%) and in BARI Sarisha 13 (92%).At 7.5 dS/m salinity level BD 9064 performed better (93%) and BARI Sarisha 13 performed least (83%) in terms of relative 1000-seed weight. At 10 dS/m salinity level, BD 9064 produced the highest relative 1000-seed weight (89%) and BARI Sarisha 14 produced the lowest relative 1000-seed weight (72%).

Seed yield

Seed yield is the function of number of siliqua/plant, seeds/siliqua and 1000-seed weight. Changes in any of the characters due to salinity would provide a detailed appraisal for the response for lower seed yield in salinized mustard plants. An negative relationship was expressed between salinity levels and seed yield. Higher the salinity levels lower was the yield. In case of seed yield of eight genotypes, BD 9093 performed better. At 5 dS/m salinity level, the relative yield was found highest in BD 9093 (99%) followed by BARI Sarisha 13 (96%) and Daulat (95%). The lowest relative yield was found in BD 9070 (81%). At 7.5 dS/m salinity level BD 9093 also performed better (84%) in respect of relative seed yield and the lowest was found in BD 9070 (50%). At 10 dS/m salinity level, yield was decreased drastically in all the genotypes but BD-9093 performed better than other genotypes. This result indicates that salinity greatly reduced the yield of all the genotypes at high salinity level.

Conclusion

The salt tolerance at seedling stage in mustard genotypes performed in Hoagland solution culture showed consistent result with that done under pot culture. Among the eight genotypes, BD 9093 performed better at all the salinity level. The experiment should be repeated in the next year with chemical analysis for final confirmation.

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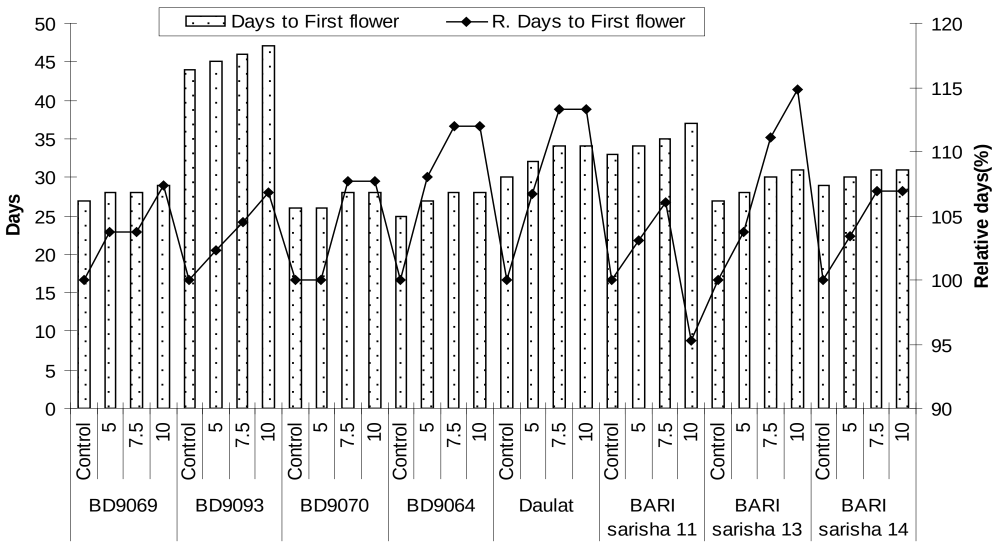

Fig .1.Effect of salinity on days to flower of eight selected mustard genotypes

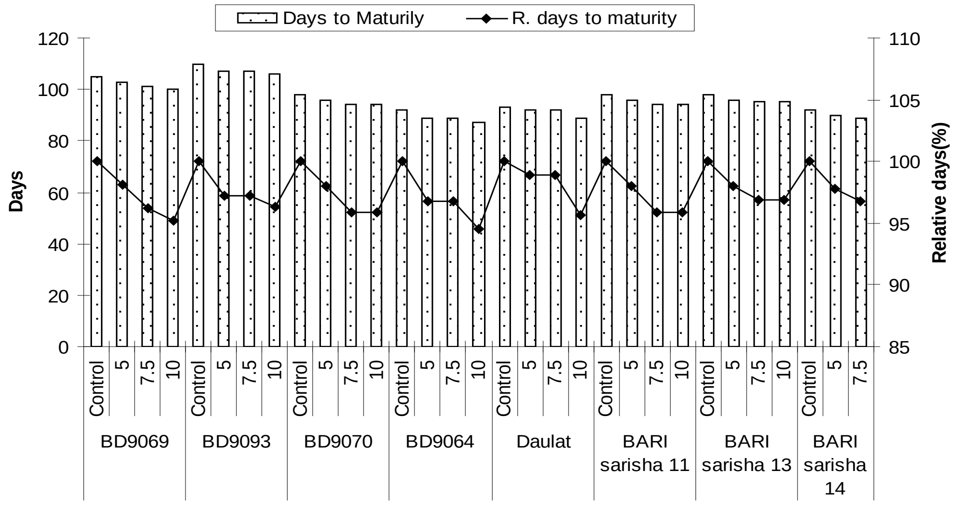

Fig . 2. Effect of salinity on days to maturity of eight selected mustard genotypes

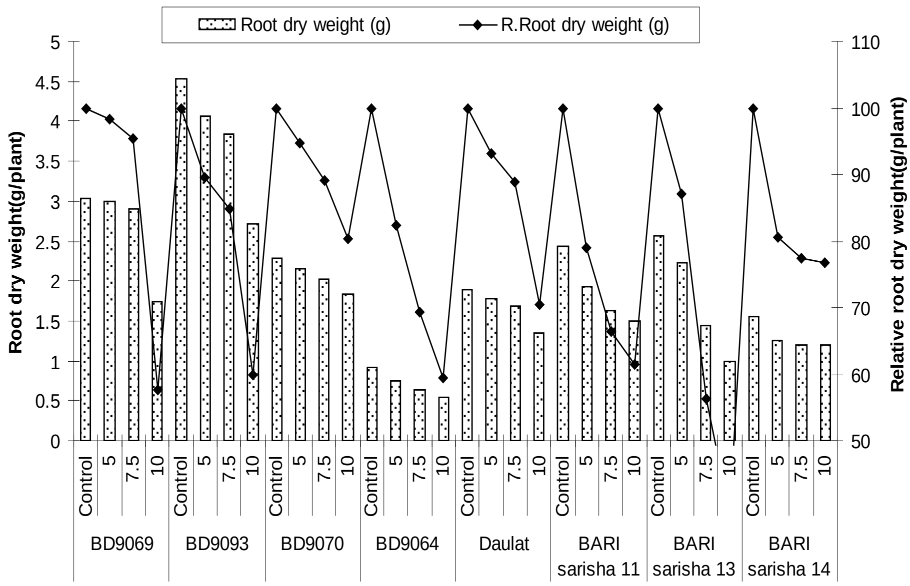

Fig .3.Effect of salinity on root dry weight of eight selected mustard genotypes

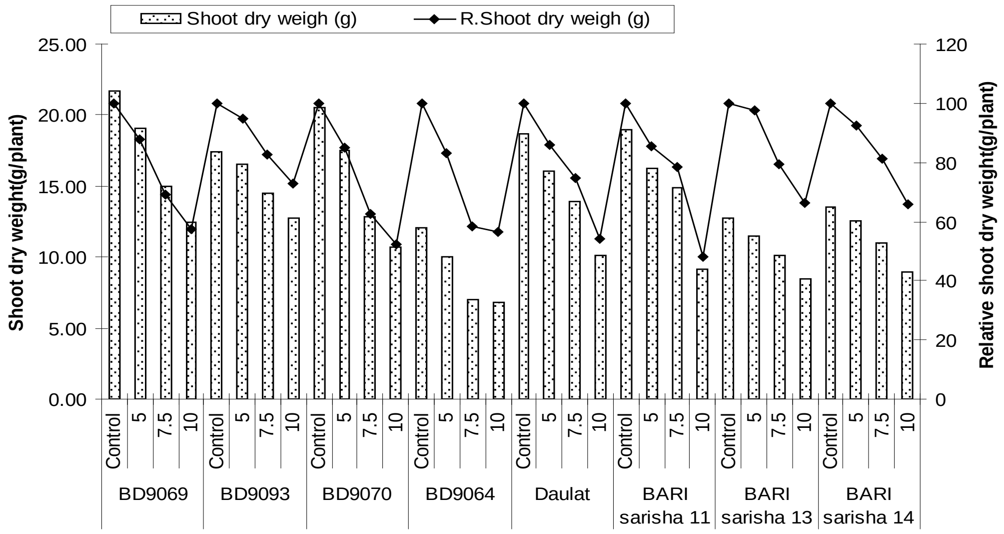

Fig .4.Effect of salinity on shoot dry weight of eight selected mustard genotypes

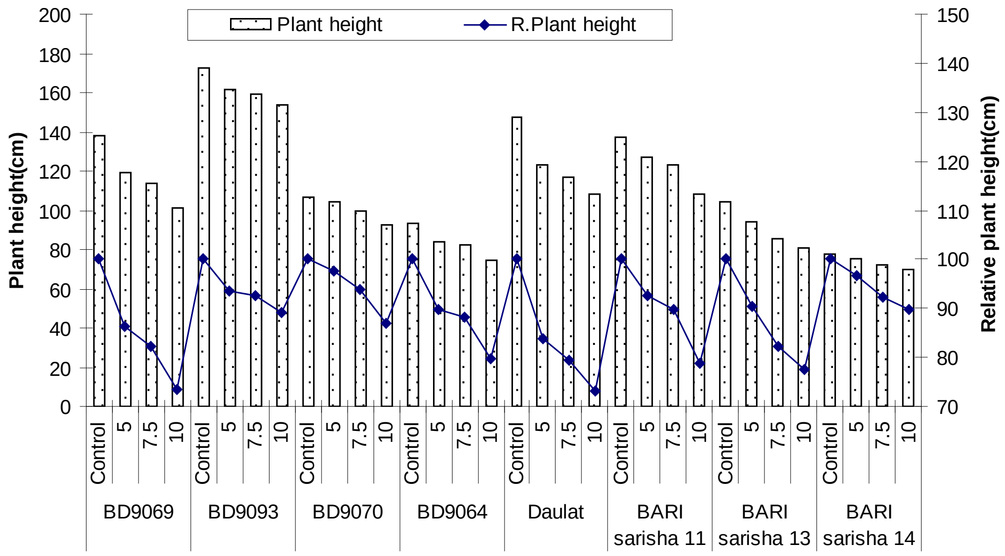

Fig .5.Effect of salinity on plant height of eight selected mustard genotypes

Table 1.Effect of salinity on yield components of selected mustard genotypes

Genotypes	Siliqua/plant (no.)				Seeds/siliqua (no.)			
	Control	5	7.5	10	Control	5	7.5	10
BD 9069	183.67	170.00 (93)	163.33 (89)	136.67 (74)	17.67	16.33 (89)	14.67 (83)	13.00 (72)
BD9093	211.00	190.00 (90)	145.33 (69)	122.00 (58)	20.00	17.00 (81)	15.67 (76)	15.00 (75)
BD9070	196.67	179.33 (91)	154.33 (78)	137.67 (70)	18.33	16.00 (89)	14.67 (83)	13.00 (72)
BD9064	172.00	132.00 (91)	116.67 (78)	93.00 (67)	21.67	19.00 (95)	16.67 (85)	14.67 (75)
Daulat	110.00	96.67 (88)	81.33 (74)	71.33 (65)	15.33	14.33 (93)	13.67 (93)	11.00 (73)
BARI Sarisha 11	125.67	115.00 (92)	89.67 (71)	78.33 (62)	15.33	13.67 (93)	13.33 (87)	10.33 (67)
BARI Sarisha 13	56.33	45.00 (80)	41.67 (74)	32.67 (58)	28.33	23.67 (86)	21.00 (75)	17.33 (61)
BARI Sarisha 14	73.67	67.33 (91)	47.33 (64)	41.67 (57)	25.00	22.00 (86)	20.33 (80)	18.67 (76)
$LSD_{(0.05)}$	13.74				1.442			
CV (%)	7.33				5.19			

Values in parenthesis show relative value over control, Calculated as [(value of parameter/ value of control) x 100]

Continued Table 1.

Genotypes	1000 seed weight (g)				Seed yield/plant(g)			
	Control	5	7.5	10	Control	5	7.5	10
BD 9069	3.67	3.53 (96)	3.21 (87)	3.05 (83)	6.00	5.45 (91)	4.22 (70)	3.16 (53)
BD9093	4.05	3.74 (92)	3.54 (87)	3.14 (77)	6.58	6.52 (99)	5.54 (84)	4.53 (68)
BD9070	3.57	3.40 (95)	3.13 (88)	3.05 (85)	4.65	3.77 (81)	2.31 (50)	1.91 (41)
BD9064	3.43	3.26 (95)	3.17 (93)	3.05 (89)	3.93	2.63 (90)	1.98 (68)	1.76 (60)
Daulat	3.63	3.17 (87)	3.10 (85)	2.83 (78)	5.00	4.73 (95)	3.15 (63)	2.48 (50)
BARI Sarisha 11	3.75	3.65 (97)	3.34 (89)	2.91 (78)	4.36	3.63 (83)	3.61 (83)	2.59 (59)
BARI Sarisha 13	3.75	3.45 (92)	3.13 (83)	3.01 (80)	3.06	2.96 (96)	2.46 (80)	1.51 (49)
BARI Sarisha 14	3.75	3.47 (93)	3.26 (87)	2.70 (72)	4.15	3.90 (94)	2.94 (71)	1.96 (47)
$LSD_{(0.05)}$	0.1459				0.1079			
CV (%)	2.65				5.19			

Values in parenthesis show relative value over control, Calculated as [(value of parameter/ value of control) × 100].

SCREENING OF CHICKPEA GENOTYPES AGAINST SALINITY STRESS

Md. Shaheenuzzamn and M. A. Malek

Abstract

Seventy genotypes of chickpea were tested during germination and seedling stage at 0, 5, 10 and 15 dS/m salinity levels in Hogland souliton culture. Distilled water (0 dS/m) was used as a control. Germination percentage (GP), relative germination percentage (RGP), germination rate (GR), relative germination rate (RGR), root length (RL), relative root length (RRL), shoot length (SL), relative shoot length (RSL), vigor index, total dry matter (TDM) and relative total dry matter (RTDM) were found to be affected by salinity. Genotypes BD-6061, BD-6066 BD-6071, BD-6060, BD-6067 and BD 6078 showed better performance at 10 dS/m and survived up to 15 days after germination as evaluated on the basis of germination percentage (GP), relative germination percentage (RGP), total dry matter (TDM) and relative total dry matter (TTDM). These genotypes can be selected for further investigation under pot culture.

Introduction

Out of 2.85 million hectares of the coastal and off shore areas about 1.00 millions hectares are arable lands, which cover over 30% of the total cultivable lands of Bangladesh. The cultivable areas in coastal districts are affected with varying degrees of soil salinity. Agricultural land use in these areas is very poor, which is roughly 50% of the country's average (Petersen and Shireen, 2001). Salinity causes unfavorable environment and hydrological situation that restrict normal crop production throughout the year. In general, soil salinity is believed to be mainly responsible for low land use as well as cropping intensity in the area (Rahman and Ahsan, 2001). Salinity in the country received very little attention in the past. Increased pressure of growing population demand more food. Thus it has become increasingly important to explore the possibilities of increasing the potential of these (saline) lands for increased production of crops.

Chickpea (*Cicer arietinum* L.) is the fifth most extensively planted grain legume (D'amorea *et al.*, 1996). Being an important source of human and animal food, the crop also plays an important role in the maintenance of soil fertility, particularly in southern regions (Saxena, 1990). A major constraint on chickpea production in coastal area is soil salinity, predominately due to chloride and sulphate accumulation in saline area. Although some soils are naturally saline, the secondary salinization largely about by the use of irrigation systems, that is the greatest threat to legume sustainability in southeast regions, where water supplies are limited, irrigation is essential to improve poor crop yields. As with many other pulses, chickpea is a salt-sensitive crop and yields are seriously reduced particularly by chloride salinity (Manchanda and Sharma, 1990.) The effects of salinity on chickpea are wide ranging. Seed germination is delayed and reduced and vegetative plant growth is suppressed under saline conditions (Sharma *et al.,* 1982 and Yadav *et al.,* 1989). Recent strategies of this Institute are to develop salt tolerant genotype of Chickpea to cope with the need of the country for better utilization of salt affected areas by fitting salt tolerant genotypes. The objective of this experiment was to evaluate chickpea genotypes for their salt tolerance.

Materials and Methods

The experiment was conducted during the period from December 13, 2010 to May 13, 2011 at the Crop Physiology Laboratory, Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Gazipur. Seeds of seventy genotypes of chickpea were collected from Plant Genetics Resource Center (PGRC), BARI, Joydebpur, Gazipur and subjected to attained different salinity levels. The experiment assessed the germination and seedling growth of chickpea genotypes at different NaCl salinity levels. Four NaCl concentrations vij. 0 (control), 5, 10, and 15 dS/m and 70 genotypes were used as treatment variables. The salt solution was prepared by calculating amount of NaCl in distilled water. Hongland solution was used as nutrient media with the salt solution. The P^H of Hongland solution was maintained 6-7. Plastic pots were used in the experiment with a diameter of 10 cm and arranged in a completely randomized design (CRD) with three replications. Each pot was supplied with 500 ml of the respective treatment solution. Seeds were sown on the plastic pots having bolting paper. The germination count was started after 72 hours of sowing and continued till the 13^{th} day. A seed was considered to have germinated when both the plumule and the radicle emerged > 0.5cm. After 15 days, the shoot and the root length of ten randomly selected seedlings from each replicate were measured following a draftsman ruler (Azhar and McNeilly, 1987).

Germination rate (GR): the average number of days needed for plumule or radicle emergence was calculated as (Lemma Desalegne, 1996):

$$\text{Germination Rate} = \frac{\text{NTn3} + \text{NTn6} + \text{NTn9} + \text{NTn12}}{\text{Total number of seeds germinated}}$$

Where: Tn = number of seeds germinated at day 3, 6, 9, 12

N = days (3, 6, 9, 12)

The plants were then collected from the pots and the following measurements were done

i. Root height (cm).
ii. Shoot height (cm)
iii. Shoot to root ratio
iv. Vigor index
v. Oven dry-weight of plant (g).

Relative indices were than calculated as follows:

$$\text{Relative Germination Percentage (RGP)} = \frac{\text{Germination of stressed seedlings} \times 100}{\text{Seedling height of control seedlings}}$$

$$\text{Relative Germination Percentage (RGP)} = \frac{\text{Germination of stressed seedlings} \times 100}{\text{Seedling height of control seedlings}}$$

$$\text{Relative Total Dry Matter} = \frac{\text{Dry - matter of stressed seedlings} \times 100}{\text{Dry - matter of control seedlings}}$$

Statistical Analysis

Data analysis was carried out by SAS package where two ways analysis of variance (ANOVA) and correlation analysis were employed. Prior to data analysis, shoot-to-root ratio (SRR) was log transformed. At 15 dS/m, almost all genotypes of chickpea were collapsed after germination. Consequently, the incomplete data obtained from these salinity levels had been excluded from the data Analysis of germination percentage (GP), relative germination percentage (RGP), germination rate (GR), relative germination rate (RGR), root length (RL), relative root length (RRL), shoot length (SL), relative shoot length (RSL), total dry matter (TDM) and relative total dry matter (RTDM) were measured.

Results and Discussion

Germination Percentage

At different salinity levels, the germination percentage (GP) and the relative germination percentage (RGP) were shown in Fig.1 and Fig 2. A variation in the germination of chickpea genotypes under salinity was observed. NaCl salinity stress decreased the rate of germination percentage at higher salinity level (15 dS/m). It was observed from Fig. 1 and Fig. 2 that the genotypes BD-6060, BD-6071, BD-6078, BD-6080, BD-6084, BD-6089, BD-6093, BD-6094, BD-6095, BD-6184, BD-6296 and BD-6309 were given higher (50-60 %) germination percentage at salinity level 10 dS/m. On the contrary, the genotypes BARI Chola-3, BARI Chola-4, BARI Chola-6, BARI Chola-7, BD-6035, BD-6040, BD-6041, BD-6046 and BD-6045 gave lower germination percentage. Genotypes BD-6089, BD-6093, BD-6094, BD-6095, BD-6108, BD-6208, BD-6284, BD-6289, BD-6295 and BD-6296 gave 30-50 % germination and lower RFGP (%) at 15 dS/m. Salinity level resulted in reduced germination percentage in all most all genotypes. Similar results were reported in triticale (Norlyn and Epstein, 1983), oats (Verma and Yadava, 1986), rice (Lee *et al*., 1998), durum wheat and tef (Tekalign Mamo *et al.*, 1996). Salt stress delayed the rate of germination. The effect being more pronounced at higher salinity levels. This is in agreement with the reports Hunt (1965) or in intermediate wheat grass, spring wheat Ashraf and McNeilly (1988) Singh *et al.*, (1999) in pearl millet, Horst and Dunning (1989) in perennial rye grass, and Marambe and Ando (1995) in sorghum.

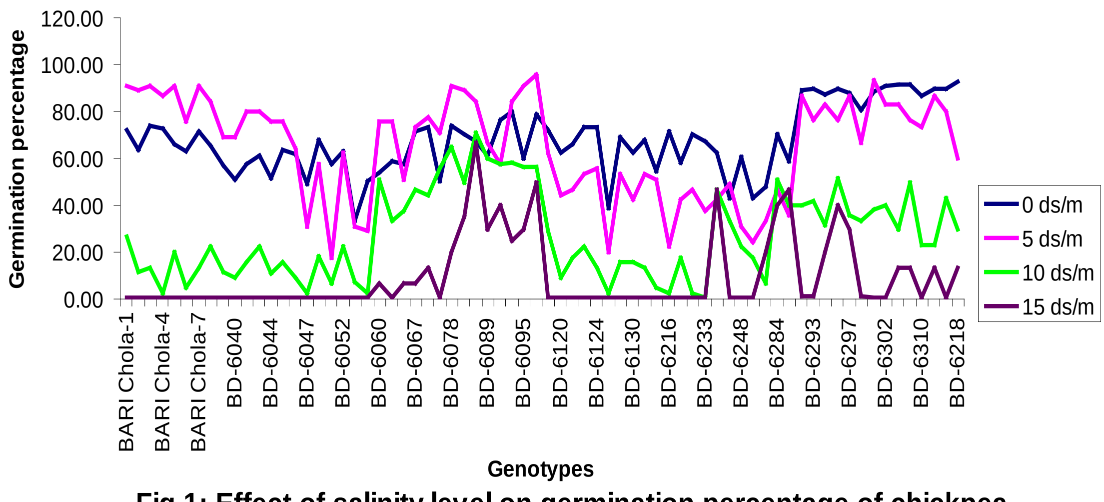

Fig.1: Effect of salinity level on germination percentage of chickpea genotypes

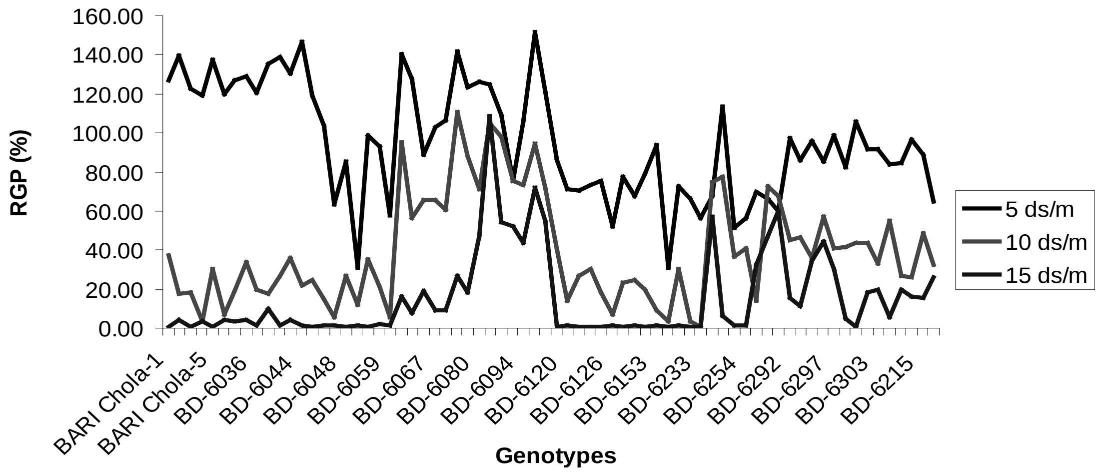

Fig. 2 :Effect of salinity levels (5,10 & 15 ds/m) on relative germination percentage of chickpea genotypes

Germination Rate (GR)

The highest germination rate (7.8) was found in genotype BD-6040 followed by BARI Chola-1 (7.5), BARI Chola-2 (7.54), BARI Chola-3 (7.51), BD-6041(7.66), BD-6044 (7.52) and BD-6048 (7.58) at higher level of salinity (10 dS/m). The lowest germination rate was found in genotype BD-6068 (6.48) followed by BD-6117 (6.66), BD-6126 (6.70), BD-6093 (6.70), BD-6129 (6.70) and BD-6122 (6.74) at same level of salinity on the basis of germination rate (Fig. 4) and relative germination rates (RGR) were reduced at higher level (15 dS/m) of salinity (Fig. 5).

The rate of germination was decreased with increasing salinity levels. The results agreed with those of Kumar *et al*. (1981), Abel and Macenzle (1964), Paliwal and Maliwal (1972), Al-Moaikal (2006), Varshney and Baijal (1977) and Basalah (1991) who reported that salinity decreased the rate of germination and emergence.

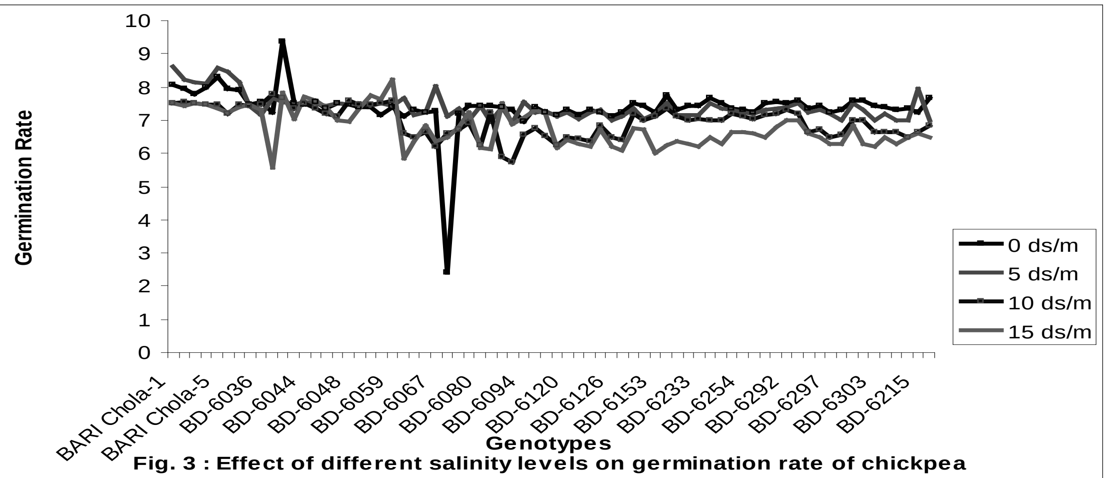

Fig. 3 : Effect of different salinity levels on germination rate of chickpea geotypes

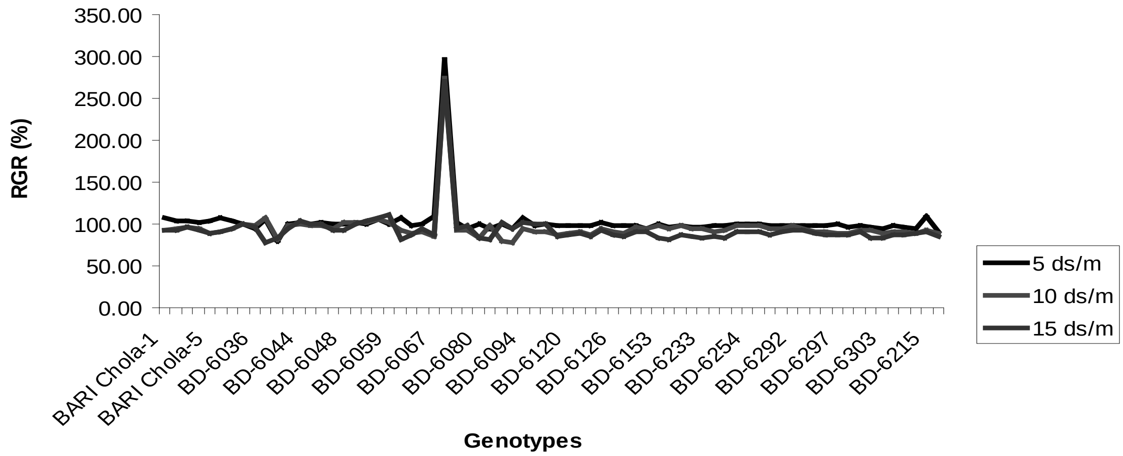

Fig. 4 :Effect of salinity on relative germination rate of chickpea genotypes

S

Seedling Root Length

The highest seedling root length (SRL) was found in genotype BD-6284 (12.52 cm) followed by BD-6078 (10.50 cm), BARI Chola-7, BD-6042, BD-6045, BD-6060, BD-6084, BD-6117, BD-6130 and BD-6245 at 10 dS/m (Fig. 5). Increasing salinity levels there were decreased the plant relative root length (Fig. 6) as observed in the study.

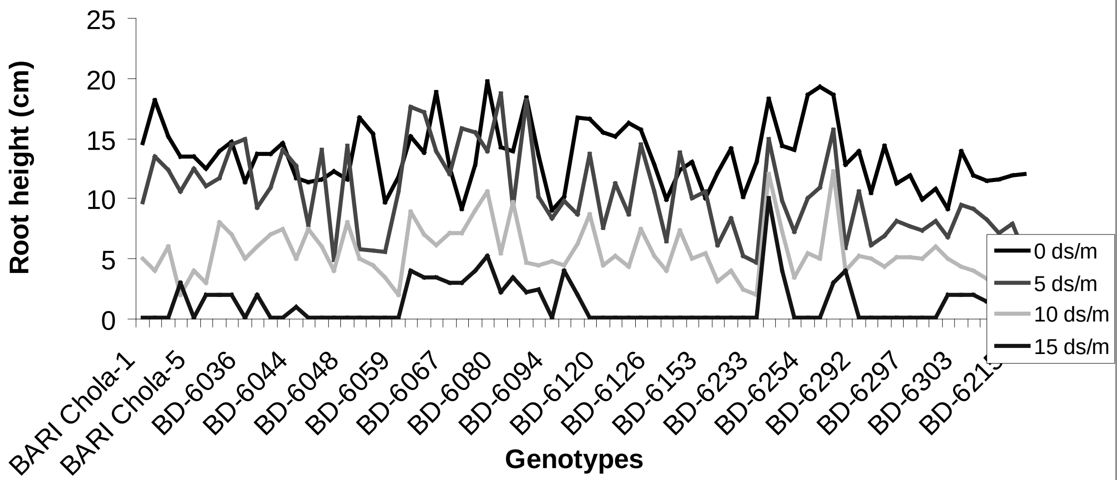

Fig. 5: Effect of salinity levels on root length (cm) of chickpea genotypes

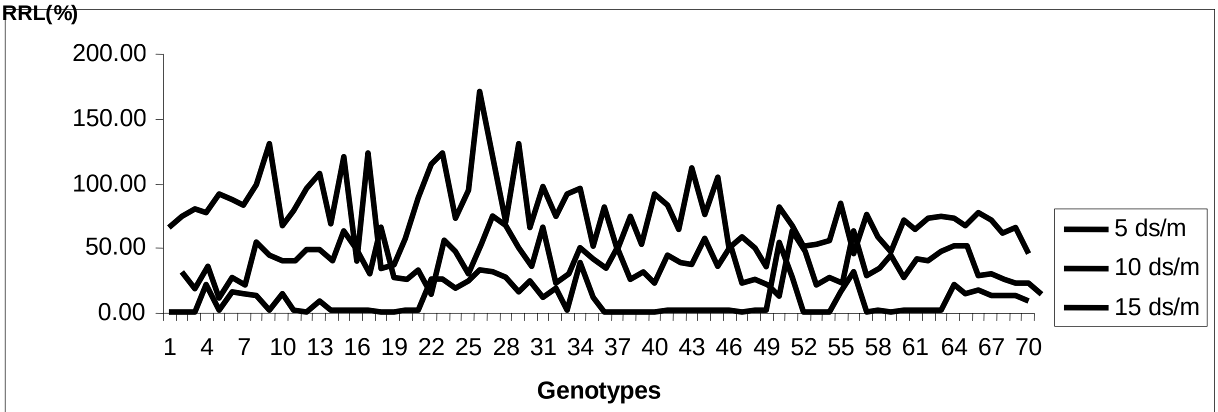

Fig. 6 : Effect of salinity levels (5,10,15 ds/m) on relative root lenght of chickpea genotypes

Seedling Shoot Length

The highest seedling shoot length (SSL) was found in genotype BD-6208 (15.50 cm) followed by BD-6295, BD-6303, BD-6060, BD-6066, BD-6067, BD-6071, BD-6078, BD-6080, BD-6084, BD-6284, BD-6292, BD-6295, BD-6226 and BD-6297 at 10 dS/m. The lowest seedling shoot length was found in genotype BARI Chola-4 followed by BARI Chola-3, BD-6035, BD-6216 and BD-6094 (Fig. 8). At 15 dS/m salinity level, most of the genotypes were failed to survive up to 15 days except BD-6060, BD-6061, BD-6066, BD-6068, BD-6071, BD-6078, BD-6080, BD-6084, BD-6089, BD-6093, BD-6284, BD-6289, BD-6302, BD-6303, BD-6309 and BD-6310. The relative shoot lengths (RSSL) were reduced with increasing salinity levels (Fig. 8).

The root and shoot lengths are the most important parameters for salt stress because roots are in direct contact with soil and absorb water from soil and shoot supply it to the rest of the plant. For this reason, root and shoot length provides an important clue to the response of plants to salt stress (Jamil and Rha, 2004). Salt stress inhibited the seedling growth (root and shoot length) but root length was more affected than shoots length .Inhibition of plant growth by salinity may be due to the inhibitory effect of ions. The reduction in root and shoot development may be due to toxic effects of the NaCl used as well as unbalanced nutrient uptake by the seedlings. High salinity may inhibit root and shoot elongation due to slowing down the water uptake by the plant (Werner and Finkelstein, 1995) may be another reason for this decrease. Neumann (1995) indicated that salinity can rapidly inhibit root growth and hence capacity of water uptake and essential mineral nutrition from soil. From the study, it was found that salt stress inhibited the growth of root more than shoot in all chickpea genotypes. The findings of the present study are in accord with findings of Demir and Arif (2003) who reported that the root growth was more adversely affected compared to shoot growth by salinity. Hussain and Rehman (1997) also reported that the roots of seedlings were more sensitive than the shoots.

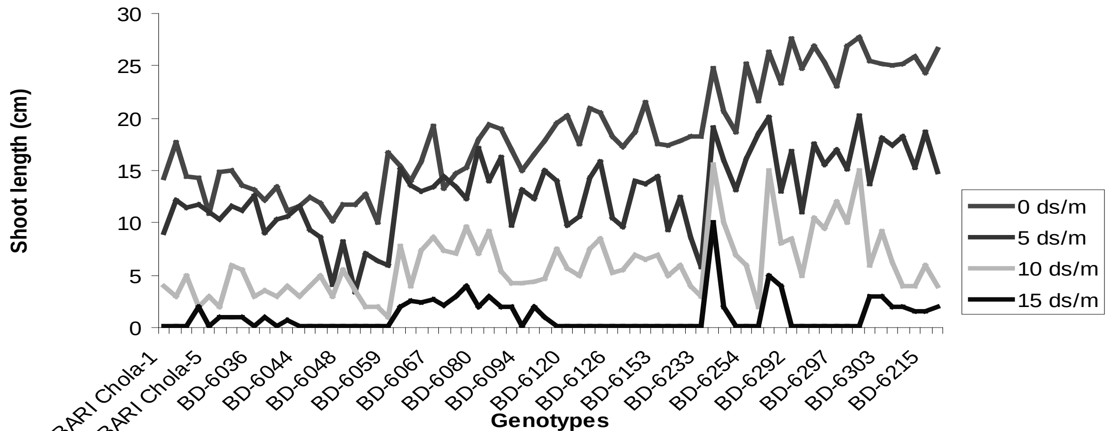

Fig. 7 : Effect of salinity levels on seedling shoot length (cm) of chickpea genotypes

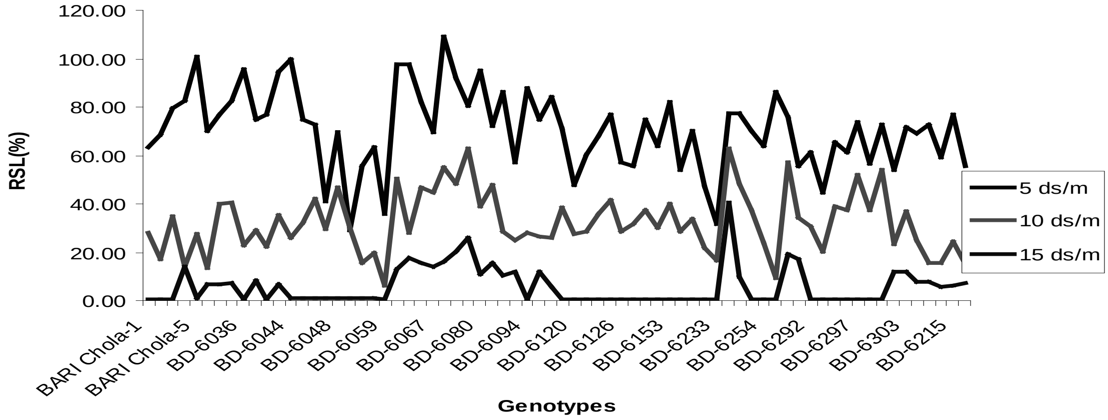

Fig. 8 : Effect of salinity levels (5,10 &15) on relative shoot lenght of chickpea genotypes

Seedling Shoot-To-Root Ratio (SRR)

The highest SRR was found in genotype BD-6248 (150.80) followed by BD-6066, BD-6297, BD-6123 and BD-6078 (Fig. 9). The lowest SRR were found in genotypes BD-6049 (48.97) followed by BD-6048 (48.83), BD-6059 (49.36), BD-6041 (56.26), BARI Chola-5 (58.89) and BD-6047 (60.58) and relative shoot-to-root ratio (RSRR) was reduced with increasing salinity levels (Fig.10).

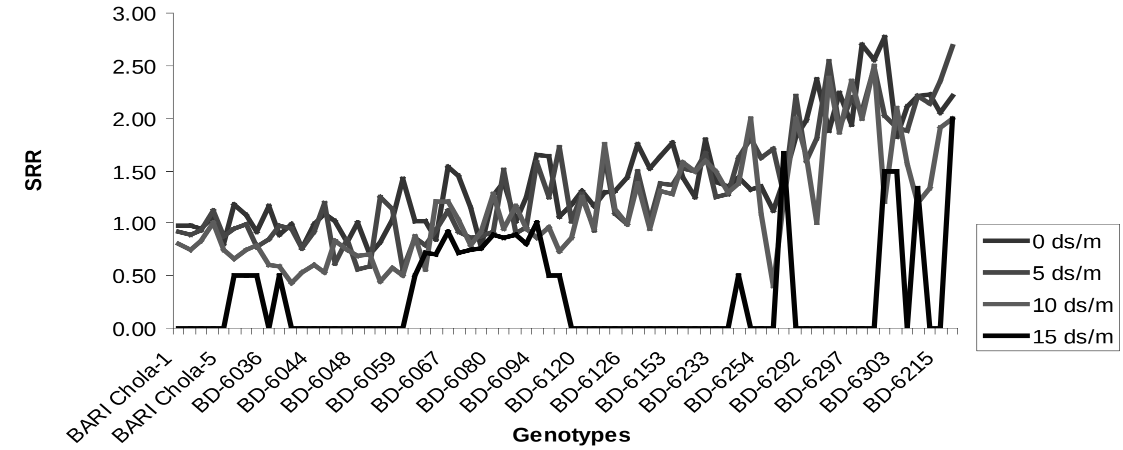

Fig. 9: Effect of salinity levels on shoot to root ratio of chickpea genotypes

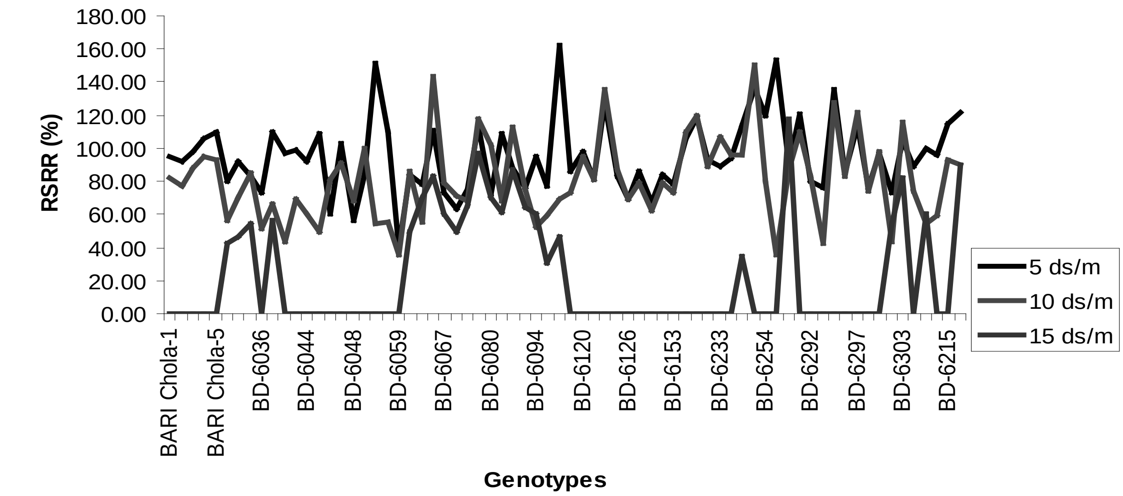

Fig.10: Effect of salinity levels (5, 10 &15 ds/m) on the relatives SRR of chickpea genotypes

Vigor Index

From Fig.11, It was observed that lower levels (5 ds/m) of salinity, vigor index was influenced in some of chickpea genotypes but increasing salinity levels, vigor index was decreased. The highest vigor index was observed in genotypes BD-6060, BD-6061, BD-6078, BD-6066, BD-6067, BD-6301 and BD-6218 at 10 ds/m which were grater than 500 but less than 1000. Vigor index were decreased in some genotypes of chickpea at 15 dS/m. So chickpea is very much sensitive to salinity. Lauter and Munns (1986) reported that chickpea is susceptible to salinity, especially during germination. The results are agreement with them.

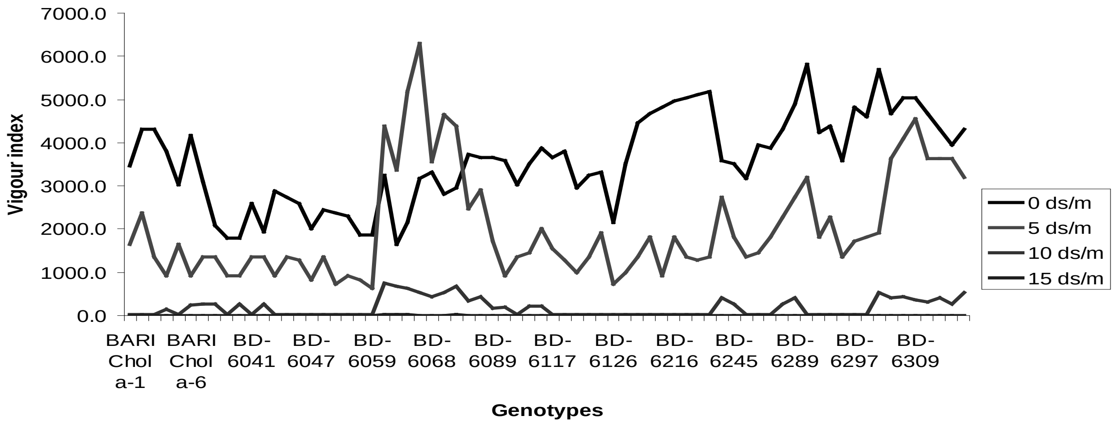

Fig. 11 : Effect of salinity levels on vigour index 0f chickpea genotypes

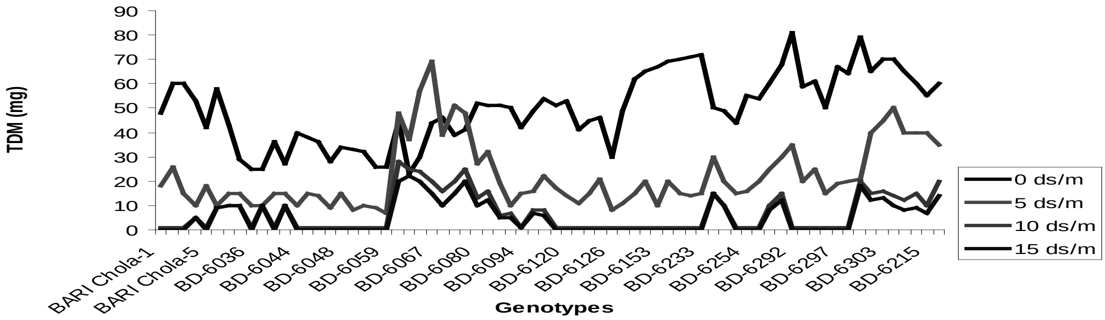

Fig. 12 :Effect of salinity levels on total dry matter of chickpea genotypes

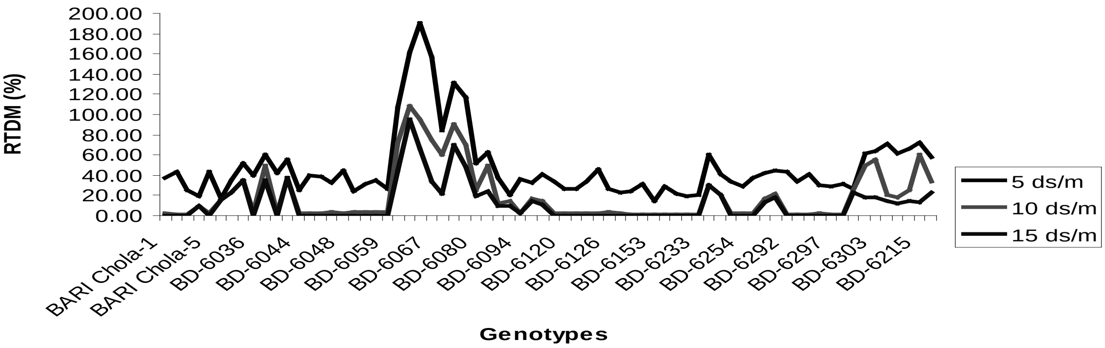

Fig.13:Effect of salinity levels on relative TDM of chickpea genotypes

Total Dry Matter

The higher total dry matter and RTDM (Fig.13 & Fig. 14) was observed in genotype BD-6061, BD-6066 and BD-6071 at all levels of salinity.

All the genotypes were then categories as tolerant (0-3), moderately (4 &5), susceptible (6-7) and highly susceptible (8-9) based on 0-9 scale. The scales measured from RDM of genotypes were as follows:

Table 1. Salinity types at different scale

Scale	RDM (%)	Tolerance Group
0 1 2 3	> 120 110-120 100-110 90-100	Tolerant
4 5	80-90 70-80	Moderately Tolerant
6 7	60-70 50-60	Susceptible
8 9	40-50 <40	Highly Susceptible

Source: Ashraf and Waheed, 1990

All the genotypes examined in this study were classified into ten groups based on 0-9 scale (Table.1), on the basis of their performance in relative total dry matter (RTDM).

At 10 dS/m NaCl there were 3 genotypes that produced greater than 90 % RTDM, 3 genotypes that had 70-90 %, 6 genotypes had 50-70 % and 58 genotypes had < 50 % RTDM. Among the 70 genotypes, at 10 dS/m the tolerant was 4 %, moderately tolerant 4 %, susceptible 9 % and highly susceptible 73 % (Fig. 14).

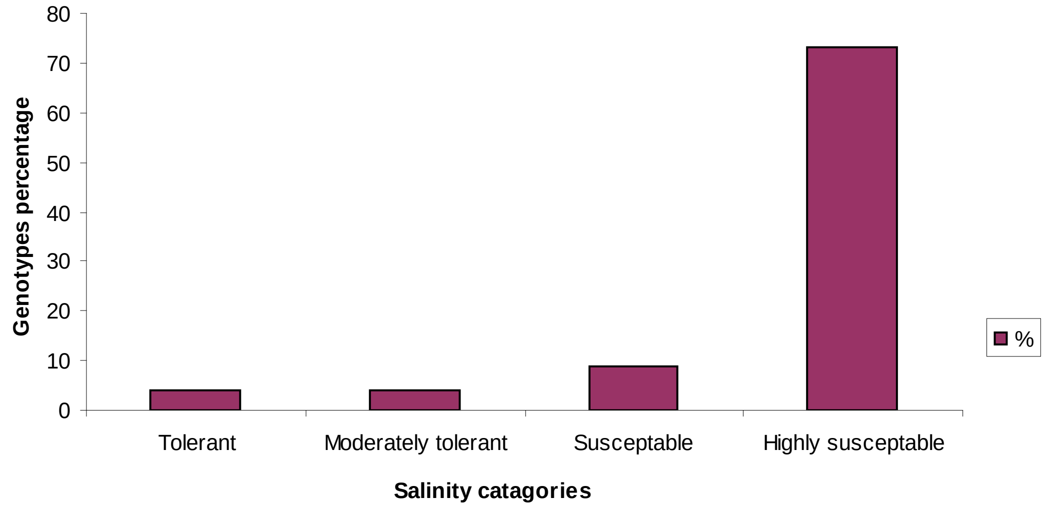

Fig.14: Percentage of salinity tolerance of 70 chickpea genotypes

It is now evident that the existence of genetic variation in salt tolerance is a prerequisite for development of salt tolerant cultivars through selection/ or breeding. To explore such variation in chickpea 70 genotypes were screened at the early stages, as salt tolerance throughout these stages is crucial for establishment of a crop in saline environment.

The result presented in this study deal with the salt tolerance of the genotypes at the vegetative growth stage. The tolerance observed in the 3 genotypes at 10 dS/m NaCl may or may not be conferred at the adult stage. Nevertheless tolerance observed at the vegetative stage is of great important because it has been emphasized by many workers that the assessment of salt tolerance at vegetative stage of a plant species is considerable value in determining the ultimate tolerance of the species (Akber and Yabuno, 1974; Ashraf and MeNeilly, 1987). Therefore, knowing the tolerance which was observed at vegetative stage of some genotypes would be of considerable economic value for crop establishment on salt affected soil.

Conclusion

The salt tolerant genotypes found in the diverse germplasm of chickpea could be of considerable economic value in increasing yield on saline areas with moderate salinity, provided the genotypes are still tolerant when adult and also have adaptability to other factor in counted in salt affected soils. The genotypes BD-6061, BD-6066 BD-6071, BD-6060, BD-6067 and BD 6078 should be tested in pot experiment for conformation in the next season.

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INFLUENCE OF MULCH MATERIAL ON SALINITY MANAGEMENT OF PIT BASED CROP

R. R. Saha, A.K.M. H. Rahman, P. K. Sarder, M. K. Bashar and M. A. Aziz

Abstract

The experiment was conducted at ARS Benarpota, Satkhira, Dakope MLT site, Khulna and Kuakata MLT site, Potuakhali during late rabi seasons of 2009-10 and 2010-11 to produce better crop yield under salinity stress by manipulating existing soil moisture through suitable mulching. Five mulch treatments viz. no mulching (control), bran mulch, straw mulch, sawdust mulch and polyethylene (black) mulch were included in the experiment. Four pit based crops viz. water melon, sweet gourd, bitter gourd and lady's–finger were selected as test crop at Benarpota and Dacope. At Kuakata, three crops viz. sweet gourd, bitter gourd and lady's-finger were used as test crop. At Benarpota, all the crops i.e., water melon, sweet gourd, bitter gourd and lady's-finger showed maximum yield by using straw mulch. At Dacope, water melon, sweet gourd and bitter gourd yielded maximum by using saw dust as mulch material but lady's-finger yielded maximum by using straw mulch. At Kuakata, the highest yield obtained from sweet gourd, bitter gourd and lady's-finger by using bran, straw and polyethylene mulch, respectively. Across over the locations and years it indicated that pit based crop i.e., water melon, sweet gourd, bitter gourd and lady's finger yielded better by using straw mulch followed by saw dust and bran mulch.

Introduction

In Bangladesh about 2.85 million hectare of land under coastal zone and during the dry season (November to March) surface layer of the soil dries up due to evaporation and the saline water from the under ground moves up by capillary forces (Aziz *et al*., 2009). Three types of stress i.e. soil moisture stress, specific ion toxicity and nutrient ion imbalance are associated with saline habitat may affected crop growth and yield. Among the different stress, soil moisture is the most limiting factor for crop production in saline area during rabi and pre-kharif transition period. For this reason, 71-96% land remain fellow after harvest of T.aman rice in saline areas of Khulna, Satkhira, Patuakhali and Noakhali coastal zone (Begum *et al.*, 2006). In this case, mulching may be an option for covering the soil surface with organic or inorganic materials such as straw, grass, plastic etc. to reduce evaporation, to keep down weeds and also to moderate diurnal soil temperatures. Therefore, it is essential to develop suitable management practice for restoring soil moisture in saline areas to enhance crop production.

Materials and Methods

The trial was conducted at ARS Benarpota, Satkhira, Dakope MLT site, Khulna and Kuakata MLT site, Potuakhali during late rabi seasons of 2009-10. Five mulch treatments viz. no mulching (control), bran mulch, straw mulch, sawdust mulch and polyethylene (black) mulch were included in the experiment. Four pit based crops viz. water melon, sweet gourd, bitter gourd and lady's–finger were selected as test crop at Benrapota and Dacope. On the contrary, three crops viz. sweet gourd, bitter gourd and lady's-finger were used as test crop at Kuakata.The experiment was laid out in RCB design with three replications. The unit plot size was 6mx4m for water melon and sweet gourd, 4mx2m for bitter gourd and 3mx2.8m for lady's-finger. Spacing was 2mx2m for water melon and sweet gourd, 1mx1m for bitter gourd and 60cmx40cm for lady's-finger. The experimental land was fertilized @ 80-35-75-18 kg/ha NPKS for sweet gourd and bitter gourd, 150-44-83 kg/ha NPK for water melon and 100-22-42 kg/ha NPK for lady's-finger. At Benarpota, watermelon was sown on 22 December 2009, sweet gourd on 11 January, bitter gourd and lady's-finger on 28 February 2010. At Dacope, seeds of water melon sweet gourd were sown on 15 February 2010 while bitter gourd and lady's-finger were sown on 18 and 19 February 2010, respectively. At Kuakata, seeds were sown on 6 to 8 January, 2010. Weeding, thinning and all other intercultural operations were done as and when required. Soil salinity levels of different crops field during the growing period were measured and are presented in Appendices 1-5.. Data on yield and yield components were collected and analyzed statistically and means were adjusted using DMRT.

Results and Discussion

Water melon

Plant mortality (%), number of fruits/plant, individual fruit weight and fruit yield of water melon markedly varied due to different mulch materials at Benarpota and Dacope locations (Tables 1 & 2). At Benarpota, water melon produced the highest yield i.e., 31.54 and 46.76 t/ha during 2009-10 and 2010-11, respectively by using straw mulch. It might be due to lowest salinity level by using straw mulch (Appendix 1) that may reduced the plant mortality and enhanced the fruits/plant, individual fruit weight which ultimately increased the yield. At Dacope, the highest yields 80.85 and 47.50 t/ha were recorded during 2009-10 and 2010-11, respectively by using saw dust as mulch material followed by straw mulch (73.30 t/ha). It was due to higher number of fruits/plant, individual fruit weight and the lowest plant mortality. From this study it also observed that plant mortality negatively related with water melon yield.

Sweet gourd

Yield and yield components of sweet gourd are presented in Tables 3 and 4. At Dacope, maximum plant mortality was found when polyethylene used as mulch material following control treatment in both the years. At Kuakata, plant mortality observed in control treatment (no mulch). Number of fruits/plant, individual fruit weight and sweet gourd yield differed due to using different mulch materials at all the three locations. At Benarpota, significantly the highest sweet gourd yield obtained by using straw mulch. At Dacope, sweet gourd yield was maximum by using sawdust mulch. At Kuakata, significantly the highest yield was found through using bran mulch. The lowest yield observed in control) treatment at Benarpota and Kuakata while it was lowest by using polyethylene mulch at Dacope. At Benarpota, straw mulch reduced the salinity to minimum level i.e., 2.01 to 3.64 dS/m (Appedices 1-4) and at Kuakata, all the mulch materials reduced the salinity level (around 2 dS/m) up to crop maturity where as it was (5.56 dS/m) in control treatment (Appendix 5).

Better gourd

Plant mortality (%), number of fruits/plant, individual fruit weight and bitter gourd yield markedly varied due to using different mulch materials at all the three locations (Tables 5 and 6). At Dacope, plant mortality was maximum when polyethylene used as mulched material following control treatment. At Kuakata, the highest plant mortality was found in control treatment followed by polyethylene mulch. Significantly the highest bitter gourd yield produced through using straw mulch at Benarpota and Kuakata in both the years. At Dacope, yield was maximum when saw dust was used as mulch material.

Lady's-finger

Yield and yield components of lady's-finger are presented in Table 7. At Dacope, higher plant mortality found in control treatment and polyethylene mulching. At Kuakata, the highest plant mortality found in control treatment followed by bran mulching. Weight of fruit/plant differed among the different mulching treatments at all the three locations in both years. The highest yield was obtained by using straw mulch at Benarpota and saw dust mulch at Dacope whereas yield was maximum when polyethylene used as mulch material at Kuakata,.

Conclusion

Across over the locations and years it is concluded that pit based crop i.e., water melon, sweet gourd, bitter gourd and lady's finger yielded better by using straw mulch followed by saw dust and bran mulch.

Table 1. Yield components of water melon as influenced by mulch materials at Benarpota and Dacope during rabi season of 2009-10 and 2010-11

Treatments	Plant mortality (%)			Fruits/plant (no.)				Individual fruit wt. (kg)			
	Benarpota	Dacope		Benarpota		Dacope		Benarpota		Dacope	
	2009-10	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
No mulch (control)	20.8	20.8	19.4b	0.0d	1.3d	1.7	2.7d	0.0d	1.91 a	0.0d	2.6 b
Bran mulch	52.1	15.5	12.5b c	2.0b	3.0c	1.9	2.8c	0.6b	1.04 b	0.6b	2.9 a
Straw mulch	2.1	8.3	11.1bc	3.7a	5.0a	2.0	3.1b	1.8a	0.74c	1.6a	2.9 a
Sawdust mulch	92.0	8.3	9.7c	0.0d	2.7c	2.2	3.2a	0.0d	1.03b	0.0d	2.9 a
Polyethelene mulch	75.0	33.3	31.9a	1.0c	4.0b	1.6	2.6d	1.1c	0.87c	1.1c	2.3 c

Table 2. Yield of water melon as influenced by mulch materials at Benarpota and Dacope during rabi season of 2009-10 and 2010-11

Treatments	Water melon yield (t/ha)				Average yield (t/ha) across the location and year
	Benarpota		Dacope		
	2009-10	2010-11	2009-10	2010-11	
No mulch (control)	0.00c	8.41d	40.42	35.39 a	21.05
Bran mulch	3.60b	23.65c	60.93	40.20 b	32.10
Straw mulch	31.54a	46.76a	73.30	45.60 a	49.30
Sawdust mulch	0.00c	18.75c	80.85	47.50 a	36.78
Polyethelene mulch	1.39bc	35.21d	29.85	30.15 c	24.15

Table 3. Plant mortality (%) and fruits/plant of sweet gourd as influenced by mulch materials Benarpota, Dacope and Kuakata during rabi season of 2009-10 and 2010-11

Treatments	Plant mortality (%)				Fruits/plant (no.)					
	Dacope		Kuakata		Benarpota		Dacope		Kuakata	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
No mulch (control)	8.3	15.28b	25.0	25	1.0c	1.00e	1.9	2.9 b	3.1d	1.9b
Bran mulch	4.2	12.50b	0.0	0	2.0b	2.33c	2.2	2.9 b	4.9a	2.1a
Straw mulch	0.0	9.72b	0.0	0	3.3a	4.33a	2.5	3.1 a	4.7b	2.0a
Sawdust mulch	0.0	8.33b	0.0	0	1.0c	1.67d	2.7	3.2 a	4.6c	1.7c
Polyethelene mulch	16.7	27.77a	0.0	0	2.0b	3.33b	1.7	2.5 c	4.6c	1.7c

Table 4. Yield of sweet gourd as influenced by mulch materials Benarpota, Dacope and Kuakata during rabi season of 2009-10 and 2010-11

Treatments	Sweet gourd yield (t/ha)						Average yield (t/ha) across the location and year
	Benarpota		Dacope		Kuakata		
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	
No mulch (control)	4.7c	5.11e	43.3	35.60 c	13.1d	12.06d	18.98
Bran mulch	7.0b	20.22c	59.1	40.95 b	31.8a	23.25a	30.39
Straw mulch	9.1a	44.44a	70.0	43.15 b	28.8b	22.29b	49.95
Sawdust mulch	6.0c	11.44d	81.0	48.30 a	27.1c	19.45c	28.97
Polyethelene mulch	6.6bc	30.22b	28.2	28.23 d	27.0c	19.51c	23.29

Table 5. Plant mortality (%) and fruits/plant of bitter gourd as influenced by mulch materials Benarpota, Dacope and Kuakata during rabi season of 2009-10 and 2010-11.

Treatments	Plant mortality (%)				Fruits/plant (no.)					
	Dacope		Kuakata		Benarpota		Dacope		Kuakata	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
No mulch (control)	18.8	10.58a	26.0	26.0a	0.0e	1.33e	15.3	21.5 cd	7.4d	3.2c
Bran mulch	16.7	8.00ab	100	10.11c	3.7c	3.33c	16.5	22.5 c	10.2c	3.9b
Straw mulch	16.7	6.23b	6.7	6.1d	6.0a	5.67a	16.2	27.8 b	11.1a	4.0b
Sawdust mulch	12.5	6.23b	10.0	10.10c	2.7d	2.33d	17.1	30.2a	11.1a	4.4a
Polyethelene mulch	25.0	10.77a	13.3	13.4b	4.7b	4.33b	14.3	22.0 c	10.8b	4.5a

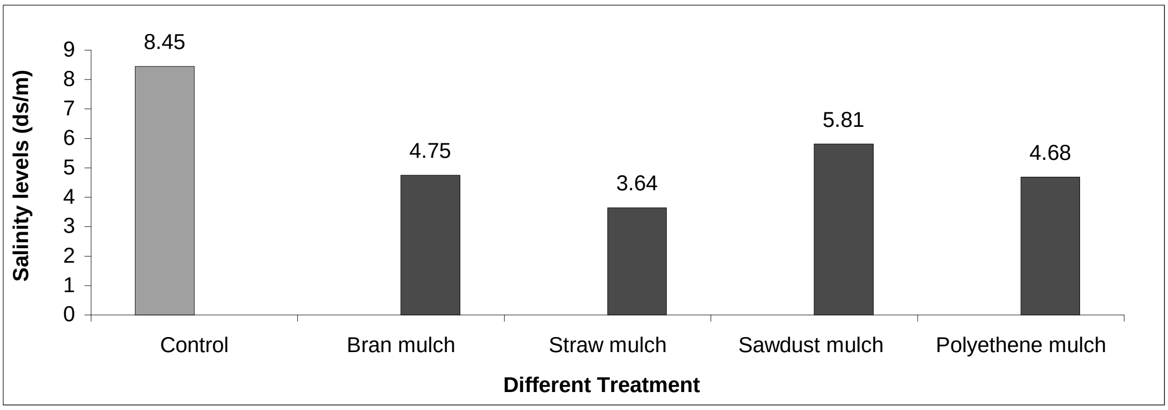
Table 6. Yield of bitter gourd as influenced by mulch materials Benarpota, Dacope and Kuakata during rabi season of 2009-10 and 2010-11.

Treatments	Bitter gourd yield (t/ha)						Average yield (t/ha) across the location and year
	Benarpota		Dacope		Kuakata		
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	
No mulch (control)	0.0d	0.28d	11.2	6.50 d	2.1e	2.05e	3.69
Bran mulch	4.3b	3.97b	12.0	7.00 c	4.4d	4.37d	6.01
Straw mulch	10.8a	10.58a	13.0	8.10 b	5.0a	4.98a	8.74
Sawdust mulch	1.5c	2.34c	14.8	9.50 a	4.8b	4.74b	6.28
Polyethelene mulch	4.0b	4.23b	10.4	5.15 e	4.5c	4.44c	5.45

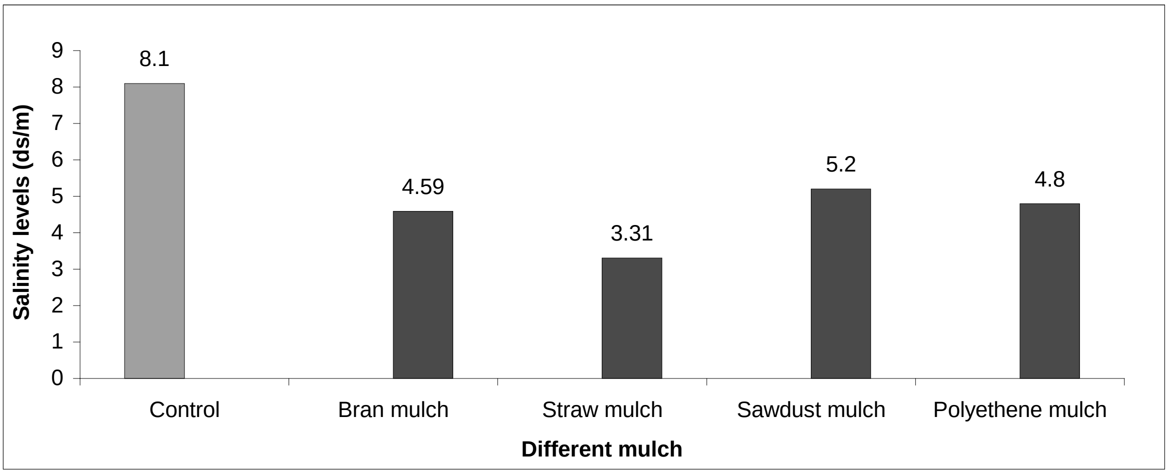
Table 7. Plant mortality (%) and yield of lady's-finger as influenced by mulch materials Benarpota, Dacope and Kuakata during rabi season of 2009-10 2010-11.

Treatments	Plant mortality (%)				Lady's-finger yield (t/ha)						Average yield (t/ha) across the locations and years
	Dacope		Kuakata		Benarpota		Dacope		Kuakata		
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	
No mulch (control)	8.75	6.74ab	20.4	19.4a	7.2e	6.54e	9.5	10.90c	4.1e	4.9e	7.18
Bran mulch	5.71	5.37b	8.0	8.5b	12.0b	12.11c	11.6	14.37a	10.5d	10.7d	11.88
Straw mulch	2.85	4.34b	4.0	4.2c	15.6a	15.51a	13.7	13.17b	12.7b	12.8b	13.91
Sawdust mulch	2.85	2.82b	4.2	4.1c	8.4d	11.38d	12.5	14.75a	11.8c	11.9c	11.79
Polyethelene mulch	8.75	10.00a	2.8	2.9d	10.1c	14.02b	8.3	10.30d	15.6a	15.7a	12.34

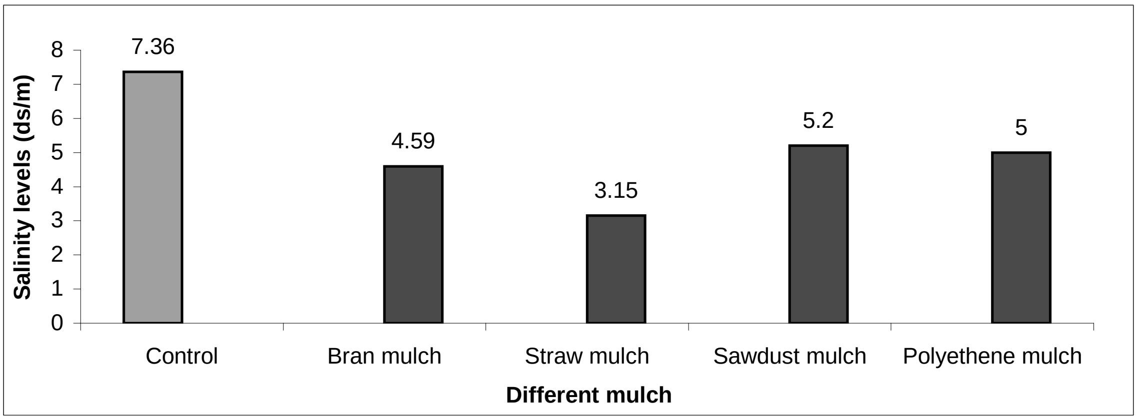
Appendix 1. Salinity levels of water melon field under different at Benerpota



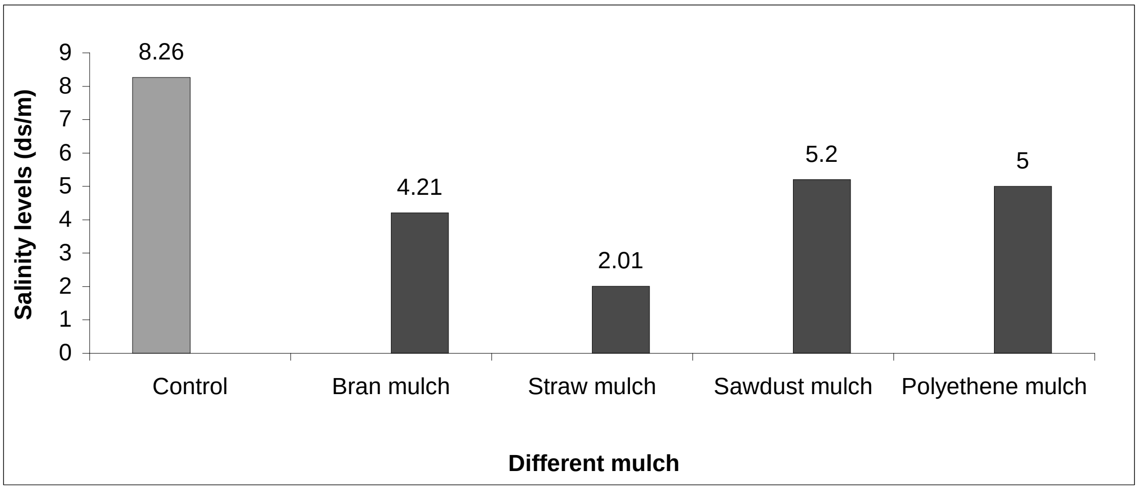
Appendix 2. Salinity levels of sweet gourd field under different at Benerpota



Appendix 3. Salinity levels of bitter gourd field under different at Benerpota



Appendix 4. Salinity levels of lady's-finger field under different at Benerpota



Appendix 5. Salinity levels during the growing periods of different crop fields under different mulch materials at Kuakata

Salinity Stress

Date	Salinity level (ds/m)				
	No mulch	Bran mulch	Straw mulch	Saw dust mulch	Polyethylene mulch
05.01.2010	0.58	0.49	0.58	0.45	0.49
15.01.2010	0.79	0.68	0.65	0.56	0.58
30.01.2010	1.02	0.86	0.89	0.87	0.98
15.02.2010	1.34	1.02	1.15	1.02	1.18
01.03.2010	2.50	1.28	1.38	1.31	1.52
15.03.2010	3.31	1.59	1.46	1.52	1.64
30.03.2010	4.46	1.89	1.60	1.71	1.68
01.04.2010	4.92	2.02	1.85	1.89	1.89
15.04.2010	5.56	2.19	1.90	1.98	1.96

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PERFORMANCE OF SALT TOLERANCE BARLEY GENOTYPES IN THE COASTAL AREA

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Abstract

The experiment was conducted at MLT site Kuakata, Patuakhali during rabi season of 2010-2011 to find out suitable barley variety for coastal area of Potuakhali. . Four varieties viz. BARI Barley 6, BARI Barley 4, BHL-18 and BHL-15 were evaluated in randomized complete block design with 3 replications under rainfed condition. The highest grain yield (1650 kg/ha) was obtained from BARI Barley 6 (1650 kg/ha) followed by BHL 18 (1618 kg/ha). The lowest yield was obtained from BHL-15 (1525 kg/ha) following BARI Barley 4 (1530 kg/ha).

Introduction

A vast area in the coastal region remains fallow after harvest of T.aman. Introduction of salt tolerant crops is the most acceptable way of intensifying crop production in these areas and for this appropriate variety has to be tried out experimentally. Since barley is relatively more salt tolerant, the crop can be grown in saline areas. For successful cultivation in coastal areas, four lines/varieties were identified under laboratory condition in Hogland solution culture as well as in pot culture at different salinity levels. The present study was conducted to evaluate the tolerance of selected barley lines/varieties to salinity in the field condition of coastal saline area in terms of yield performance.

Materials and Methods

The experiment was conducted at MLT site Kuakata, Patuakhali during Rabi 2010-2011 under rainfed condition. The experiment was conducted in a RCB design with three replications. Four varieties/lines viz. BARI Barley 6, BARI Barley 4, BHL-18 and BHL-15 were sown on 26 December, 2010 and harvested on 6 April, 2011. Unit plot size was 10 m × 5 m. Seeds were sown continuously in 25 cm row distance. Fertilizers @ 100-60-40 kg/ha N-P-K were applied as basal.

Results and Discussion

Yield and yield contributing characters are presented in Table 1. Statistically significant variations were found in all parameters except in plants/m^2, plant height and spike length. The highest number of grains/spike was recorded in BARI Barley 6 (49) which was followed by BARI Barley-4 and BHL-18 and lowest was BHL-15. Weight of 100 grain was maximum in BARI Barley-6 which was at par with that of BHL-18. The highest grain yield was obtained from BARI Barley-6 (1650 kg/ha) followed by BHL-18 (1618 kg/ha). The lowest yield was obtained from BHL-15 (1525 kg/ha) following BARI Barley-4 (1530 kg/ha). Salinity levels of the experimental plots were increased with the progressing of the time (Appendix I).

Table 1. Yield and yield contributing characters of barley genotypes during rabi 2010-2011 at Kuakata, Patuakhali

Variety	Plants/ m^2	Plant height (cm)	Spike length (cm)	Effective tillers/plant	Grains /spike (no.)	100 grain wt. (g)	Yield (kg/ha)
BARI Barley-6	58	58.7	7.6	3.6a	49 a	3.66 a	1650 a
BARI Barley-4	59	58.5	7.7	3.1b	43 b	3.33b	1530b
BHL-18	58	58.5	7.8	3.3b	45 b	3.50 ab	1618 a
BHL-15	59	58.6	7.6	3.2b	41c	3.34b	1525b
Cv (%)	NS	NS	NS	9.34	4.12	1.02	10.12

The values with same letter within a column do not differ significantly at 5% level of significance

Farmers' Opinion

1. Post harvest processing was not easy.
2. Marketing was a problem.
3. Farmers are not interested to cultivate barley.

Appendix I. Salinity levels in the experimental plots at different intervals

Dates	Salinity level (dS/m)	Dates	Salinity level (dS/m)
25.12.2010	2.93	01.03.2011	5.56
15.01.2011	3.83	15.03.2011	5.96
30.01.2011	4.12	30.03.2011	6.12
15.02.2011	4.98		

DEVELOPMENT OF ALTERNATE CROPPING PATTERN FOR COASTAL SALINE AREA OF BANGLADESH AGAINST FARMER EXISTING T. AMAN-FALLOW-FALLOW PATTERN

M.A. Aziz and A.K.M. H. Rahman

Abstract

An experiment was conducted at ARS, Benarpota, Satkhira during rabi season of 2009-2010 to improved the existing cropping pattern. Three cropping patterns viz. T.Aman (BR-33)-Wheat (Prodip)-Fallow, T.Aman (BR-33)-Mustard (BARI Sarisha-11)- Fallow and T.Aman (BR-33)-Cowpea(BARI Felon-1)-Fallow were used in the study. The grain yield was recorded 2.37, 0.90 and 1.79 t/ha from wheat, cowpea and mustard, respectively. The highest net return obtained from mustard (Tk 24800/ha) followed by wheat (Tk 21755/ha) but the highest benefit cost ratio (BCR) was found in cowpea (1.84).

Introduction

After harvest of T.aman rice in the southern part of Bangladesh a vast coastal and offshore areas remaining fallow. However, during the dry season (November through March) surface layer of the soil dries up due to evaporation and the saline water from the under ground moves up by capillary forces. Thus a considerable amount of salt from the sub soil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops is very limited due to absence of irrigation water. Previous study showed that musard, mungbean, cowpea and wheat could be grown after harvest of T.aman rcie if the land becomes free during the month of last November to early December. Cultivation of short duration T. aman rice would be the option to make the scope. Short duration variety of T.aman like BRRI dhan-33 or BINA dhan-7 which may mature 10-15 days earlier that can be grown in the existing cropping pattern. Therefore, the experiment would be carried out to develop alternate cropping pattern against farmers T.aman-fallow-fallow cropping pattern for the coastal saline area of Bangladesh.

Materials and Methods

The study was conducted at the ARS, Benarpota, Satkhira during November 2009 to May 2010. The trial was laid out in a RCB design with four replications. Three cropping patterns viz. T.Aman (BR-33)-Wheat (Prodip)-Fallow, T.Aman (BR-33)-Mustard (BARI Sarisha-11)- Fallow and T.Aman (BR-33)-Cowpea(BARI Felon-1)-Fallow were used in the study. Seeds of wheat and mustard were sown on on 23 November 2009 and cowpea on 02 January 2010. The unit plot size was 1000 m^2. Recommended doses (FRG/2005) of fertilizers for respective crops were applied. Intercultural operations were done as and when required. Data on plant population, plant height, branch/plant, pod/plant, seed/pod and grain yield/ha were recorded and analyzed statistically.

Results and Discussion

Data on plant population/m^2, plant height, number of branches/plant, pods/plant, seeds/pod, grain yield are presented in Table 1. Plant population, plant height, number of branches/pant, pods/plant, seeds/pod, grain yield were significantly varied among the tested crops. Grain yield was recorded 2.37 t/ha in wheat, 0.90 t/ha in cowpea and 1.79 t/ha in mustard. The highest net return obtained from mustard (Tk.24800 /ha) followed by wheat (Tk.21755 (/ha) and the lowest net return obtained from cowpea (Tk 17400 /ha). but the highest benefit cost ratio (BCR) was found in cowpea (1.84) due to lowest cultivation cost. Lowest salinity was recorded 5 dS/m during sowing time and it increased 15.23 dS/m during harvesting period.

Conclusion

Results revealed that T.aman-Cowpea –Fallow cropping pattern found suitable for coastal area of Satkhira. This experiment should be continued for next year including other saline area.

Table 1. Yield and yield contributing characters of cropping pattern at ARS, Benarpots, Satkhira during 2009-2010.

Treatment	Plant population/m^2	Plant height (cm)	No. of Branch or tiller per plant	No. of pod or spike per plant	No. of seed per pod or spike	Grain yield (t/ha)
Cowpa	38.33c	74.00b	3.67b	2.67b	10.33b	0.90c
Mustard	72.00b	107.00a	16.67a	268.33a	8.33b	1.79b
Wheat	146.3a	85.33b	3.00b	2.00b	47.00a	2.37a
$LSD_{(0.05)}$	7.15	18.75	3.02	65.83	6.905	0.35
CV%	3.69	9.32	17.14	31.91	13.92	10.39

Means having same or without letter do not differ significantly at 5% level

Table 2. Economic performances of different varieties on yield and yield components of Cropping pattern at ARS, Satkhira during 2009-2010

Treatment	Gross return (Tk/ha)	TVC (Tk./ha)	Net return (Tk./ha)	BCR
Cowpa	38000	20600	17400	1.84
Mustard	53700	31900	24800	1.68
Wheat	59325	37570	21755	1.58

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PILOT PRODUCTION OF HIGH VALUE CROPS THROUGH SUPPLEMENTAL IRRIGATION IN THE COASTAL AREA

M. A. Aziz, P.K. Sardar, M.M. Hossain, A. K. M.H. Rahman and M.A. Hossain

Abstract

The experiment was conducted in the farmer’s field at ARS Benarpota, Satkhira and MLT site Dacope, Khulna during 2009-10 and 2010-11. Five high value winter crops viz. watermelon, sweet gourd, ribbed gourd, cucumber and bitter gourd were included at Dacope Khulna and tomato, knolkhol, chili, sweet gourd and cabbage at Benarpota, Satkhira to evaluate the performance of tested crops in the coastal saline areas using supplemental irrigation. At Dacope, the highest yields (66.50 t/ha in 2009-10 and 46.50 t/ha in 2010-11) were obtained from watermelon in both the years. Averaged over years, the highest benefit cost ratio (BCR) was found in watermelon (2.19) due to its better yield and the lowest in ribbed gourd (1.10) at Dacope. At Benarpota, the highest yield obtained from cabbage (52.76 t/ha) during 2009-10 and from Knolkhol (55.33 t/ha) during 2010-11while chili gave the lowest yield 1.32 t/ha in 2009-10 and 3.55 t/ha in 2010-11. Two years result revealed that highest BCR (2.55) was found in sweet gourd followed by cabbage (2.44) at Benarpota and in watermelon (2.19) at Dacope.

Introduction

After harvest of T. Aman rice, in the southern part of Bangladesh, a vast area of coastal land remains fallow. During the dry season (November to March), in this region, surface layer of the soil dries up due to evaporation and the saline water moves up by capillary forces. Thus, a considerable amount of salt from the subsoil is carried to the surface and accumulates as salt crust. Scarcity of fresh irrigation water is another problem in dry rabi season resulting limited cultivation of winter crops in this area. During survey of existing crops and cropping pattern in the coastal areas, it was observed that some farmers use supplemental irrigation from reserve sources in dry season. Growing crops with supplemental irrigation increase yield as well as farmers’ economic return. Therefore, the experiment was undertaken to find out the performance of high value crops through supplemental irrigation in the coastal area of Bangladesh.

Materials and Methods

The experiment was conducted in the farmer’s field at the MLT site, Dacope, and ARS Benarpota, Satkhira during 2009-10 and 2010-11. Five crops viz. water melon, sweet gourd, ribbed gourd, cucumber and bitter gourd were taken as treatment variables at Dacope, Khulna. On the contrary, tomato, knolkhol, chili, sweet gourd and cabbage were used as the test crop at Benarpota, Satkhira. The unit plot size was 6m x 4 m. The experiment was laid out in RCB design with three replications. Seeds were sown on 18 to 28 February at Dacope and seedling of all the test crops were transplanted on 10 to 15 November at Benarpota. Recommended spacing was maintained for each crop and also recommended fertilizer doses (FRG/2005) were applied. Proper intercultural operations were taken as per crops need. Supplemental irrigations were done two to six times. Data on yield and economic evaluation of the crops were done. The lowest level of soil salinity was recorded in sowing time (1.63 ds/m) and the highest (8.75 ds/m) at harvesting period at Benerpota.

Results and Discussion

Dacope

Yield, gross return, net return and benefit cost ratio of different crops are presented in Table 1. Among the five crops the highest yield and net return was found from watermelon in both the years and the lowest yield and return from bitter gourd. Averaged over years, the highest benefit cost ratio (BCR) was observed in watermelon (2.19) due to its better yield and the lowest BCR was recorded in ribbed gourd (1.10).

Table 1. Yield and economic performance of high value crops at MLT site, Dacope during 2009-10 and 2010-11

Crops	Yield (t/ha)		Gross return (Tk/ha)		Net return (Tk/ha)		BCR	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Water melon	66.50	46.50	266000	232500	153125	117300	2.36	2.01
Sweet gourd	60.50	42.90	226875	214500	144975	73663	2.77	1.52
Ribbed gourd	15.00	10.50	105000	63000	9950	8000	1.10	1.10
Cucumber	13.00	12.30	117000	86100	3950	23900	1.03	1.38
Bitter gourd	12.10	9.00	84700	81000	21450	15700	1.34	1.24

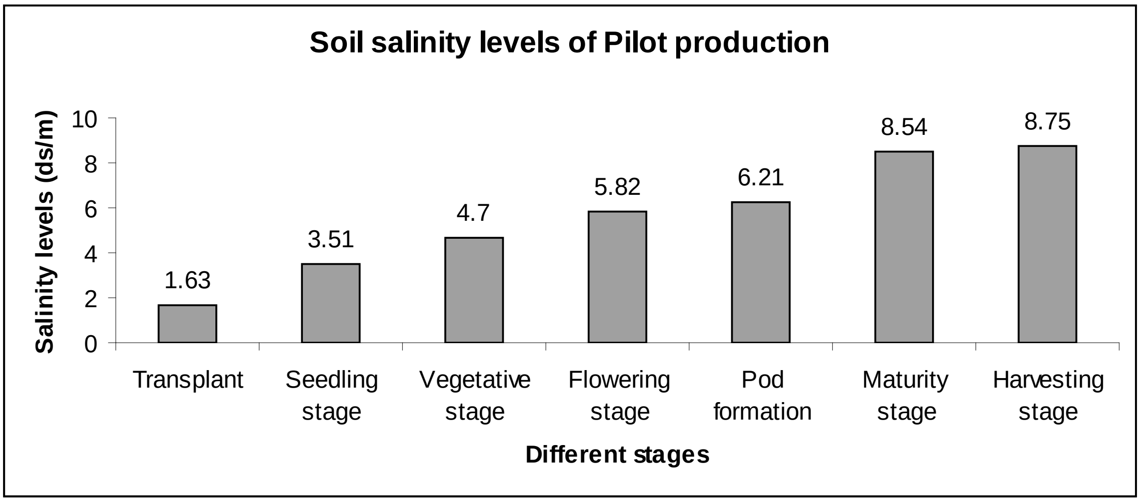
Price (Tk/kg): Water melon-5, Sweet gourd-5, Ribbed gourd-6/, Cucumber-7 and Bitter gourd- 9

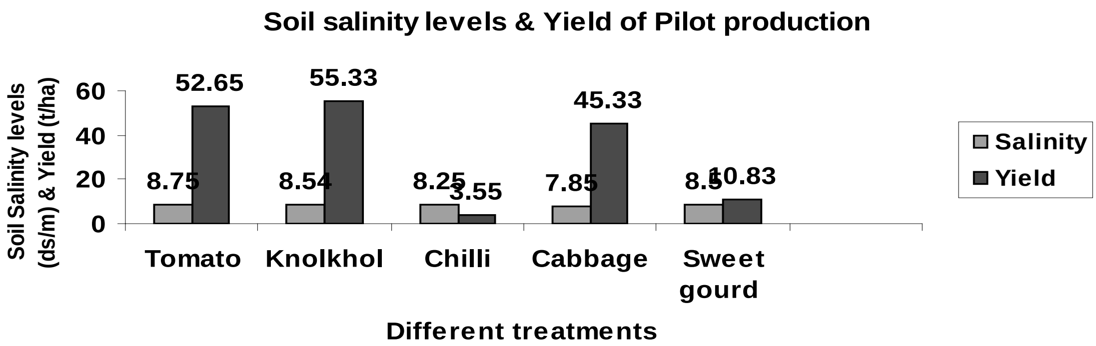
Benarpota

Yield and economic evaluation on different high value crops are presented in Table 2. The highest yields were obtained from cabbage (52.76 t/ha in 2009-10) and Knolkhol (55.33 t/ha in 2010-11) and chili gave the lowest yield 1.32 t/ha in 2009-10 and 3.55 t/ha in 2010-11. Maximum net return was obtained from cabbage (Tk.295136/ha) in 2009-10 but it was maximum in tomato (Tk.97875 /ha) in 2010-11. Averaged over years, the highest. BCR was found in sweet gourd (2.55) followed by cabbage (2.44) and the lowest in chili (0.88).

Table 2. Yield and economic performance of high value crops at ARS, Benarpota, Satkhira during 2009-10 and 2010-11

Crops	Yield (t/ha)		Gross return (Tk/ha)		Net return (Tk/ha)		BCR	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Tomato	30.63	52.65	214410	263250	78855	97875	1.58	1.59
Knolkhol	28.82	55.33	230560	133325	115266	38637	2.00	1.40
Chili	1.32	3.55	52800	53250	(-)28088	5625	0.65	1.12
Cabbage	52.76	45.33	422080	135990	295136	49365	3.32	1.56
Sweet gourd	4.03	10.83	60450	75810	35992	46935	2.47	2.62





Conclusion

The results of the experiment revealed that watermelon in the coastal saline area at Dacope, Khulna and sweet gourd and cabbage in Benarpota can successfully be cultivated by using supplemental irrigation.

VERIFICATION TRIAL OF HYBRID MAIZE-SWEET POTATO INTERCROPPING SYSTEM

M.N. Islam, A. K. M. Habibur Rahman and M.A. Hossain

Abstract

The experiment was conducted at the ARS, BARI, Benarpota, Satkhira during Rabi season of 2010-11 to evaluate the performance of hybrid maize (BARI Hybrid Maize-5) intercropping with sweet potato (BARI SP-6). Five treatment combinations were T_1= sole hybrid Maize, T_2 = sole sweet potato, T_3 = Maize paired row +2 rows of sweet potato, in between two maize paired row, T_4 = Maize normal row, one row of sweet potato in between two maize rows and T_5 = SP (Sweet potato) normal row + 1 row maize. The highest gain yield (8.94 t/ha) was recorded from sole maize, which was significantly different from all other treatments. The yield and yield contributing characters of sweet potato were significantly varied among the intercrop combinations. The highest tuber yield (46.67 t/ha) was recorded from sole sweet potato which was significantly differed from other treatments. The highest maize equivalent yield (45280 kg/ha) was obtained from SP normal row + 1 row maize. The gross margin Tk.517360 /ha and maximum BCR (4.18) were also recorded from maize normal row + 1 row sweet potato intercropping.

Introduction

Maize is the third important cereal crop in our country. Now a day's maize is cultivating about 300000 hectare in our country. Maize mainly used as feed, fodder, fuel and bakery industry. Sweet potato plays an important role in the daily diet in the different countries of the world. It also compares favorably in terms of nutritional value with other root crops, such as cassava, yam and other root crops. Hence the study was undertaken to sow the performance of maize and sweet potato intercropping system and to popularize it to the farmers level.

Materials and Methods

The experiment was conducted at the ARS, BARI, Benarpota, Satkhira during rabi season of 2010-11. The soil salinity levels of maize and sweet potato at different growth stages are shown in Fig. 1. The experiment was laid out in RCB design with three replications. There were five treatment combinations viz. T_1 = sole hybrid Maize, T_2 = sole sweet potato, T_3 = Maize paired row+2 rows of sweet potato, in between two maize paired row, T_4 = Maize normal row, one row of sweet potato in between two maize rows and T_5 = SP (Sweet potato) normal row + 1 row maize. The unit plot size was 4.5 m X 4.5 m. The hybrid maize variety BARI Hybrid maize-5 and sweet potato BARI SP-6 were used in this trial. Seeds of maize and cutting of sweet potato were sown/planted in the field on 31 December 2010. The trial was fertilized with sole maize and intercrop were 250-60-130-30-4-1 kg NPKS Zn and B/ha. Half of N and all other fertilizer were applied as basal. Rest of N was top dressed in two equal splits at 35 and 65 DAS. Sole sweet potato was fertilized with 125-50-125-18-2-1 kg NPKS Zn and B/ha. Half of N and all others fertilizers were applied as basal. Rest of N was top dressed at 35 DAS followed by earthling up and irrigation. Plant protection measures were taken as and when required. Total duration required for maize and sweet potato were 142 and 125 days, respectively.

Results and Discussion

Yield and yield contributing characters of maize were significantly differed among different intercrop combinations (Table 1). Tallest plant, longest cob, highest grains/cob and 1000-grain weight were obtained from sole maize. The highest grain yield (8.94 t/ha) was recorded from sole maize, which was significantly different from all other treatments. The yield and yield contributing characters of sweet potato were varied significantly among the treatments (Table 2). Tallest plant, maximum tubers/plant and highest tuber weight/plant were obtained from sole sweet potato. The highest tuber yield was recorded from sole sweet potato (46.67 t/ha) which was significantly differed from other treatments. The highest maize equivalent yield (45280 kg/ha) was obtained from SP normal row + one row maize (Table 3). The highest gross margin (Tk.517360 /ha) and BCR (4.18) were recorded from maize normal row + 1 row sweet potato (T4). The lowest level of soil salinity was recorded in the sowing time and the highest level of salinity was recorded in the maturity stage (Fig.1).

Table 1. Yield and yield contributing characters of hybrid maize in intercropping maize with sweet potato.

Treatment	Plant population /m^2 (no.)	Plant height (cm)	Cob/ Plant (no.)	Cob length (cm)	Grains/ Cob (no.)	1000-seed wt. (gm)	Grain yield (t/ha)	Straw yield (t/ha)
Sole Maize	108a	177.0a	2.00	31.00a	625.0a	330.4a	8.94a	6.14a
Maize paired row + 2 rows SP	108a	166.7b	2.00	29.33b	555.3b	330.3b	7.60b	5.86c
Maize normal row + 1 row SP	108a	164.0c	2.00	27.67c	541.3b	330.2c	7.33b	5.79d
SP normal row + 1 row Maize	54b	175.3a	2.00	29.67b	514.3c	330.4d	6.45c	6.04b

Means having same or without letter(s) do not differ significantly at 5% level of probability

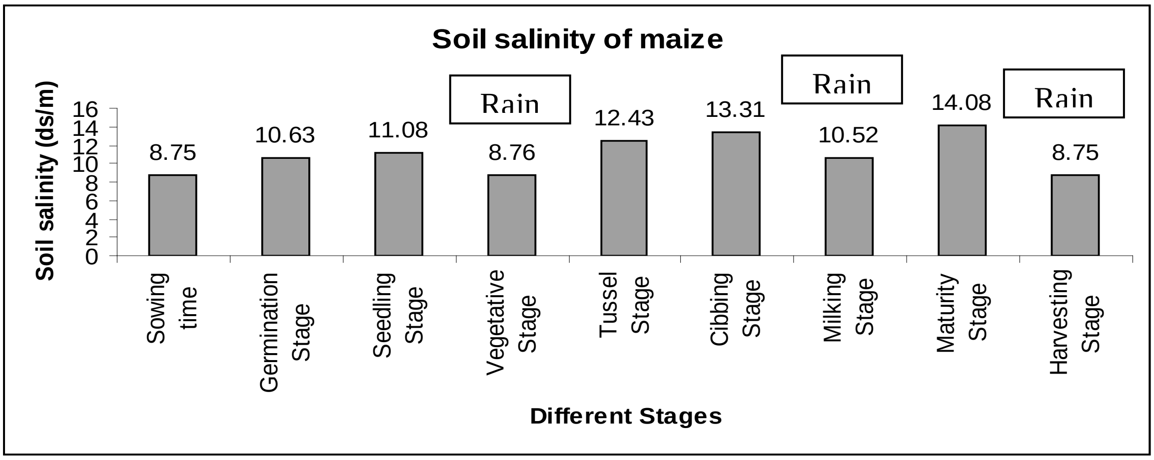
Table 2. Yield and yield contributing characters of sweet potato in intercropping maize with sweet potato.

Treatment	Plant population/m^2 (no.)	Plant height (cm)	Tubers/ plant (no.)	Wt. of tubers/ plant (kg)	Tuber yield (t/ha)
Sole sweet potato	105.00a	298.3a	6.33a	0.90a	46.67a
Maize paired row + 2 rows SP	60.00c	231.7b	5.33b	0.71b	21.13d
Maize normal row + 1 row SP	75.00b	220.0b	5.33b	0.62c	22.96c
SP normal row + 1 row Maize	105.00a	241.7b	6.33a	0.87a	45.28b

Means having same or without letter(s) do not differ significantly at 5% level of probability

Table 3. Economic performance of hybrid maize sweet potato intercropping system

Treatment	Maize equivalent yield (kg/ha)	Gross return (Tk/ha)	Variable cost (Tk/ha)	Gross margin (Tk/ha)	BCR
Sole Maize (T_1)	8940	178800/-	54920/-	123880/-	1.00
Sole sweet potato (T_2)	42670	466700/-	61652/-	405048/-	3.27
Maize paired row + 2 rows SP (T_3)	21130	363300/-	59860/-	303440/-	2.45
Maize normal row + 1 row SP (T_4)	22960	376200/-	59860/-	316340/-	2.55
SP normal row + 1 row Maize (T_5)	45280	583200/-	65840/-	517360/-	4.18



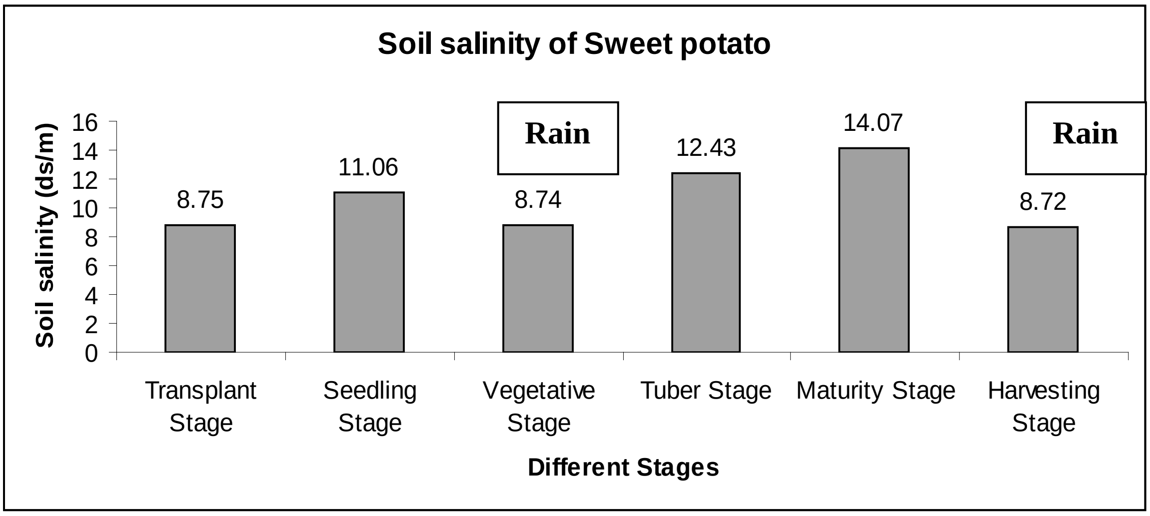
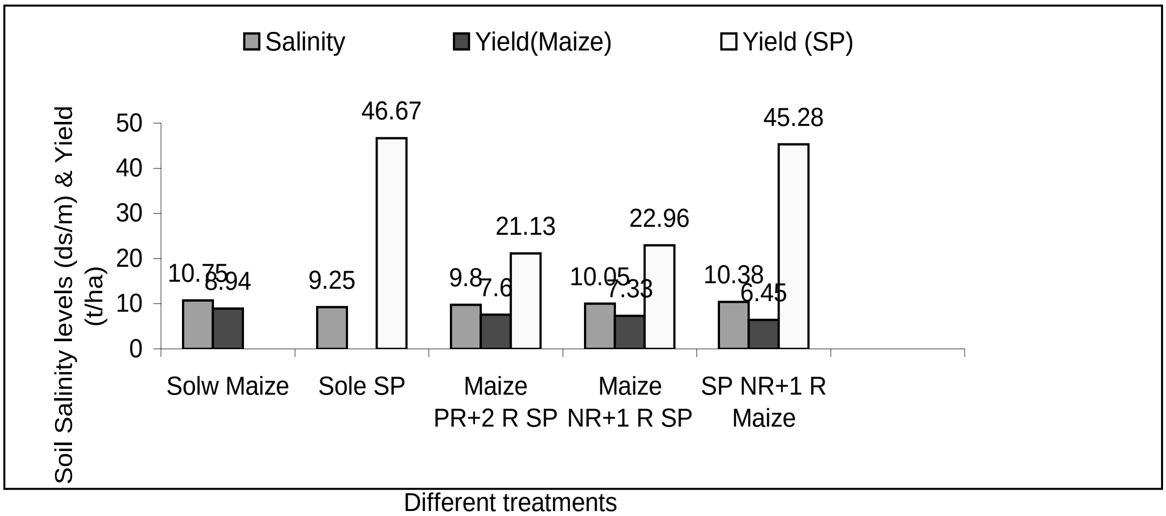


Fig. 3 Showing the salinity level during the growing period of crop

Soil salinity levels & Yield of Maize-Sweet potato



Conclusion

The results of the experiment indicated that maize normal row + one row sweet potato intercropping might be suitable and profitable at Benerpota, Satkhira areas.It should be continued for the next year.

PERFORMANCE OF SELECTED MUSTARD GENOTYPES UNDER SALINITY IN POT CULTURE

S.N. Mahfuza, F.Ahmed and M. A. Aziz

Abstract

The experiment was carried out in vinyl house of Agronomy division at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2010-2011 to examine the variation of salt tolerance of selected mustard genotypes up to maturity .Eight mustard genotypes (DB 9069, BD 9093, BD 9070, BD 9064, Daulat, BARI Sarisha 11, BARI Sarisha 13 and BARI Sarisha 14) were tested for their salt tolerance at different degrees of salinity (0, 5, 7.5 and 10 dS/m of NaCl) in vinyl house. Genotypes were greatly influenced by salinity with respect to root dry weight, shoot dry weight, plant height, days to flowering, days to maturity and yield. Among the eight genotypes, BARI Sarisha-14, BD 9093, BARI Sarisha-11and BD 9069 showed more salt tolerance at all the salinity levels in respect of root-shoot growth and yield performance.

Introduction

In Bangladesh coastal areas occupy almost thirty percent of the net cultivable land. Almost 1.06 million hectares of coastal land is affected by salinity of varying degrees. Mustard is one of the most important oil crops in Bangladesh which can be grown in the coastal area. The most common adverse effect of salinity on the crop of Brassica is the reduction in plant height, seed size and yield as well as deterioration of the quality of the product (Kumar, 1995). Fifty genotypes of mustard available in BARI gene bank were screened for their salt tolerant at early vegetative stage in Hoagland solution under laboratory condition. But salinity may affect mustard plants at any stage of growth. It has been reported by a number of workers that in some crops selection for salt tolerance at the early growth stages may not correlate with their tolerance at the later growth stages (Ashraf and McNeilly, 1988).Nevertheless, seed germination and seedling establishment are the most critical stages in life cycles of plants in a saline environment (Blum,1985) and are of importance in assessing the over all salt tolerance of a crop(Akbar and Yabuno 1974, Ashraf *et al*,.1990). However, Brassica has some potential to cope with the toxicity of salts (Francois, 1984). So it can be successfully grown on salt affected soils. Keeping this view in mind, the experiment was undertaken to examine the variation in salt tolerance of selected mustard genotypes up to maturity.

Materials and Methods

The experiment was carried out in vinyl house of Agronomy division at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2011-2012. Eight selected (BD 9069, BD 9093, BD 9070, BD 9064, Daulat, BARI Sarisha-11, BARI Sarisha-13 and BARI Sarisha-14) mustard genotype screened in laboratory under Hoagland nutrient solution culture were used in the study at 0, 5, 7.5 and 10 dS/m of Nacl solution. Plastic pots (top dia 76 cm, bottom dia 74 cm and height 30 cm) were filled with soil and cow dung in 4:1 volume ratio and final weight of pot was 13 kg. N_{120} P_{35} K_{65} S_{25} Zn_2 B_1kg/ha in the form of urea, triple super phosphate, muriate of potash, zypsum, zinc sulphate and boric acid were incorporated in the soil. Ten seeds of each genotype were sown in each pot on 15 November 2011.The pots used during the present study had five small holes at the bottom. Thinning of seedling was done at 10 day after sowing by keeping four plants in each pot. The pots were irrigated with tap water, to grow crop without moisture stress. The study was evaluated under completely randomized design (factorial) with four replications. Two weeks after sowing, salt solutions were applied in treated pot. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 5.0, 7.5 and 10.0 dS/m solution. Soil salinity was measured by Portable water conductivity & soil activity meter (model no. HI 993310,346886, made in ROUMANIE). Tap water was used as control and that was 0.3 dS/m. The salt solution was applied with an increment of 2.5 dS/m in every alternate day till respective salinity level of 5, 7.5 and 10 dS/m were attained. Treatment solution was applied in excess so that the extra solution dripped from the bottom of the pots. The root and shoot sample were collected prior to harvest. The collected sample was oven dried at 80^0C, for 72 hours. For root sampling, plastic pots were soaked in water, soil was washed with water and the roots were recovered by passing the soil water suspension through a 2mm mesh sieve. The yield and yield component data were collected from five randomly selected plants from each treatment at harvest. Data were analyzed following MSTAT program and means were compared using LSD test.

Results and Discussion

The days to first flowering was delayed with the increase of salinity levels for all the eight genotypes of mustard (Fig. 1).BD 9064 took 25 days for flower initiation whereas BD 9093 took 44 days under control condition. All the genotypes flowered 2-4 days later at salinity level of 10 dS/m compared to control. Days to maturity (Fig. 2) followed the reverse trend as days to flowering in all the eight genotypes . However, there is a general view that the crop maturity period is shortened by environmental stress because of limited source for the sink due to leaf senescence (Levitt, 1972; Hye, 2000).

There was variation in root dry weight among the genotypes under control condition (Fig.3). The genotype BD 9093 gave the highest root dry weight (4.55g/plant) followed by BD 9069 genotypes (3.06g/plant) and the genotype BD 9064 gave the lowest root dry weight (1.00g/plant) in control condition. Root dry weight decreased linearly with increasing the salinity level from 5.0 to 10.0 dS/m in all the genotypes. The reduction in root dry weight was minimum in genotype BD 9069 at salinity level up to 7.5 dS/m.

The genotype BD9069 gave the highest shoot dry weight (21.73 g) followed by BD 9070 and the lowest (12.77 g) from BARI Sarisha-13 in control condition (Fig.4). Shoot dry weight was significantly decreased with increasing salinity level up to 10 dS/m. The highest reduction was observed under high salinity level. The reduction in shoot dry weight might be due to decrease in co_2 uptake in leaves (Fedina and popova, 1996) mainly because of sodium chloride treatment decrease stomatal conductance and consequently less co_2 was available for carboxylation reaction in the photosynthetic apparatus (Yadav *et. al*., 1996).

At control condition, BD 9093 showed the tallest plant (173cm) and BARI Sarisha-14 the shortest (78cm) one. This was might be due to the variation in genetic characteristic of the genotypes (Fig.5). At 10 dS/m salinity level, plant height decreased in all the genotypes. This result indicated that higher salinity level affect plant height. The figure clearly showed that among the *Brassica napus* genotypes, BD 9093 was the best performer under different levels of salinity with the minimum reduction in plant height. Shannon *et al*. (1993) reported similar results regarding the decrease in plant height with the increase of salinity level in mustard.

Yield components

The yield components of mustard genotypes like no. of siliqua/plant, no. of seeds/siliuqa and 1000-seed weight differed significantly among the genotypes both under control and saline condition (Table 1).

The highest no. of siliqua/plant (213.33) was recorded in BD 9093 at control condition followed by BD 9069 (191.67). The lowest no. of siliqua/plant (51.33) was found in genotype BARI

Sarisha-13 at10 dS/m salinity level. Increasing salinity level led to a significant reduction in no. of siliqua/ plant. The reduction of no. of siliqua/plant at 5 dS/m was observed and BD 9093 gave 87% no. of siliqua/plant followed by BD 9064, BARI Sarisha-14 and BARI Sarisha-11. The lowest relative no. of siliqua/plant was obtained from BD 9070(79%) which was followed by Daulat. At 7.5 dS/m salinity level relative no. of siliqua/plant was highest in BARI sarisha-11 (78%) and the lowest relative no. of siliqua/plant was recorded in BARI Sarisha-13 (75%). At 10 dS/m salinity level relative no. of siliqua/plant decrease sharply and it was below 80% of control treatment in all the genotypes. BARI Sarisha-11 gave the highest (73%) relative no. of siliqua per plant and the lowest in BD 9064 (58%).

The no. of seeds/siliqua was more or less affected by salinity in all the genotypes of mustard. The highest no. of seeds/siliqua was obtained from BARI Sarisha-13 (26.33) followed by BARI Sarisha-14 (25.00) and the lowest from BARI Sarisha-11 (15.33) under control condition. At 5 dS/m salinity level reduction in no. of seeds/siliqua was also observed in all the cultivars. The highest relative no. of seeds/siliqua (96%) was in BARI Sarisha-13 and the lowest (84%) in BD 9069. At 7.5 dS/m salinity level BD 9070 produced the highest (92%) relative no. of seed/siliqua and Daulat produced the lowest relative no. of seeds/siliqua (67%). At 10 dS/m BD 9093 performed best in producing relative no. of seed/silliqua (82%) followed by BARI Sarisha-11 and BD 9093.The lowest relative no. of seeds/siliqua was obtained from Daulat (61%).

The 1000-seed weight under non saline condition was the highest in BD 9093 (4.07g) followed by BARI Sarisha-11(3.95g), BARI Sarisha-13 (3.84g), BD 9069 (3.76g) and BARI Sarisha-14 (3.73 g). The lowest 1000-seed weight under nonsaline condition was in Daulat (2.39 g). At 5 dS/m salinity level, relative 1000-seed weight was highest in BD 9064 (97%) followed by BD 9069 (96%) and Daulat (96%). The lowest relative 1000-seed weight was in BARI Sarisha-11 (91%).At 7.5 dS/m salinity level BD 9069 performed better (92%), BARI Sarisha-13 and Daulat performed least (83%) in terms of relative 1000-seed weight. At 10 dS/m salinity level, BD 9093 and BD 9064 produced the highest relative 1000-seed weight (89%) and Daulat produced the lowest relative 1000-seed weight (80%).

Seed yield

Seed yield is the function of no. of siliqua/plant, no. of seeds/siliqua and 1000-seed weight. Changes in any of the characters due to salinity would provide a detailed appraisal for the response for lower seed yield in salinized mustard plants. An inverse relationship was expressed between salinity levels and seed yield. Higher the salinity levels lower was the yield. In control condition BD 9093 gave the highest seed yield (18.89g/plant) followed by BD 9064(14.84g/plant) and BD 9070(14.78 g/plant). At 5 dS/m salinity level the relative yield was found highest in BD 9093 (89%) followed by BARI Sarisha-13 (89%). The lowest relative yield was found in BD 9070 (70%). At 7.5 dS/m salinity level BD 9069 also performed better (78%) in respect of relative seed yield and the lowest was found in BD 9070 (63%).At 10 dS/m salinity level, yield was decreased drastically in all the genotypes but BARI Sarisha-14, BD 9093, BARI Sarisha-11and BD 9069 performed better than other genotypes which was above 60%. Result indicates that salinity greatly reduced the yield of all the genotypes at high salinity level.

Conclusion

Among the eight genotypes, BARI Sarisha-14, BD 9093, BARI Sarisha-11 and BD 9069 performed better. From the two years result it can be concluded that BARI Sarisha-14, BD 9093, BARI Sarisha-11 and BD 9069 are more salt tolerant than the other genotypes. For more confirmation a field trial should be needed in saline prone area.

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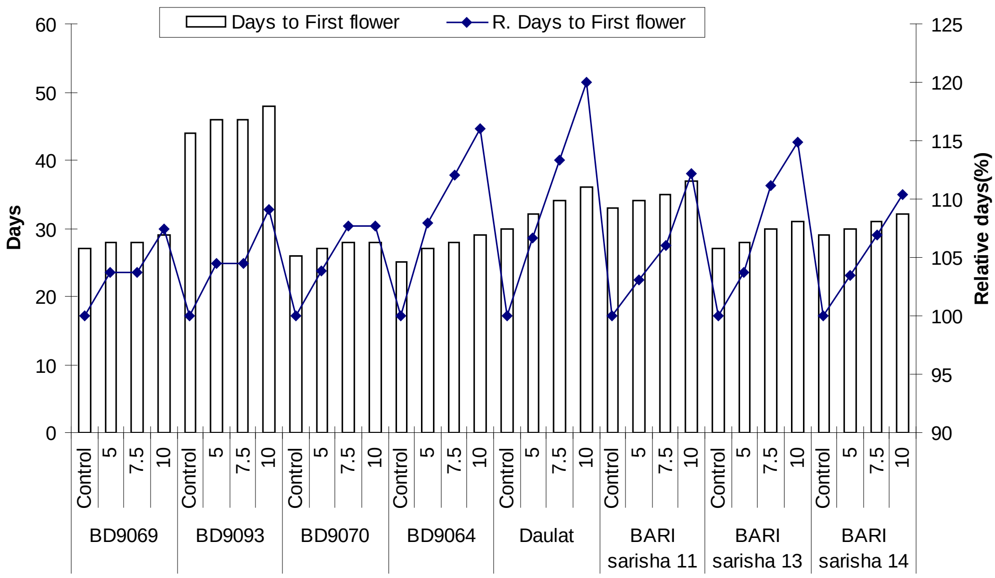


Fig .1.Effect of salinity on days to first flower of eight selected mustard genotypes

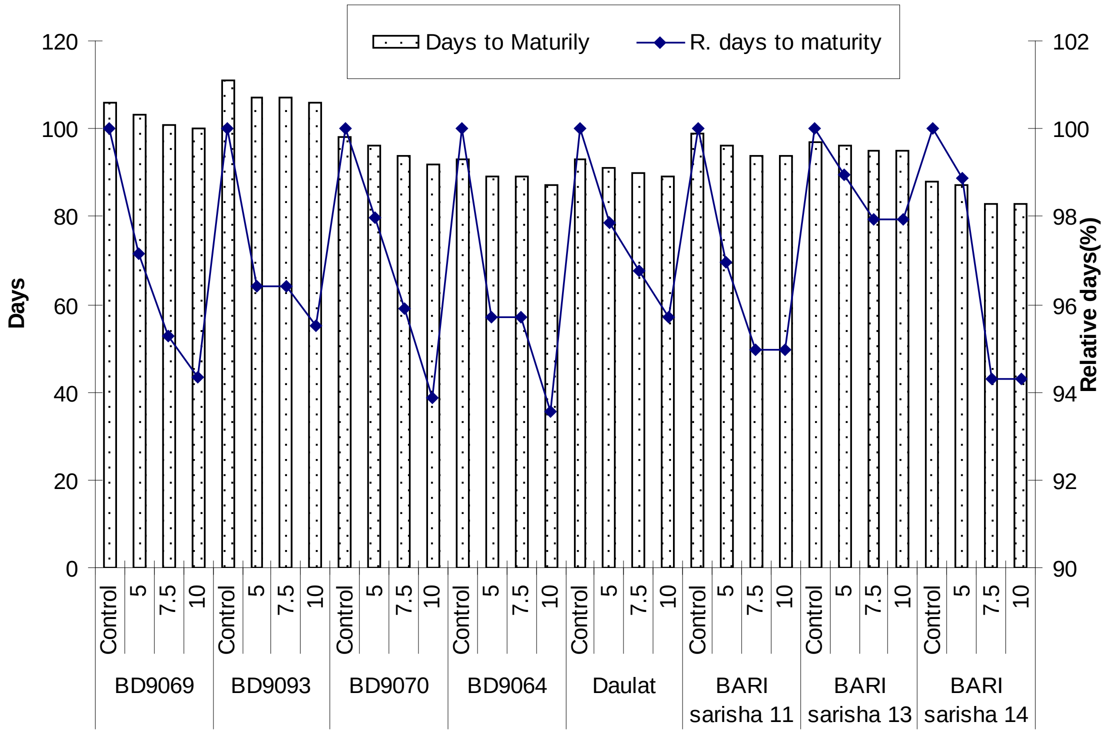


Fig . 2. Effect of salinity on days to maturity of eight selected mustard genotypes

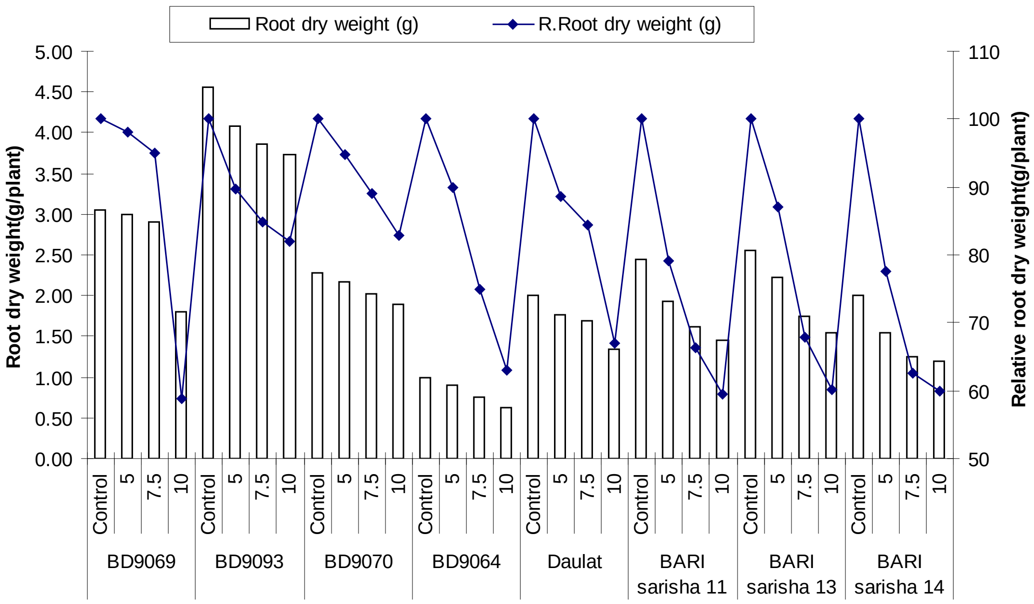


Fig .3.Effect of salinity on root dry weight of eight selected mustard genotypes

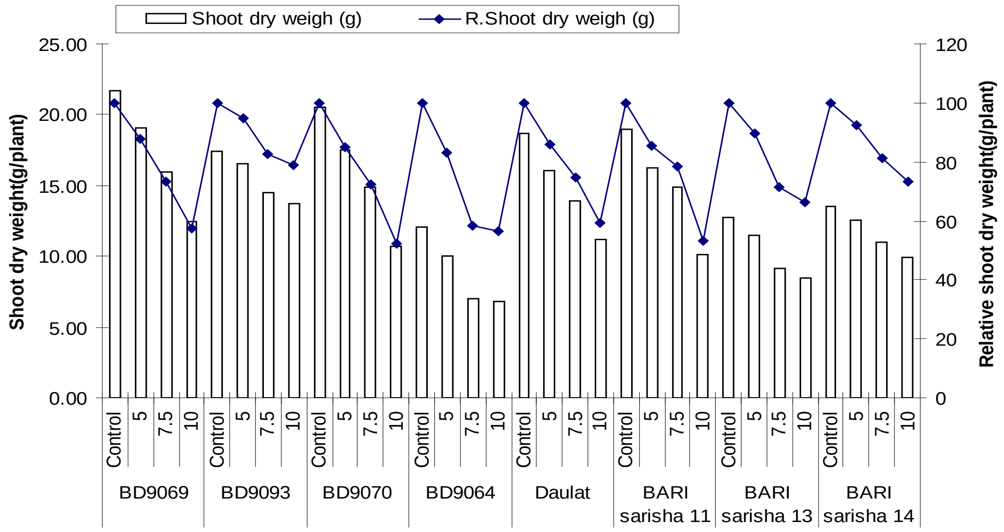


Fig .4.Effect of salinity on shoot dry weight of eight selected mustard genotypes

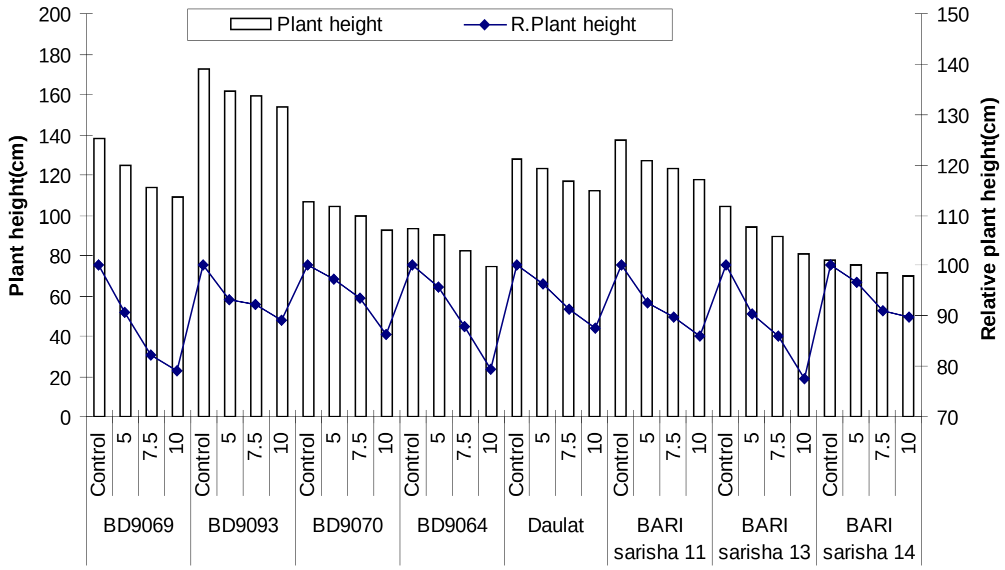


Fig .5.Effect of salinity on plant height of eight selected mustard genotypes

Table .1.Effect of salinity on yield components of selected mustard genotypes

Genotypes	Salinity(dS/m)							
	Control	5 dS/m	7.5	10	Control	5	7.5	10
	Siliqua/plant				Seeds/siliqua			
BD 9069	191.67	161.67 (84)	144.33 (75)	138.67 (72)	18.67	15.67 (84)	15.00 (80)	14.67 (79)
BD9093	213.33	186.00 (87)	161.67 (76)	153.67 (72)	18.00	16.00 (89)	16.00 (89)	14.67 (82)

Salinity Stress

Genotypes	Salinity(dS/m)							
	Control	5 dS/m	7.5	10	Control	5	7.5	10
	Siliqua/plant				Seeds/siliqua			
BD9070	108.00	85.00 (79)	81.00 (75)	74.67 (69)	19.67	18.33 (93)	18.00 (92)	14.67 (75)
BD9064	133.33	115.67 (87)	102.33 (77)	77.33 (58)	21.33	18.67 (88)	16.33 (80)	17.00 (77)
Daulat	122.00	97.67 (79)	93.67 (77)	85.67 (70)	16.33	14.00 (86)	11.00 (67)	10.00 (61)
BARI Sarisha- 11	145.00	125.00 (86)	113.67 (78)	105.33 (73)	15.33	14.00 (91)	13.67 (89)	9.00 (58)
BARI Sarisha- 13	73.33	60.67 (83)	55.33 (75)	51.33 (70)	26.33	25.33 (96)	20.67 (79)	19.67 (75)
BARI Sarisha- 14	92.33	80.67 (87)	71.00 (77)	65.67 (71)	25.00	23.00 (92)	21.67 (86)	19.33 (77)
$LSD_{(0.05)}$	10.41				4.20			
CV (%)	10.74				4.99			

Values in parenthesis show relative value over control, Calculated as [(value of parameter/ value of control) × 100]

Table 1. Continued

Genotypes	Salinity(dS/m)							
	Control	5	7.5	10	Control	5	7.5	10
	1000-seed weight (g)				Seed yield/plant(g)			
BD 9069	3.76	3.60 (96)	3.46 (92)	3.24 (86)	14.00	11.83 (85)	10.92 (78)	8.40 (60)
BD9093	4.07	3.79 (93)	3.72 (91)	3.61 (89)	17.89	15.93 (89)	13.23 (74)	11.41 (63)
BD9070	3.27	3.09 (94)	2.99 (91)	2.78 (85)	14.78	10.41 (70)	9.45 (63)	7.67 (52)
BD9064	3.45	3.34 (97)	3.18 (92)	3.08 (89)	14.84	11.95 (81)	11.40 (77)	8.50 (57)
Daulat	2.39	2.30 (96)	1.99 (83)	1.91 (80)	6.42	5.41 (84)	4.32 (67)	3.00 (46)
BARI Sarisha- 11	3.95	3.62 (92)	3.35 (85)	3.27 (83)	8.56	6.61 (77)	5.76 (67)	5.19 (61)
BARI Sarisha- 13	3.84	3.51 (91)	3.18 (83)	3.07 (80)	10.50	9.32 (89)	8.58 (82)	5.88 (56)
BARI Sarisha- 14	3.73	3.52 (94)	3.26 (87)	3.09 (83)	9.48	7.66 (81)	6.83 (72)	6.37 (67)
$LSD_{(0.05)}$	0.213				2.32			
CV (%)	3.98				5.15			

Values in parenthesis show relative value over control, Calculated as [(value of parameter/ value of control) ×100]

SCREENING OF KHESARI GENOTYPES AGAINST SALINITY STRESS

Bulbul Ahmed, F. Ahmed, M.A. Hossain and M. A. Malek

Abstract

Forty nine khesari genotypes were tested against varying levels of salinity 0, 5 10 and 15 dS/m in Hoagland solution under laboratory condition during 2011-2012, to study the salt tolerance of the genotypes at germination and seedling stages. Distilled water (0 dS/m) was used as a control. Germination percentage (GP), root length (RL), shoot length (SL), Vigor Index and total dry matter (TDM) were found to be affected by salinity. The genotypes BD-4774, BD-4782 and BD-4962, showed better performance at 5 dS/m, and 10 dS/m and survived up to 15 days after germination. At 15 dS/m salinity level no genotypes can survive. These genotypes can be selected for further investigation under pot culture.

Introduction

Out of 2.85 million hectares of the coastal and off shore areas about 1.00 millions hectares are arable lands, which cover over 30% of the total cultivable lands of Bangladesh. The cultivable areas in coastal districts are affected with varying degrees of soil salinity. Agricultural land use in these areas is very poor, which is roughly 50% of the country's average (Petersen and Shireen, 2001). Salinity causes unfavorable environment and hydrological situation that restrict normal crop production throughout the year. In general, soil salinity is believed to be mainly responsible for low land use as well as cropping intensity in the area (Rahman and Ahsan, 2001). Salinity in the country received very little attention in the past. Increased pressure of growing population demand more food. Thus it has become increasingly important to explore the possibilities of increasing the potential of these (saline) lands for increased production of crops.

Lathyrus is a genus in the *Leguminosae* family and contains species such as *Lathyrus savitus* (grass pea) and *Lathyrus odorata* (sweet pea). Grass pea is used as a famine food, especially in India, the Middle East, and parts of Asia, because the plants are extremely hardy and the seeds are high in protein. Grass pea is probably the most drought tolerant legume crop and it is also resistant to moderate salinity (Yang *et al.*, 2005). Besides being an important source of human and animal food, the crop also plays an important role in the maintenance of soil fertility, particularly in southern regions (Saxena, 1990). A major constraint on Khesari production in coastal area is soil salinity, predominately due to chloride and sulphate accumulation in saline area. Although some soils are naturally saline, the secondary salanization largely about by the use of irrigation systems, that is the greatest threat to legume sustainability in southeast regions, where water supplies are limited, irrigation is essential to improve poor crop yields. As with many other pulses khesari is a salt-sensitive crop and yields are seriously reduced particularly by chloride salinity (Manchanda and Sharma, 1990.) The effects of salinity on khesari are wide ranging. Seed germination is delayed and reduced and vegetative plant growth is suppressed under saline conditions (Sharma *et al.*, 1982; Yadav *et al.*, 1989). Salt tolerant genotype(s) need to identify to cop with the salinity problem in coastal areas of Bangladesh. Therefore, objective of this experiment was undertaken to evaluate genotypes of khesari for their salt tolerance.

Materials and Methods

The experiment was conducted from November 16, 2011 to February 16, 2012 at Crop Physiology Lab, Agronomy Division, Bangladesh Agricultural Research Institute (BARI). 49 genotypes of Khesari (BD-4774, BD-4775, BD-4749, BD-4782, BD-4783, BD-4786, BD-4787,

BD-4791, BD-4793, BD-4798, BD-4801, BD-4828, BD- 4837, BD-4838, BD-4843, BD-4846, BD-4858, BD-4860, BD-4861, BD-4866, BD-4867, BD-4889, BD-4898, BD-4901, BD-4902, BD-4903, BD-4905, BD-4910, BD-4911, BD-4912, BD-4915, BD-4918, BD-4919, BD-4920, BD-4926, BD-4933, BD-4943, BD-4947, BD-4950, BD-4951, BD-4959, BD-4961, BD-4962, BD-4963, BD-4969, BD-4970, BD-4971, BARI Khesari-1 and BARI khesari-2) collected from plant Genetics Resource Center (PGRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur were used in the study. The experiment assessed the germination and seedling growth of khesari genotypes at different NaCl salinity levels. The NaCl concentrations used were 0 (control), 5, 10, and 15 dS/m. The salt solution was prepared calculated amount of NaCl in distilled water. Hoagland solution was used as nutrient media with the salt solution. The P^H of Hoagland solution was maintained 6-7. Plastic pots were used in the experiment with a diameter of 10cm and arranged in a completely randomized design (CRD) with three replications. Each pot was supplied with 500ml of the respective treatment solution. Seeds were sown on the plastic pots having bolting paper. The germination count was taken after 72 hours of sowing seeds. A seed was considered to have germinated when both the plumule and the radicle emerged > 0.5cm. After 15 days, the shoot and the root length of ten randomly selected seedlings from each replicate were measured following a draftsman ruler (Azhar and McNeilly, 1987).

Germination percentage (GP): The average number of days needed for plumule or radicle emergence was calculated as:

Germination percentage (GP) = $\frac{a}{b} \times 100$

Where: a = Number of seeds germinated

b = Total numbers of seeds to germinate

Vigor Index = (Root length + Shoot length) x Germination percentage

The plants were then collected from the pots and the following measurements were done

i. Root Length (cm).
ii. Shoot Length (cm)
iii. Root to Shoot ratio
iv. Oven dry-weight of plant (g).

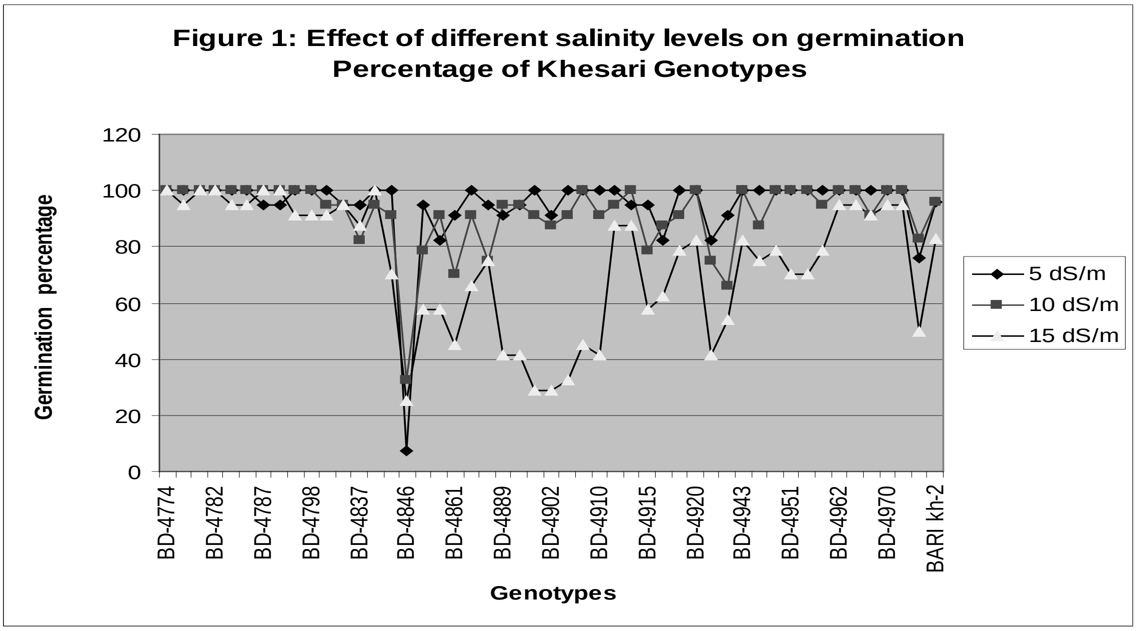
Statistical Analysis

Data analysis was carried out by MSTAT-C where two ways analysis of variance (ANOVA) and correlation analysis were employed. Prior to data analysis, root-to-soot ratio (RSR) was log transformed. At 15 dS/m, all varieties collapsed after germination. Consequently, the incomplete data obtained from these salinity levels had been excluded from the data Analysis of germination percentage (GP), germination rate (GR), root length (RL), shoot length (SL), and total dry matter (TDM).

Results and Discussion

Germination Percentage:

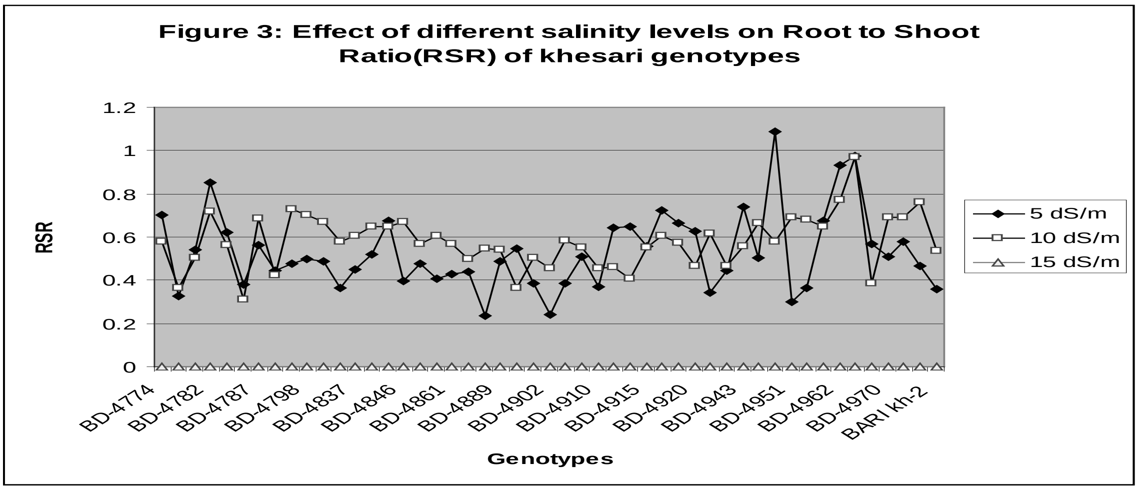
At different salinity levels, the germination percentage (GP) presented in Fig.1 A variation in the germination of Khesari genotypes under salinity was observed. NaCl salinity stress decreased the rate of germination percentage at higher salinity level (15 dS/m). It was observed from Fig. 1 that at lower salinity level (5 dS/m), the genotypes BD-4774, BD-4782, BD-4786, BD-4912, BD-4920, BD-4950, BD-4962, BD-4970, BD-4971, BD-4793, BD-4798 and BD-4749 gave higher (more than 80%) germination percentage except BD-4846. At 10 dS/m, BD-4774, BD-4782, BD-4786, BD-4912, BD-4920, BD-4950, BD-4970, BD-4971, BD-4793, BD-4889 and BD-4962 gave 60%- 80% germination. At 15 dS/m of salinity BD-4774, BD- 4775, BD-4782, BD-4787 and BD-4962 gave 50%- 60% germination, The genotypes BARI Khesari-1, BARI Khesari-2, BD-4801, BD-4828, BD-4837, BD-4846, BD-4866, BD-4947, BD-4961, BD-4969, and BD-4926 gave lower germination percentage at all levels of salinity.. Salinity level resulted in reduced germination percentage in all most all genotypes. Similar results were reported in triticale (Norlyn and Epstein, 1983), oats (Verma and Yadava, 1986), rice (Lee *et al*., 1998), durum wheat and tef (Tekalign Mamo *et al.,* 1996).



Root to shoot Ratio:

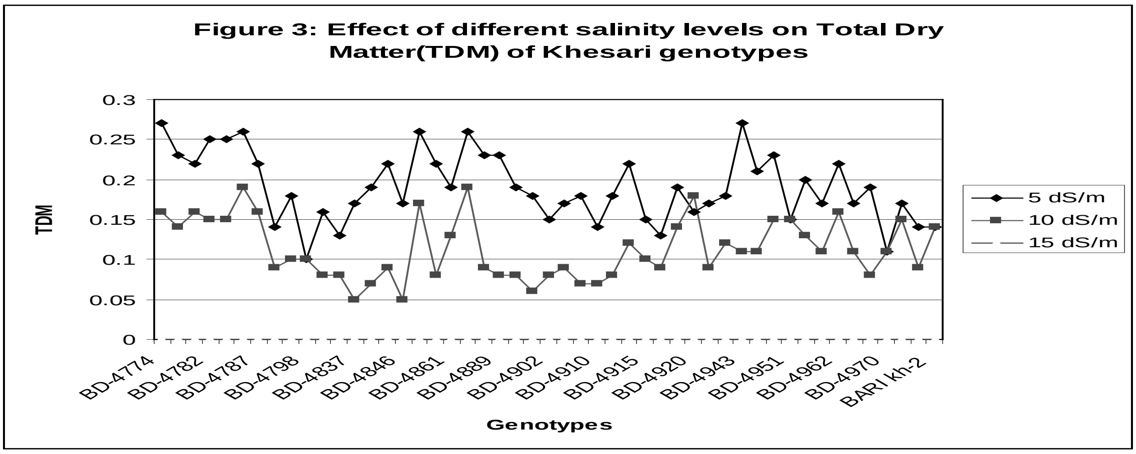
The root and shoot lengths are the most important parameters for salt stress because roots are in direct contact with soil and absorb water from soil and shoot supply it to the rest of the plant. For this reason, root and shoot length provides an important clue to the response of plants to salt stress (Jamil and Rha, 2004). Salt stress inhibited the seedling growth (root and shoot length) but root length was more affected then shoots length .Inhibition of plant growth by salinity may be due to the inhibitory effect of ions. The reduction in root and shoot development may be due to toxic effects of the NaCl used as well as unbalanced nutrient uptake by the seedlings. High salinity may inhibit root and shoot elongation due to slowing down the water uptake by the plant (Werner and Finkelstein, 1995).

From Figure: 2, the highest root to shoot ratio was found in genotypes BD 4774, BD-4782, BD-4787, BD-4793, BD-4947, BD-4959 and BD-4963 gave at 5 dS/m. At 10 dS/m the genotypes BD 4774, BD-4782, BD-4787, BD-4793, BD-4947, BD-4962, BD-4959, BARI Khesari 1 gave highest RSR and BD-4986, BD-4866 and BD- 4898 gave the lowest RSR at all levels of salinity. At15 dS/m no genotypes can survive up to 15 days.



Total dry matter:

It is now evident that the existence of genetic variation in salt tolerance is a prerequisite for development of salt tolerant cultivars through selection/ or breeding. To explore such variation in khesari, 49 genotypes were screened at the early stages, as salt tolerance throughout these stages is crucial for establishment of a crop in saline environment.



From figure 3, It was found that BD- 4774, BD-4786, BD-4858, BD-4962, BD-4866 and BD-4943 gave the higher total dry matter content following BD-4918, BD-4919, BD-4920 and BD-4926 at all levels of salinity.

Vigor Index:

From Figure 4, it observed that lower levels (5 ds/m) salinity, vigor index was influenced in some of Khesari genotypes but increasing salinity levels, vigor index was decreased. The highest vigor index was observed in genotypes BD-4782, BD-4749, BD-4951, BD-4962, BD- 4963, BD-4971, BD-4970 and BARI Khesari 2 at 10 ds/m which ranged from 1000 but less than 2500. Vigor index were drastically decreased in all genotypes of Khesari at 15 dS/m. So Khesari is sensitive to higher salinity.

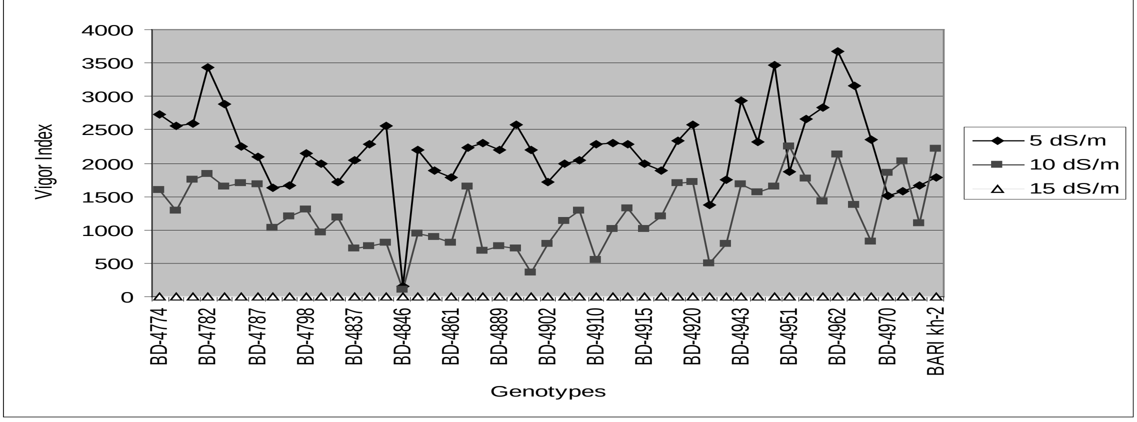


Figure 4: Effect of different levels of salinity on vigor index

Conclusion

Results revealed that genotypes BD-4774, BD-4782, BD-4950 BD-4962 and BD-4963 are more salt tolerant than other genotypes. However, for further confirmation trial is needed.

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EFFECT OF PLANTING METHOD AND SALT WATER SEED PRIMING ON THE YIELD OF HYBRID MAIZE IN SALINE AREA

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Abstract

An experiment was conducted at Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during rabi season of 2011-12 to evaluate Planting method and seed Priming effect on the yield of hybrid maize in saline area. There were six treatments combinations viz. T_1: No Priming + normal sowing, T_2: No Priming + ridge sowing, T_3: Seed priming with 1% NaCl Solution + normal sowing, T_4: Seed priming with 1% NaCI Solution + ridge sowing, T_5: Seed Priming with water + normal sowing, T_6: Seed Priming with water + ridge sowing. Planting method and seed priming showed significant influence on grain yield of maize. The highest grain yield (8.83 t/ha) was recorded in T_6 treatment followed by T_5 (8.75 t/ha) and the lowest (8.22 t/ha) T_4 treatment.

Introduction

Salinity is a major limiting factor in crop production all over the world. In Bangladesh, about 0. 84 million hectare of coastal land is affected by various degrees of salinity. It is predicted that the saline area in Bangladesh would be increased further due to climate changes. Our population is increasing while agricultural land is decreasing by 1% in every year. In this situation we have find out the way to produce more crops in saline soil. Different strategies have been adopted by various crop scientists to overcome the salinity problem. Strogonov (1964) reported that salt tolerance of plants can be increased by priming of seeds with saline water before sowing. Priming of maize seeds with NaCI before sowing induces Physiological and biochemical changes, which resulted in better performance when subsequently exposed to different levels of salinity (Bakht *et al*, 2011), besides, management practices like ridge –furrow planting can improve the crop productivity under saline soil with appropriate management practices. Therefore, the present experiment was conducted to evaluate seed priming and planting system effect on hybrid maize production in saline soil.

Materials and Methods

The experiment was conducted at ARS, BARI, Benarpota, Satkhira during the rabi season of 2011-12 to evaluate Planting method and seed Priming effect. There variety was BARI hybrid maize-7. There were six treatment combinations viz. T_1: No Priming + normal sowing, T_2: No Priming + ridge sowing , T_3: Seed priming with 1% NaCI Solution + normal sowing, T_4: Seed priming with 1% NaCI Solution + ridge sowing, T_5: Seed Priming with water + normal sowing, T_6: Seed Priming with water + ridge sowing were tested in a randomized complete block design with three replications. Seeds of maize were sown on 21 December 2011 at Benarpota with a spacing of 75 cm × 25 cm. Unit plot size was 3m × 4m. The trial was fertilized with 253-52-110-46-5-1.2 kg/ha of N-P-K-S-Zn-B+CD, respectively. All fertilizer along with 6 t/ha cowdung and $\frac{1}{3}$ N were applied as basal during final land preparation. The rest of urea was applied in two equal splits at 35 and 65 DAS, respectively. Two irrigations were given following the urea top dressing. Earthing up was done after 2^{nd} top dress of urea. Three times weeding and necessary plant protection measures were taken. The lowest level (5.54 ds/m) of soil salinity was recorded (Fig. 3) at the sowing stage and the highest level of salinity (15.89 ds/m) was recorded at the harvesting stage. Data on different plant characters and yield were recorded and analyzed statistically using MSTAT-C program.

Results and Discussion

Almost all characters of the crop were influenced by different treatments. Plant height of maize was not significantly affected by treatments and it ranged from 186.33 cm to 214.67 cm in different treatments. Plants in all treatments produce double cobs/plant. Cob length varied significantly among the treatments.

The highest cob length (33.33 cm) was found in T_3 and T_6 treatments which were significantly higher than other treatments. Cob diameter in different treatments was also varied significantly. The highest cob diameter was observed in T_6 treatment which was statistically identical with all other treatments except T_4 treatment. Treatment T_4 produced the lowest cob diameter. Number of grains per cob was statistically identical in different treatments and it ranged from 561 to 591 grains/cob. Thousand seeds weight in different treatments varied significantly.

Table 4. Yield and yield contributing characters of maize as affected by different planting methods and seed priming technique.

Treatments	Plant height (cm)	No. of Cobs /plant	Length/cob cm)	Diameter /Cob (cm)	No. of grains/cob	1000-seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
T_1	214.67	2.0	30.00b	27.06ab	595.33	330.21b	8.58ab	11.65d
T_2	186.33	2.0	30.33b	27.15a	585.67	330.40a	8.73a	11.81c
T_3	216.67	2.0	33.33a	26.91ab	585.00	330.01d	8.30b	11.77c
T_4	220.33	2.0	30.33b	24.95b	561.67	330.15c	8.22b	11.81c
T_5	208.67	2.0	31.00b	26.92ab	567.67	330.39a	8.75a	11.91b
T_6	230.00	2.0	33.33a	27.25a	591.00	330.43a	8.83a	11.97a
Significance levels	NS	NS	*	*	NS	*	*	*
$LSD_{(0.05)}$	-	-	1.090	2.172	-	0.054	0.374	0.054
CV (%)	11.24	2.55	2.05	4.73	3.68	1.00	2.52	0.22

T_1: No Priming + normal sowing, T_2: No Priming + ridge sowing, T_3: Seed priming with 1% NaCl Solution + normal sowing, T_4: Seed priming with 1% NaCI Solution + ridge sowing, T_5: Seed Priming with water + normal sowing, T_6: Seed Priming with water + ridge sowing

The highest 1000-seed weight was found in T_6 treatment which was identical with T_2 and T_5 treatments but significantly higher than others. The lowest thousand seed weight was recorded in T_4 treatment. Significant variation was observed in grain yield in different treatments. The highest grain yield (8.83 t/ha) was recorded in T_6 treatment which was which was identical with T_1 T_2 and T_5 treatments but significantly higher than others. The lowest grain yield (8.22 t/ha) was recorded in T_4 treatment. Significant variation in straw yield was observed in different treatments. The highest straw yield (11.97 t/ha) was found in T_6 treatment which was significantly higher than others and the lowest (11.65 t/ha) in T_1 treatment.

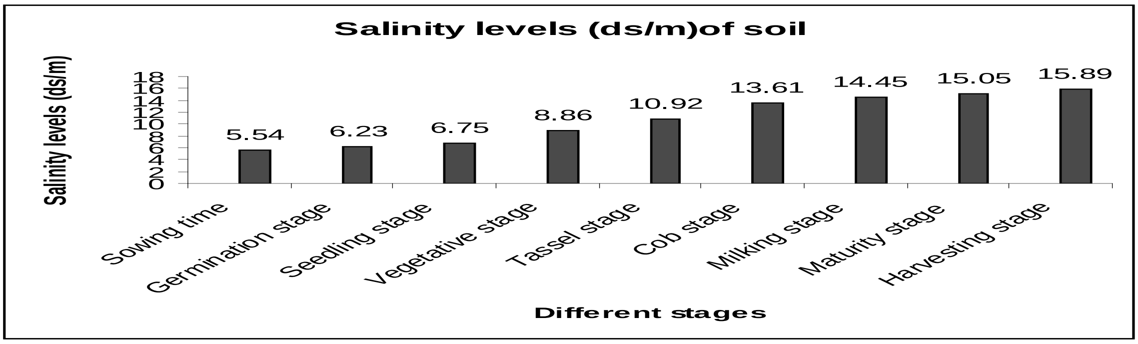

Fig. 3. Salinity levels (ds/m) of soil at different growth stages of maize.

Conclusion

Based on the results obtained from the above experiment it can be concluded that maize performed better in saline soil when seeds were primed with water and sown in ridges in respect of grain yield. This is the 1st year experiment. It should be continued for the next year.

INTERCROPPING HYBRID MAIZE WITH SWEET POTATO UNDER DIFFERENT PLANTING SYSTEMS IN SALINE AREA

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Abstract

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during rabi season of 2011-12 to evaluate the performance of hybrid maize intercropping with sweet potato. There were five treatment combinations viz. T1: sole hybrid Maize, T2: sole sweet potato, T3: Maize paired row +2 rows of sweet potato in between two maize paired row, T4: Maize normal row, one row of sweet potato in between two maize rows and T5: SP normal row + 1 row maize. Results showed that different intercropping combinations significantly influenced number of plant/plot, row/cob, growth/cob, 1000 grain weight and yield of maize and plant/m2, stem/plant, tubers/plant, weight of tuber/plant and tuber yield of sweet potato. The highest maize equivalent yield (51.23 t/ha) was obtained from SP normal row + 1 row maize (T_5). The highest gross return (Tk.329205/ha) and gross margin (Tk.253330/ha) were also recorded from SP normal row + 1 row maize (T5) Sweet potato normal row + one row maize wowed be most feasible and profitable management for sweet potato –maize intercropping system.

Introduction

Intercropping is the most popular crop production system in subsistence agriculture. It mostly involves cereals and legumes, where cereal is often considered as the main crop. Maize is the third important cereal crop in our country. Now a day's Maize is cultivating about 300000 hectare land in our country. Maize mainly used as feed, fodder, fuel and bakery industry. Sweet potato plays an important role in the daily diet in other countries of the world. It also comparable favorably in terms of nutritional value with other root crops, such as cassava, yam and other root crops, However inclusion of maize into sweet potato as intercropping system may increase production of maize. Intercropping provides on opportunity to avoid crop competition and advantages of increased production (Rahman, 1999) and greater profit margin (Hashem and Monirizzamn, 1986). So if sweet potato and maize con be grown as intercrop in the same piece of land, the farmers may be benefited economically. Hence, the study was undertaken to evaluate the performance of the system and to popularize it to the farmer's level.

Materials and Methods

The experiment was conducted at the ARS, BARI, Benarpota, Satkhira during rabi season of 2011-12. The experiment was laid out in RCB design with three replications. There were five treatment combinations viz. T1: sole hybrid maize, T2: sole sweet potato, T3: Maize paired row +2 rows of sweet potato, in between two maize paired row, T4: Maize normal row , one row of sweet potato in between two maize rows and T5: SP normal row + 1 row maize. The unit plot size was 4.5 m × 4.5 m. The BARI Hybrid maize-7 and sweet potato BARI-8 were used in this trial. Seeds of maize and cutting of sweet potato were sown in the field on 22 December 2011. The trial was fertilized with 250-60-130-30-4-1 kg NPKS Zn and B. /ha. Half of N and all other fertilizers were applied as basal. Remaining N was top dressed in two equal splits at 35 and 65 DAS. Sole sweet potato was fertilized with 125-50-125-18-2-1 kg NPKS Zn and B/ha, respectively. Half of N and all others fertilizers were applied as basal. Rest of N was top dressed at 35 DAS followed by earthing up and irrigation. The lowest level of soil salinity was recorded (Fig. 1) at sowing time (4.76 ds/m) and the highest level of salinity (14.97 ds/m) was recorded (Fig. 2) at the harvesting stage of maize. For the sweet potato, lowest level of soil salinity was recorded at planting time (4.76 ds/m) and the highest level of salinity (13.63 ds/m) was recorded at the harvesting stage. Plant protection measures were taken as and when require. Data on plant population, plant height no. of cob/plant, no. of row/cob, no. of grain/cob, 1000 seed weight, and grain yield of maize, number of plants/m^2, no. of stem/plant, no. of tuber/plant, weight of tuber/plant, and tuber yield/ha were collected and analyzed statistically using MSTAT-C program. Means were compared by DMRT.

Results and Discussion

Yield and yield contributing characters of maize were significantly influenced by different treatments combinations except plant height and no. of cobs/plant. (Table1). Significantly highest number of row/cob, grain/cob and 1000 grain weight were obtained from the sole maize. The highest gain yield (8.40 t/ha) was recorded in T_1, which was significantly higher from all other treatment. This might be due to higher plant population, higher number of grains/cob and 1000 grain weight. Treatments T_2, T_3 and T_4 gave statistically identical yield/ha. Yield and yield contributing characters of sweet potato as was influenced by different intercropping treatments (Table 2). Highest number of plants/m^2, stem/plant, tuber/plant, wt. of tubers/plant were recorded in T_2 treatment which was significantly higher than other treatments. Significantly highest tuber yield /ha was obtained from sole sweet potato (T_2) might be due to higher plant population, higher tuber/plant and tuber wt./plant. The lowest tuber yield/ha was obtained from T_3 treatment. The highest maize equivalent yield (51.23 t/ha) was obtained from SP normal row + 1 row maize (Table 3). The highest gross return Tk.329205/ha and gross margin Tk.253330/ha were also recorded from SP normal row + 1 row maize (T5).

Table 1. Yield and yield contributing characters of hybrid maize in intercropping maize with sweet potato

Treatments	Plant population/ plot	Plant height (cm)	Cobs /plant (no.)	Row /cob (no.)	Grain/cob (no.)	1000 seed weight (gm)	Grain yield (t/ha)
T_1	108.00a	191.33	2.00	16.00a	602.00a	9.94a	8.40a
T_3	108.00a	190.67	2.00	14.67b	585.00b	8.69b	7.63b
T_4	108.00a	186.67	2.00	14.67b	583.33b	8.66b	7.60b
T_5	54.00b	189.67	2.00	14.67b	584.00b	8.65b	7.31c
CV (%)	0.00	1.40	0.00	3.33	0.54	0.29	0.26

Means having same or without letter (s) do not differ significantly at 5% level of probability

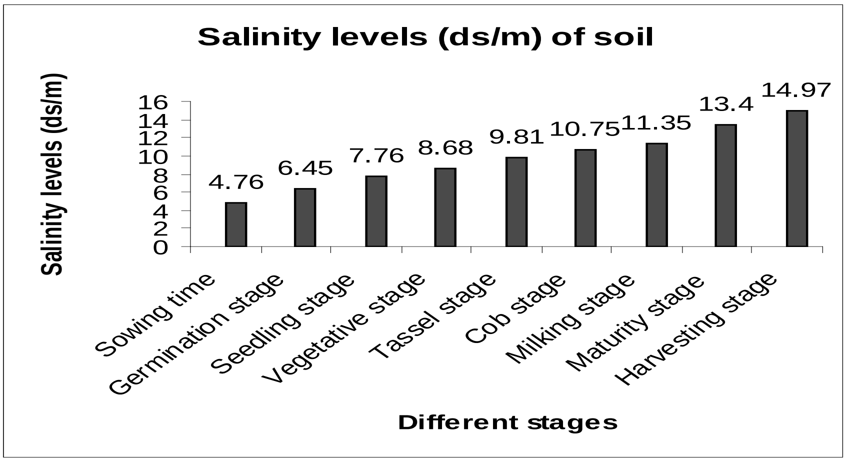

Fig. 1. Salinity levels (ds/m) of soil at different growth stages of maize.

Table 2. Yield and yield contributing characters of sweet potato in intercropping maize with sweet potato

Treatment	Plant population /m^2	Stem plant (no.)	Tubers/plant (no.)	Wt. of Tubers/plant (kg)	Tuber yield (t/ha)
T_2	105.00a	5.33a	6.33a	0.88a	39.50a
T_3	60.00c	3.33c	5.00b	0.73c	24.13c
T_4	75.00b	4.33b	5.00b	0.65c	22.66d
T_5	105.00a	4.33b	6.00a	0.83a	38.92b
CV (%)	0.00	0.00	5.17	1.69	1.95

Means having same or without letter (s) do not differ significantly at 5% level of probability

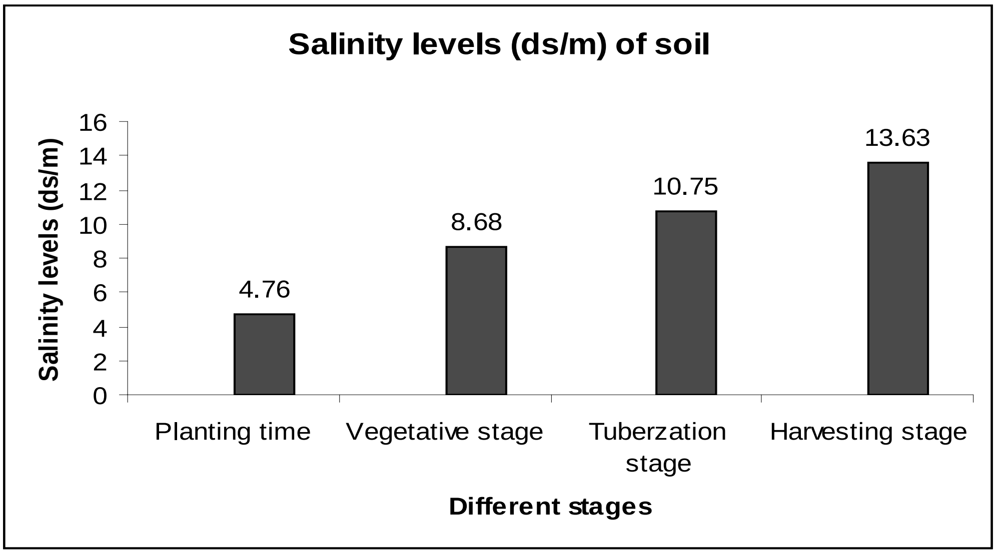

Fig. 2. Salinity levels (ds/m) of soil at different growth stages of sweet potato.

Table 3. Economic performance of hybrid maize sweet potato intercropping system

Treatment	Maize equivalent yield (t/ha)	Gross return (Tk/ha)	Variable cost (Tk/ha)	Gross margin (Tk/ha)	BCR
T_1 Sole Maize	8.40	129300	75750	53550	1.00
T_2 Sole sweet potato	39.50	183520	60380	123140	2.29
T_3 Maize paired row + 2 rows SP	31.76	235115	75875	159240	2.97
T_4 Maize normal row + 1 row SP	30.26	227255	75875	151380	2.82
T_5 SP normal row + 1 row Maize	51.23	329205	75875	253330	4.73

Conclusion

In appears from the results that maize grown as intercrop with sweet potato is more profitable than sole maize. The results also suggest profitable economic return from intercropping maize with sweet potato having the planting system of normal row + one row maize.

PILOT PRODUCTION OF HIGH VALUE CROPS THROUGH SUPPLEMENTAL IRRIGATION IN THE COASTAL AREA

M.A. Aziz, A.K.M. H.Rahman, P.K. Sarder, R.R. Saha, M.M. Hossain, M.M. Howlader, H.M.K. Basar.

Abstract

The experiment was conducted at the Agricultural Research Station (ARS), Benarpota, Satkhira and MLT site Dacope, Khulna of BARI during rabi season of 2011-2012 to find out the performance of high value crops through supplemented irrigation in the coastal saline area and to increase employment opportunity and economic return of the farmers. Three high value winter crops like tomato, cabbage, sweet gourd at Benerpota and two crops line watermelon and sweet gourd at Dacope were evaluated. All the crops are local variety. Tomato gave the yield 40.00 t/ha, Cabbage 41.00 t/ha and sweet gourd 10.33 t/ha at Benerpota and water melon 56.60 t/ha and sweet gourd 40.56 t/ha at Dacope. The highest gross return (Tk.260360/ha) and gross margin (Tk.88785/ha) and benefit cost ratio (2.52). Were recorded from tomato followed by cabbage at Benerpota and water melon (Gross return: Tk.556000/ha, gross margin: Tk.431250/ha, BCR: 4.46) at Dacope, Khulna. The results revealed that tomato and cabbage at Benerpota and water melon at Dacop would be economically profitable.

Introduction

After harvest of T. aman rice in the southern part of Bangladesh a vast coastal and offshore areas remain fallow. However, during the dry season (November through March) surface layer of the soil dries up, due to upword evaporation of saline water from the under ground by capillary forces. Thus a considerable amount of salt from the subsoil is carried to the surface and accumulates as salt crust. Cultivation of winter crops is very limited due to absence of irrigation water. During survey of existing crops and cropping patterns in the coastal area it was observed that some farmers use supplemental irrigation from reserve sources during the dry season. Growing of high value crops through supplemental irrigation in the coastal saline area would increase economic return of farmers. Therefore, the experiment was undertaken to find out the performance of high value crops through supplemental irrigation in the coastal saline areas of Bangladesh.

Materials and Methods

The study was conducted at the ARS, Benarpota, Satkhira and MLT site Dacope, Khulna of BARI from November 2011 to April 2012. The trial was laid out in a RCB design with three treatments having 3 replications. The test crops were tomato, cabbage and sweet gourd at Benerpota, and watermelon and sweet gourd at Dacape. All the crops are local variety. The crops were planted on 30 November 2011 at Benerpota and 25 February, 2012 at Dacope. The unit plot size was 5 m × 4 m. The lowest level of soil salinity was recorded (Fig. 1) at the planting stage (4.25 ds/m) and the highest level of salinity (6.25 ds/m) was recorded at the harvesting stage at Benerpota. Recommended doses of fertilizers were applied (FRG 2005). Intercultural operations were done when required. Data on was collected properly.

Results and Discussion

At Benerpota, highest yield of cabbage was recorded from cabbage followed by tomato and higher than that of sweet gourd. (Table 1) The gross return (Tk.260360/ ha), gross margin (Tk.88785/ha) and benefit cost ratio was (2.52) were recorded tomato followed by cabbage. At Dacope, the highest gross margin (Tk.431250/ha), gross return (Tk.124750/ha) and BCR (4.46) was achieved from water melon.

Table 1. Yield equivalent yield and economics of tomato, cabbage, sweet gourd and water milon

	Yield (kg/ha)		(Tk/ha)		Variable cost (Tk/ha)		Gross margin (Tk/ha)		BCR	
	Ben.	Dac.	Ben.	Dac.	Ben.	Dac.	Ben.	Dac.	Ben.	Dac.
Tomato	40.0	-	26.360	-	171575	-	88785	-	2.52	-
Cabbage	41.0	-	136220	-	92250	-	43970	-	1.24	-
Sweet gourd	10.33	40.56	70550	324480	35350	105460	35200	219020	1.00	3.08
Water melon	-	55.60	-	556000	-	124750	-	431250	-	4.46

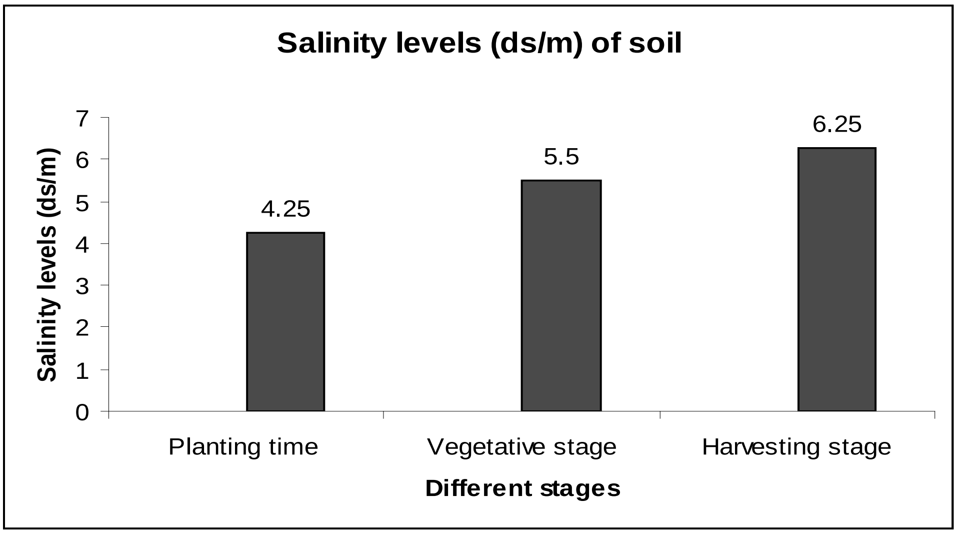

Fig.1. Salinity levels (ds/m) of soil at different growth stages of tomato

Conclusion

The results indicated that as tomato and cabbage might be the leading rabi crops at Benerpota and water melon at Dacope when farmers adopted supplemental irrigation to grow them.

IMPROVEMENT OF CROPPING PATTERN FOR COASTAL SALINE AREA OF KHULNA AGAINST FARMERS' EXISTING T.AMAN-FALLOW-FALLOW PATTERN

M.A. Aziz, P.K. Sardar, M.M. Hossain, M.M. Howlader and R.R. Saha

Abstract

The experiment was conducted at MLT site Dacope, Khulna during 2011-'12 to study the suitability of the improved cropping pattern and to increase economic returns of the farmers. The existing predominant cropping pattern of Dacope area is T.aman-Fallow-Fallow while the proposed cropping patterns are T. aman (BR 11)-wheat (Saurav), T. aman (BR 11)-mustard (BARI sarisha 9), T. aman (BR 11)-cowpea (BARI felon 1) and T. aman (BR 11)- maize (BARI hybrid maize 3). The highest gross margin (Tk. 16,725) and BCR (1.39) was obtained from maize based pattern.

Introduction

After harvest of T. aman rice in the southern part of Bangladesh a vast coastal and offshore area remains fallow. However, during the dry season (November to March) surface layer of the soil dries up due to evaporation and saline water from the underground moves up by capillary forces. Thus a considerable amount of salt from the sub-soil is carried to the surface and accumulates as salt crust. So, cultivation of winter crops becomes very limited due to absence of irrigation water. Previous study showed that mustard, mungbean, cowpea and wheat could be grown after harvest of T.aman rice provided the land becomes free during the month of last November to early December. Cultivation of short duration T.aman rice is the prerequisite to make the land free for winter crop cultivation. BR 11/BINA dhan 7 is a short duration T. aman rice variety matures 10-15 days earlier. So, there is a scope to make free the land for cultivate winter crop by harvesting short duration T. aman rice. Therefore, the experiment was conducted to verify alternate cropping pattern against farmers' existing T. aman-Fallow-Fallow cropping pattern for the coastal saline area of Khulna.

Materials and Methods

The experiment was conducted at MLT site, Dacope, Khulna during 2011-'12. The existing cropping pattern in this area is T.aman-Fallow-Fallow and the proposed cropping patterns are T. aman (BR 11)-wheat (Saurav), T. aman (BR 11)-mustard (BARI Sarisha 9), T.aman (BR 11)-cowpea (BARI Felon 1) and T.aman (BR 11)- maize (BARI Hybrid maize 3). The alternate cropping patterns were tested with 3 dispersed replications across the farmers' field under same land type. The unit plot size was 100 m^2. For maize, the land was fertilized with 250-55-144-34-13-1 Kg of N-P-K-S-Zn-B respectively. One third of nitrogen and all other fertilizers were applied as basal and rest N was applied in two equal splits at 8-10 leaves stage and the other at teaseling stage. In case of mustard, 138-36-50-32 kg/ha of N-P-K-S was applied. One third of nitrogen and all other fertilizers were applied as basal and rest of N was applied in two equal splits at 25 and 45 DAS. Seeds of mustard (BARI Sarisha 9) and maize (BARI Hybrid maize 3) were sown on 17 November, 2011. Maize was sown in line with spacing of 75 cm x 25 cm and mustard was broadcasted. For maize, four irrigations and two weedings were done while irrigation, thinning and weeding were done once for each activity in mustard. Malathion 57 EC and Diazinon 10 G was applied for controlling aphid and cutworm. Mustard and maize was harvested on 9 February, 2012 and 29 March, 2012 respectively. Wheat and cowpea could not have been established due to severe cold and rainfall.

Results and Discussion

Yield and yield contributing characters of BR 11 and yield of maize and mustard and their economic analysis in alternate cropping pattern are presented in Tables 1 and 2. The yield of BR 11 was 5.00 t/ha. Maize produced the highest gross margin (Tk. 16,725/ha) and BCR (1.39) compared to mustard.

Table 1. Yield and yield attributes of T.aman at MLT site, Dacope, Khulna

Variety	Plant ht. (cm)	Tillers/hill (no.)	Panicle length (cm)	Grains/ panicle (no.)	1000-grain wt. (g)	Grain yield (t/ha)	Straw yield (t/ha)
BR 11	101.20	10.20	25.35	86.60	23.00	5.00	6.90

Table 2. Yield and economic return of different crops in the alternate cropping pattern at MLT site, Dacope, Khulna

Crop	Yield (t/ha)	Gross return (Tk./ha)	Total cultivation cost (Tk./ha)	Gross margin (Tk./ha)	BCR
Maize	4.25	67,000	50,275	16,725	1.39
Mustard	0.80	33,600	26,748	6852	1.26

Price (Tk./kg): Maize-15 and Mustard-42

Farmers' Opinion

Farmers are pleased with the performance of maize and mustard in Dacope area of Khulna. They opined that cultivation of maize and mustard in alternate cropping pattern could expose the scope of employment as well as would increase their family income.

Conclusion

Maize is a deep rooted crop and it could escape salinity stress. So, maize could be the suitable crop in this area and it can be introduced in existing cropping pattern. It needs to verify the result in the next year.

PERFORMANCE OF HYBRID MAIZE VARIETIES IN THE SALINE AREA

M.A. Hossain, A.K.M. H. Rahman, M. Idrids and S.M. Zaman

Abstract

An experiment was conducted at Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during rabi season of 2011-12 to select the suitable hybrid maize variety adaptive for saline area. Six hybrid maize varieties viz. BARI Hybrid maize-2, BARI Hybrid maize-5, Pacific-11, Pacific-60, Pacific-555 and Pacific-984 were used as experiment materials. Results showed that yield and yield attributes of maize varied significantly among the varieties. The highest grain yield (10.50 t/ha) was obtained from Pacific-984 followed by Pacific-11 (10.30t/ha) and Pacific-60 (10.02 t/ha) and the lowest from Pacific-555 (8.57 t/ha).

Introduction

Maize is one of the most important grain crops in the world. It has a good potential as a cereal crop side by side with rice and wheat in Bangladesh. Its grain has high nutritive value containing 66.2% starch, 11.1% protein, 7.12% oil and 1.5% minerals (Chowdhury and Islam, 1993). Grain parts of the plant at grain are sued as feeds for livestock and poultry respectively. The agro-climatic condition of Bangladesh is favorable for is cultivating round the year. It is mentioned that the last devastating cyclone in the coastal area of Bangladesh especially Satkhira has broken the backbone of all most all farmers. T. aman crop in those areas is completely damaged. Maize could be grown as cyclone rehabilitation program in the cyclone affected areas. Among the popular hybrid maize varieties which one will be most suitable for those areas is not yet studied. The present study was undertaken to find out suitable hybrid maize variety for the saline area of Bangladesh.

Materials and Method

The experiment was conducted at ARS, BARI, Benarpota, Satkhira during rabi season of 2011-12. Six hybrid maize varieties viz BARI Hybrid maize-2, BARI Hybrid maize-5, Pacific-11, Pacific-60, Pacific-555 and Pacific-984 were tested in a randomized complete block design with three replications. Seeds of different varieties were sown on 25 December 2011 at Benarpota with a spacing of 75cm × 25cm. The trial was fertilized with 253-52-110-46-5-1.2 kg/ha of N-P-K-S-Zn-B, respectively. In addition to chemical fertilizers 6t/ha cowdung was used. All fertilizer along with 6 t/ha cowdung and $\frac{1}{3}$ N were applied as basal during final land preparation. The rest of urea was applied in two equal split at 35 and 65 DAS. Two irrigations were given following the urea top dressing. Earthing up was done after 2^{nd} top dress of urea. Three times weeding and necessary plant protection measures were taken. The lowest level (6.25 ds/m) of soil salinity was recorded at the sowing time and the highest level of salinity (11.50 ds/m) was recorded at the harvesting stage (Fig. 1). Data on different plant characters and yield were recorded and analyzed statistically using MSTAT-C program.

Result and Discussion

The yield and yield contributing characters of maize varieties varied significantly by natural soil salinity at Satkhira (Table 1). Highest cob length was recorded from Pacific 984 (24 cm) followed by Pacifc-60 (23 cm). BARI Hybrid maize-5 gave the lowest cob length (17.21 cm). Highest number of seed per cob was obtained from Pacific-984 (603 seed/cob) and the lowest from BARI Hybrid maize-5 (453). The highest grain weight (36.3 g/100 grain) was recorded in Pacific-984 followed by BARI Hybrid maize-2 (27.4 g/100 grain). Pacific-555 gave the lowest grain weight

(29.0 g/100 grain). Highest grain yield (10.50 t/ha) was obtained from Pacific-984 and it was statistically identical with Pacific-11 and Pacifica-60. This might be due to higher number of grains/cob and 100 grain weight. Pacific-555 gave the lowest grain yield (8.57 t/ha) due to lower yield contributing characters.

Table 1. Yield and contributing characters of hybrid maize in rabi, 2011-12 at Benarpota, Satkhira.

Variety	Plant population /10m^2	Plant height (cm)	Length cob	Grains/cob (no.)	100-grain wt (gm)	Grain yield (t/ha)
BARI Hybrid maize-5	8	200a	20.5bc	492bc	35.7ab	9.04bc
BARI Hybrid maize-7	8	172c	17.21c	453c	33.4ab	9.43bc
Pacific-11	8	190ab	23.0ab	454c	29.5b	10.30ab
Pacific-60	8	192ab	23.0ab	581b	27.4c	10.02ab
Pacific-555	8	199ab	20.0bc	521bc	29.0b	8.57c
Pacific-984	8	185b	24.0a	603a	36.3a	10.50a
CV (%)	5.61	10.35	9.52	6.32	10.12	9.68

Means having same or without letter (s) do not different significantly at 5% level of probability

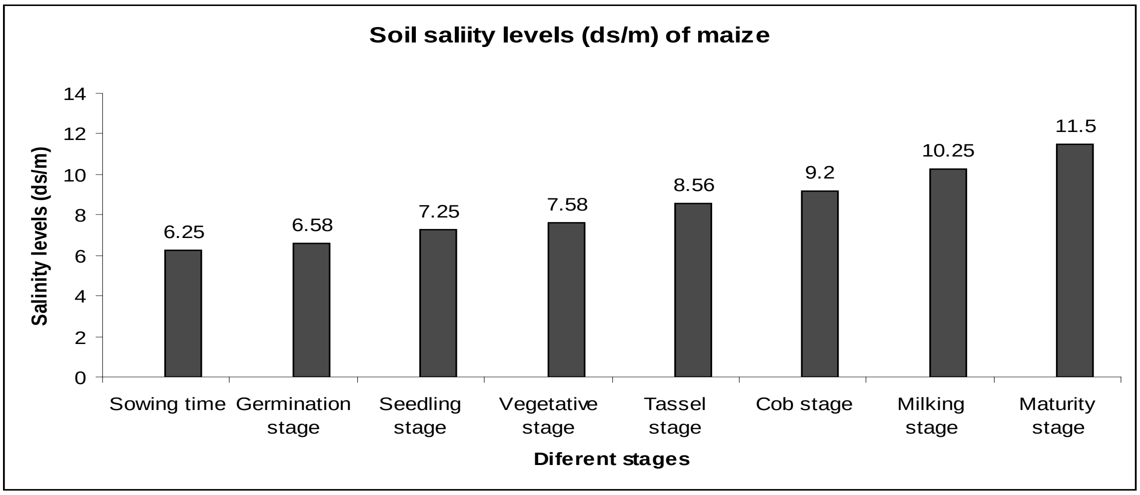

Fig. 1. Salinity levels (ds/m) of soil at different growth stages of maize.

Conclusion

The result indicated that Pacific-984, Pacific-11 and Pacific-60 would be suitable for higher production in coastal saline areas.

PERFORMANCE OF SALT TOLERANT BARLEY GENOTYPES IN THE SALINE AREA

M.A. Hossain, A. K. M. Rahman, M.I.A. Howlader, S.M. Zaman and M. Amin

Abstract

An experiment was conducted at ARS, BARI, Benarpota, Satkhira during rabi season of 2011-12 to find out the suitable salt tolerant barley lines Three salt tolerant lines viz.BHL-18, BHL-15 and BHL-19 were used as treatment variables. The results showed that number of spikelet/spike grains/spike and yield/ha the genotypes. Highest grain yield (0.98 t/ha) was recorded from BHL-15 followed by BHL-18 and the lowest (0.83 t/ha) from BHL-19.

Introduction

Barley (*Hordium vulgare* L.) is the world's 4th most important cereal crops and it has the potential to become one of the important crops in Bangladesh. Barley though a minor crop of the country can play an important role in enhancing the food security of the country and in reducing the drainage of foreign currency. Barley is popular for home consumption of rural people. This has several industrial uses also for which import is unavoidable. Further of all cereals barley is well known for its high resistance to salinity and thus has a great potentiality for expansion is the coastal saline area, which mostly remains fallow in the rabi season. Therefore, development of high yielding and salt tolerant superior quality barley varieties is very much necessary for reducing the drainage of foreign currency and for enhancing the over all food security of the country.

Materials and Methods

The experiment was conducted at ARS, BARI, Benarpota, Satkhira during rabi season of 2011-12. Three lines namely BHL-18, BHL-15, BHL-19 were used in this experiment. The crop was sown on 15 December 2011 in Satkhira. Seeds were sown continuously and line to line spacing was 30 cm. Fertilizer was applied at the rate of 100-60-40 kg/ha of NPK respectively in the form of urea, TSP and MP and were applied as basal. The lowest level of soil salinity was recorded at the sowing time (5.5 ds/m) and the highest level of salinity (12.45 ds/m) was recorded at the harvesting stage (Fig. 1). Data on yield and yield attributes were collected and analyzed statistically using MSTAT-C program.

Results and Discussion

Number of spikelet/spike, grains/spike and grain yield/ha were significantly influenced due to genotype variations (Table 1). Highest spikeles/spike was obtained from BHL-15 and it was statistically identical with BHL-18. Number of grains/spike varied from 28.0 to 42.0 across the lines. Lines BHL-15 consistently produced higher number of grains/spike and the lowest from BHL-19. Lines BHL-15 and BHL-18 gave statistically identical yield but significantly different from BHL-19. The lowest grain yield was obtained from BHL-19. A decrease in yield possibly due to increased in salinity level during crop growth period. Similar results was reported by Karmoker (1997) in wheat.

Table 10.Yield and yield attributing characters of salt tolerant Barley varieties during rabi season, 2011-2012.

Variety	Spikelet/spike(no.)	Grains/spike (no.)	Grain yield (t/ha)
BHL-18	49.7a	42.0a	0.98a
BHL-15	45.0a	38.0b	0.96a
BHL-19	39.0b	28.0c	0.83b
CV(%)	5.76	5.64	5.63

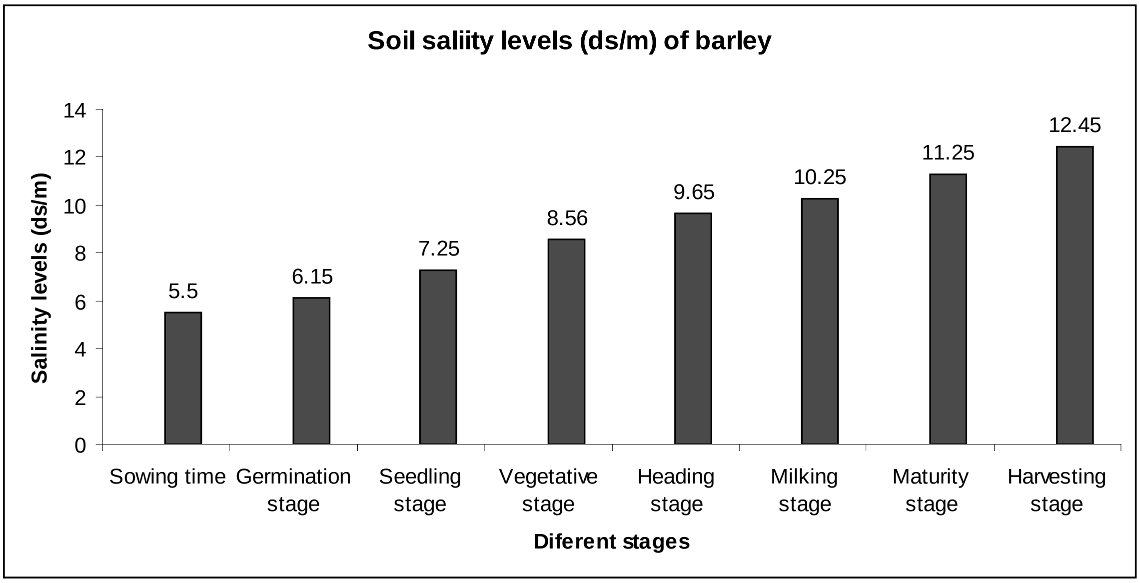

Fig. 1. Salinity levels (ds/m) of soil at different growth stages of barley

Conclusion

It may be concluded that salt tolerance made in laboratory condition showed consistency under field condition in the coastal area. BHL-15, 18 would be suitable for cultivation in the coastal saline area. The experiment should be repeated in the next season for further confirmation.

INFLUENCE OF MULCH MATERIAL ON SALINITY MANAGEMENT OF PIT BASED CROPS

M.A. Hossain, P.K. Sardar, R.R. Saha, M.M. Hossain and M.M. Howlader

Abstract

The experiment was conducted at MLT site, Dacope during 2011-12 to evaluate the effect of mulch material on the yield and yield attributes three vegetable crops Two mulch materials viz. straw mulch, saw dust mulch along with control (no mulch) and three vegetable crops viz. watermelon, sweet gourd and bitter gourd were taken as treatments. The results showed that mortality percentage of seedling, number of fruits/plant, fruit size individual fruit weight and yield of water melon, sweet gourd and bitter gourd were significant in. In hence by different mulch materials. All the pit based crops used in the study gave the highest yield when straw mulch was used and the lowest yield was obtained from control plots where no mulch was used.

Introduction

In Bangladesh, about 2.85 million hectare of net cultivable area is under coastal zone of which 0.88 million hectares is affected by different degrees of seasonal salinity. Three types of stress i.e. soil moisture stress, specific ion toxicity and nutrient ion imbalance are associated with saline habitat that may affect crop growth and yield. Among the different stresses, soil moisture is the most limiting factor for crop production in saline area during *rabi* and pre-*kharif* transition period. For this reason, 71-96% land remains fallow after harvest of T.aman rice in saline area of Khulna, Satkhira, Potuakhali and Noakhali coastal zone (Begum *et al*., 2006). Mulch reduces soil salinity considerably by interrupting capillary movement. Farmers in this area irrigate their crops from mini pond, locally known as *kuni*. But during *rabi* season, crop production in this saline area is seriously hampered due to lack of sufficient irrigation water. Use of organic mulch can reduce irrigation frequency by conserving soil moisture. Hence, the experiment was undertaken to evaluate the effect of mulch materials on the yield attributes and yield of pit based crops water melon, sweet gourd and better gourd in the farmers' field at Dacope Khulna.

Materials and Methods

The experiment was conducted at MLT site, Dacope, Khulna during 2011-12. Two mulch materials viz. straw mulch, saw dust mulch along with control (no mulch) were taken as treatments. Three vegetables crops viz. watermelon, sweet gourd and bitter gourd were selected for the experiment. The unit plot size was 6m x 6m. The land was fertilized with different fertilizer doses recommended for a particular crop (FRG, 2005). The experiment was laid out in RCB design with four replications. Seeds of the crops were sown in pit maintaining recommended spacing. Seeds of watermelon and sweet gourd were sown on 10 March, 2012 while that of bitter gourd were sown on 13 March, 2012, respectively. The crops were harvested on 20-25 May, 2012 according to maturity. Yield and yield contributing characters of crop were collected by analyzed statistically.

Results and Discussion

Water melon

Mulch materials were found to have significant influence on mortality percentage, fruit size, individual fruit weight and yield of water melon. Mulching did not show any significant effect on fruits/ plant (Table 1). The highest yield (56.22 t/ha) was recorded from the plot where straw mulch was used. This might be due to its higher number of fruits per plant (1.28), individual fruit weight (4.01) and the lowest plant mortality (8.33 %). The plot where saw dust was used as mulch gave secont highest fruit yield of (47.04t/ha). The lowest yield was observed in the plots where no mulch was used (42.45 t/ha) probably due to its higher mortality percentage (20.83 %) caused by water stress and development of soil salinity.

Table 1. Yield and yield contributing characters of watermelon influenced by mulch materials

Treatment	Mortality (%)	Fruit/plant (no.)	Fruit length (cm)	Fruit diameter (cm)	Individual fruit wt. (kg)	Yield (t/ha)
No mulch	20.83	1.21	30.11	18.01	3.69	42.45
Saw dust mulch	16.67	1.22	31.03	19.46	3.86	47.04
Straw mulch	8.33	1.28	30.11	19.64	4.01	56.22
LSD $_{(0.05)}$	5.55	NS	0.75	0.09	0.07	3.32
CV (%)	20.98	3.76	1.41	0.96	1.08	3.95

Sweet gourd

Seedling mortality percentage, number of fruits/plant, fruit size, individual fruit weight and yield of sweet gourd varied significantly across the mulch treatments (Table 2). All the yield attributes were highest were straw much was used followed by that of saw dust mulch. The highest yield of sweet gourd (38.62 t/ha) was recorded from the plot where straw was used as mulch. Retention of more soil moisture for long period helped the plant to grow vigorously and reduced soil salinity which ultimately increased number of fruits/plant, and individual fruit weight that resulted in higher yield. The lowest mortality (9.92 %) was also one of the causes of the highest yield. The lowest yield was recorded from no mulch (26.36 t/ha) due to the highest mortality (22.89 %) rate.

Table 2. Yield and yield contributing characters of sweet gourd influenced by mulch materials

Treatment	Mortality (%)	Fruit/plant (no.)	Fruit length (cm)	Fruit diameter(cm)	Individual fruit wt. (kg)	Yield (t/ha)
No mulch	22.89	1.38	16.83	16.97	2.06	26.36
Saw dust mulch	14.24	1.44	17.13	17.83	2.14	31.68
Straw mulch	9.92	1.55	17.64	18.24	2.31	38.62
LSD $_{(0.05)}$	2.17	0.05	0.26	0.34	0.05	1.61
CV (%)	7.99	1.77	0.88	1.11	1.77	2.88

Bitter gourd

Effect of mulching on seedling mortality percentage, number of fruits/plant fruit size individual fruit weight and yield of bitter gourd were significantly different among the much treatment (Table 3). Plant grown with straw mulch treatment produced highest yield attributes of bitter gourd followed by saw dust mulch.The highest yield (13.59 t/ha) of bitter gourd was received from the plot where straw was used as mulch. The second highest yield (13.02 t/ha) was recorded from saw dust mulch. The lowest yield (10.20 t/ha) was observed where no mulch was used.

Table 3. Yield and yield contributing characters of bitter gourd influenced by mulch materials

Treatment	Mortality (%)	Fruit/plant (no.)	Fruit length (cm)	Fruit diameter (cm)	Individual fruit wt. (g)	Yield (t/ha)
No mulch	40.50	14.15	9.00	3.03	241.25	10.20
Saw dust mulch	15,08	16.28	10.13	3.15	326.25	13.02
Straw mulch	9.56	16.96	10.48	3.27	347.00	13.59
LSD $_{(0.05)}$	2.39	0.39	0.12	3.03	38.76	0.57
CV (%)	6.37	1.41	0.70	0.09	7.35	2.70

Farmers' Opinion

Farmers' are interested with the application of mulch to produce pit based crops in the region for its impact on water holding capacity in the root zone area, which reduces the amount of irrigation water substantially.

Conclusion

Considering higher yield and lower mortality percentage, it can be concluded that rice straw could be the best as mulch material followed by sawdust for producing pit based crops in the saline coastal area of Khulna.

SALINITY INDUCED CHANGES IN YIELD OF SELECTED MUSTARD GENOTYPES

S.N. Mahfuza, F.Ahmed and M. A. Aziz

Abstract

The experiment was carried out in vinyl house of Agronomy field at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2012-2013 to examine the variation in salt tolerance of selected mustard genotypes up to maturity .Four mustard genotypes (DB-9069, BD-9093, BARI Sarisha-11 and BARI Sarisha-14) were tested for their salt tolerance at different degrees of salinity (0, 5, 7.5 and 10 dS/m of NaCl). Genotypes were greatly influenced by salinity with respect to root dry weight, shoot dry weight and yield over control. Among the four genotypes, BARI Sarisha-14 and BD 9093 perform better in respect of relative root dry weight, relative shoot dry weight and yield component than the other genotypes.

Introduction

In Bangladesh coastal areas occupy almost thirty percent of the net cultivable land. Almost 1.06 million hectares of coastal land is affected by salinity of varying degrees. Mustard is one of the most important oil crops in Bangladesh which can be grown in the coastal area. The most common adverse effect of salinity on the crop of Brassica is the reduction in plant height, seed size and yield as well as deterioration of the quality of the product (Kumar, 1995). Fifty genotypes of mustard available in BARI gene bank were screened for their salt tolerant at early vegetative stage in Hoagland solution under laboratory condition. It has been reported by a number of workers that in some crops selection for salt tolerance at the early growth stages may not correlate with their tolerance at the later growth stages (Ashraf and McNeilly, 1988).Nevertheless, seed germination and seedling establishment are the most critical stages in life cycles of plants in a saline environment (Blum,1985) and are of importance in assessing the over all salt tolerance of a crop(Akbar and Yabuno 1974, Ashraf *et al*,.1990). However, Brassica has some potential to cope with the toxicity of salts (Francois, 1984). So it can be successfully grown on salt affected soils. Keeping this view in mind, the experiment was undertaken to examine the effect of salinity levels on root dry weight, shoot dry weight and yield of selected mustard genotypes up to maturity in pot culture.

Materials and Methods

The experiment was carried out in vinyl house of Agronomy field at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2012-2013. Four selected (BD 9069, BD 9093, BARI Sarisha-11 and BARI Sarisha-14) out of 50 genotypes of mustard screened in laboratory under Hoagland nutrient solution culture were used in the study at 0, 5, 7.5 and 10 dS/m of Nacl solution. Plastic pots (top dia 76 cm, bottom dia 74 cm and height 30 cm) were filled with soil and cow dung in 4:1 volume ratio and final weight of pot was 13 kg. N_{120} P_{35} K_{65} S_{25} Zn_2 B_1kg/ha in the form of urea, triple super phosphate, muriate of potash, zypsum, zinc sulphate and boric acid were incorporated in the soil. Ten seeds of each genotypes were sown in each pot on 25 November 2012. Thinning of seedling was done at 10 day after sowing by keeping four plants for each pot. The pots were irrigated with tap water to grow crop without moisture stress. The study was evaluated under completely randomized design (factorial) with four replications. Fifteen days after sowing, salt solutions were applied in treated pot. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 5.0, 7.5 and 10.0 dS/m solution. Tap water was used as control and its EC was 0.3 dS/m. The salt solution was applied with an increment of 2.5 dS/m in every alternate day till respective salinity level of 5, 7.5

and 10 dS/m were attained. Treatment solution was applied in excess so that the extra solution dripped from the bottom of the pots. The root and shoot sample were collected prior to harvest. The collected sample was oven dried at 80^0C, for 72 hours. For root sampling, plastic pots were soaked in water, soil was washed with water and the roots were recovered by passing the soil water suspension through a 2mm mesh sieve. The yield and yield component data were collected from five randomly selected plants from each treatment at harvest. Data were analyzed following MSTAT program and means were compared using LSD test.

Results and Discussion

There was variation in root dry weight among the genotypes under control condition (Fig.1). The genotype BD-9093 gave the highest root dry weight (4.55g/plant) followed by genotypes BD-9069 (3.06g/plant) and the genotype BARI Sarisha-14 gave the lowest root dry weight (2.00g/plant) in control condition. Root dry weight decrease linearly with increasing the salinity level from 5.0 to 10.0 dS/m in all the genotypes. The reduction in root dry weight was minimal in genotype BD-9069 at salinity level up to 7.5 dS/m.

The genotype BD-9069 gave the highest shoot dry weight (21.73 g) and the lowest shoot dry weight (12.77 g) was obtained from BARI Sarisha-14 in control condition (Fig.2). Shoot dry weight was significantly decreased with increasing salinity level up to 10 dS/m. The highest reduction was observed under high salinity level. The reduction in shoot dry weight might be due to decrease in Co_2 uptake in leaves (Fedina and Popova, 1996) mainly because of sodium chloride treatment decrease stomatal conductance and consequently less Co_2 was available for carboxylation reaction in the photosynthetic apparatus (Yadav *et. al*., 1996).

Yield components

The yield components of mustard genotypes like no. of siliqua/plant, no. of seeds/siliuqa and 1000-seed weight differed significantly among the genotypes both under control and saline condition (Table 1). The highest no. of siliqua/plant (213.33) recorded in BD-9093 at control condition followed by BD-9069 (191.67). The lowest no. of siliqua/plant (51.33) was found in BARI Sarisha-14 at10 dS/m salinity level. Increasing salinity level led to a significant reduction in no. of siliqua/ plant. The reduction of no. of siliqua/plant at 5 dS/m was observed and BARI Sarisha-14 gave 97% no. of siliqua/plant followed by BD-9093 and BARI Sarisha-11. The lowest relative no. of siliqua/plant was obtained from BD-9069 (84%). At 7.5 dS/m salinity level relative no. of siliqua/plant was highest in BARI Sarisha-14 (88%) and the lowest relative no. of siliqua/plant was recorded in BD-9069 (75%). At 10 dS/m salinity level relative no. of siliqua/plant decrease and it was below 80%, except BARI Sarisha-14 of control treatment in all the genotypes. BARI Sarisha-14 gave the highest (81%) relative no. of siliqua per plant and the lowest was recorded in BD-9069 (70%).

The no. of seeds/siliqua was more or less affected by salinity in all the genotypes of mustard. The highest no. of seeds/siliqua was obtained in BARI Sarisha-14 (25) which was followed by BD 9093 (18) and the lowest no. of seeds/siliqua was obtained from BARI Sarisha-11 (15.33) under control condition. At 5 dS/m salinity level reduction in no. of seeds/siliqua was also observed in all the genotypes. The highest relative no. of seeds/siliqua was 92% in BARI Sarisha-14 and the lowest relative no. of seed / siliqua was 84% in BD-9069. At 7.5 dS/m salinity level BD-9093 and BARI Sarisha-11 (89%) produced the highest relative no. of seed/siliqua and BD -9069 produced the lowest relative no. of seeds/siliqua (80%). At 10 dS/m BARI Sarisha-14 performed best in producing relative no. of seed/silliqua (81%).The lowest relative no. of seeds/siliqua was obtained from BARI Sarisha-11 (72%).

The 1000-seed weight under non saline condition was the highest in BD-9093 (4.07g) followed by BARI Sarisha-11(3.95g) and BD-9069 (3.76g).The lowest 1000-seed weight under non saline condition was in BARI Sarisha-14 (3.73 g). At 5 dS/m salinity level, relative 1000-seed weight was highest in BD-9069 (96%). The lowest relative 1000-seed weight was in BARI Sarisha-11 (92%). At 7.5 dS/m salinity level BARI Sarisha-14 performed better (93%) and BARI Sarisha-11 performed least (85%) in terms of relative 1000-seed weight. At 10 dS/m salinity level, BARI Sarisha-14 produced the highest relative 1000-seed weight (91%) and BARI Sarisha-11 produced the lowest relative 1000-seed weight (78%).

Seed yield

Seed yield is the function of no. of siliqua/plant, no. of seeds/siliqua and 1000-seed weight. Changes in any of the characters due to salinity would provide a detailed appraisal for the response for lower seed yield in salinized mustard plants. An inverse relationship was expressed between salinity levels and seed yield. Higher the salinity levels lower was the yield. In control condition BD-9093 gave the highest seed yield (18.89g/plant) and the lowest in BARI Sarisha-11. At 5 dS/m salinity level the relative yield was found highest in BD-9069 (85%) followed by BARI Sarisha-14 (81%). The lowest relative yield was found in BARI Sarisha-11(77%). At 7.5 dS/m salinity level BD-9069 also performed better (78%) in respect of relative seed yield and the lowest was found in BARI Sarisha-11 (67%). At 10 dS/m salinity level, yield was decreased drastically in all the genotypes but BARI Sarisha-14 produce higher relative seed yield (69%) and BARI Sarisha-11(57%) produced the lowest relative seed yield. The revealed in this study result indicates that salinity greatly reduced the yield of all the genotypes at high salinity level.

Conclusion

Among the four genotypes, BARI Sarisha-14 and BD-9093 perform better in respect of relative root dry weight, relative shoot dry weight and yield component than the other genotypes.

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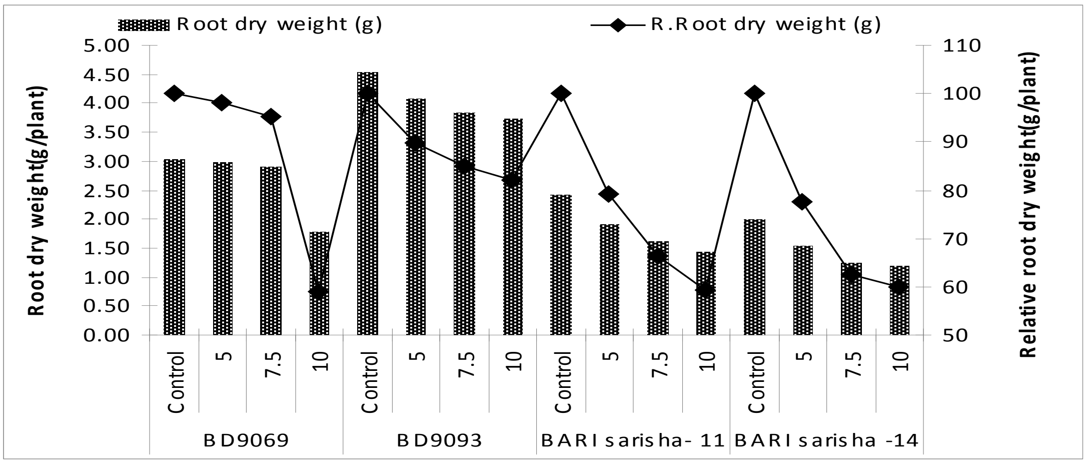

Fig .1.Effect of salinity on root dry weight of four selected mustard genotypes

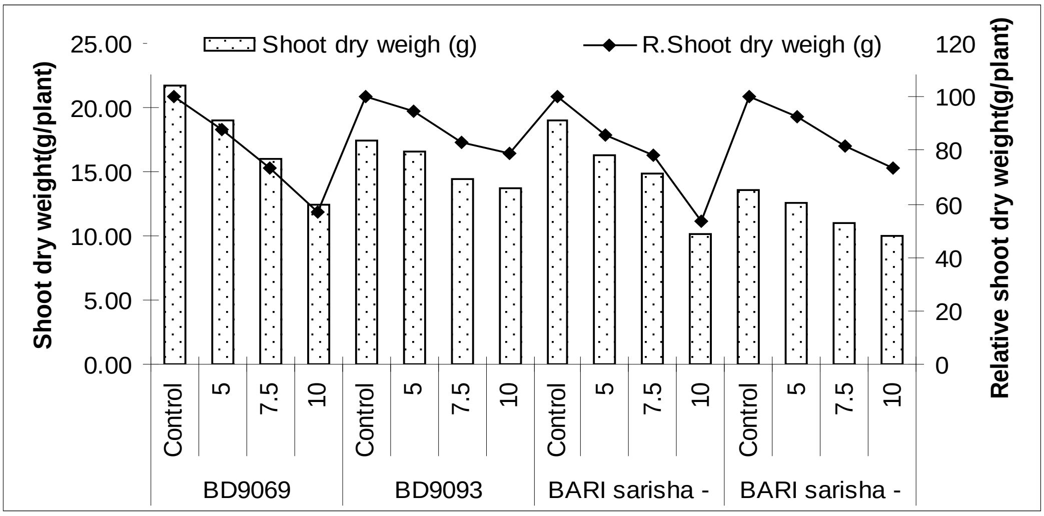

Fig .2.Effect of salinity on shoot dry weight of four selected mustard genotypes

Table 1.Effect of salinity on siliqua/plant and seeds/siliqua of selected mustard genotypes

Genotypes	Siliqua/plant				Seeds/siliqua			
	Control	5	7.5	10	Control	5	7.5	10
BD-9069	191.67	161.67 (84)	144.33 (75)	133.67 (70)	18.67	15.67 (84)	15.00 (80)	13.67 (73)
BD-9093	213.33	198.00 (93)	181.67 (85)	163.67 (77)	18.00	16.00 (89)	16.00 (89)	13.67 (76)
BARI Sarisha-11	145.00	125.00 (86)	113.67 (78)	105.33 (73)	15.33	14.00 (91)	13.67 (89)	11.00 (72)
BARI Sarisha-14	92.33	90.67 (97)	81.00 (88)	75.67 (81)	25.00	23.00 (80)	21.67 (87)	20.33 (81)
$LSD_{(0.05)}$	9.41				4.34			
CV (%)	10.74				4.99			

Values in parenthesis showed relative value over control, Calculated as [(value of parameter/ value of control) × 100

Table 1. Effect of 1000–seed weight and seed yield/plant of selected mustard genotypes

Genotypes	1000- seed weight (g)				Seed yield/plant(g)			
	Control	5	7.5	10	Control	5	7.5	10
BD-9069	3.76	3.60 (96)	3.46 (92)	3.24 (86)	14.00	11.83 (85)	10.92 (78)	8.40 (60)
BD-9093	4.07	3.79 (93)	3.72 (91)	3.61 (89)	18.89	15.93 (89)	13.23 (70)	12.41 (66)
BARI Sarisha-11	3.95	3.62 (92)	3.35 (85)	3.07 (78)	8.56	6.61 (77)	5.76 (67)	4.92 (57)
BARI Sarisha-14	3.73	3.52 (94)	3.46 (93)	3.39 (91)	9.48	7.66 (81)	6.83 (72)	6.57 (69)
$LSD_{(0.05)}$	0.213				2.32			
CV (%)	4.98				5.25			

Values in parenthesis showed relative value over control, Calculated as [(value of parameter/ value of control) ×100

EFFECT OF PLANTING METHOD AND SALT WATER SEED PRIMING ON THE YIELD OF HYBRID MAIZE IN SALINE AREA

Md. Atikur Rahman, F. Ahmed, A.H.M. Fazlul Khabir and Sadia Afrin

Abstract

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during rabi season of 2012-2013 to evaluate planting method and seed priming effect on the yield of hybrid maize in saline areas. There were six treatment combinations viz. T_1: No Priming + normal sowing, T_2: No Priming + ridge sowing, T_3: Seed priming with 1% NaCI Solution + normal sowing, T_4: Seed priming with 1% NaCI Solution + ridge sowing, T_5: Seed Priming with water + normal sowing, T_6: Seed Priming with water + ridge sowing. The highest grain yield (10.07 t/ha) was recorded in T_4 treatment while the lowest in T_1 treatment (7.91 t/ha). The lowest level of soil salinity was (3.25 ds/m) recorded at the sowing time and the highest level of salinity was (10.15 ds/m) recorded at the harvesting stage.

Introduction

Salinity is a major limiting factor in crop production all over the world. In Bangladesh, about 0.84 million hectare of coastal land is affected by various degrees of salinity. It is predicted that the saline area in Bangladesh would be increased further due to climate changes. Our population is increasing while agricultural land is decreasing by 1% in every year. In this situation we have to find out the way to produce more crops in saline soil. Different strategies have been adopted by various crop scientists to overcome the salinity problem. Strogonov (1964) reported that salt tolerance of plants can be increased by priming of seeds with saline water before sowing. Priming of maize seeds with NaCl before sowing induces Physiological and biochemical changes, which resulted in better performance when subsequently exposed to different levels of salinity (Bakht *et. al*, 2011), besides, management practices like ridge –furrow planting can improve the crop productivity under saline soil with appropriate management practices. Therefore, the present experiment was conducted to evaluate seed priming and planting system on hybrid maize production in saline soil.

Materials and Method

The experiment was conducted at Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2012-13. The variety was BARI hybrid maize-7. There were six treatment combinations viz. T1: No Priming + normal sowing, T2: No Priming + ridge sowing , T3: Seed priming with 1% NaCI Solution + normal sowing, T4: Seed priming with 1% NaCI Solution + ridge sowing, T5: Seed Priming with water + normal sowing, T6: Seed Priming with water + ridge sowing were tested in a randomized complete block design with three replications. Seeds of different varieties were sown on 01 January, 2013 at Benarpota with a spacing of 75cm ^ 25cm. Unit plot size was 4.2m ^ 4m. The trial was fertilized with 250-55-110-40-5-1.5 kg/ha of N P K S Zn B (FRG/2005), respectively. One third N along with full amount of other fertilizers was applied as basal. Remaining N was top dressed in 2 equal splits at 40 and 70 DAS. Two irrigations were given following the urea top dressing. Earthing up was done when plants attained at three leaves stage. Three times weeding and necessary plant protection measures were taken. Data on different plant characters and yield were recorded and analyzed statistically using MSTAT-C program.

Results and Discussion

Planting methods and seed priming showed significant influence on plant population, yield components and yield of hybrid maize (Table). The treatment combinations those have been studied significantly varied from each other under saline environment of soil.

Table 1. Yield and yield contributing characters of planting method and seed priming effect on maize

Treatment	Initial popln/ plot	Final popln/ plot	Plant height (cm)	No. of grain/cob	1000-grain weight (g)	Grain yield (t/ha)
T_1	107.33	102.00ab	136.00cd	373.27b	341.67b	7.91b
T_2	110.00	104.00ab	143.33bc	411.60b	342.00ab	8.71ab
T_3	108.67	102.67ab	135.13d	417.13b	340.00ab	8.88ab
T_4	116.00	113.67a	154.67a	451.73a	346.67a	10.07a
T_5	108.67	105.00ab	146.13b	434.13b	341.67ab	9.26ab
T_6	101.33	95.67b	139.67bcd	410.40b	342.33b	8.05b
CV (%)	8.35	9.51	3.10	6.07	0.53	10.16
Significance levels	NS	-	-	-	-	-
LSD $_{(0.05)}$	15.62	17.01	7.60	43.51	3.14	1.54

T_1= No priming + normal sowing, T_2= No priming + ridge sowing, T_3= Seed priming with 1% NaCl solution + normal sowing, T_4 = Seed priming with 1% NaCl solution + ridge sowing, T_5= Seed priming with water + normal sowing and T_6 = Seed priming with water + ridge sowing

Plant establishment was highest in T_4 treatment which was statistically higher from T_6 treatment. Highest plant height was recorded in T_4 treatment which was significantly higher than the rest of the treatments. Similar results were found in case of number of cobs/m^2, cob length and cob diameter. Number of rows/cob was higher in T_4 treatment which was statistically similar with T_3 and T_5 but significantly higher than the rest of the treatments. Highest grain number/cob was recorded in T_4 treatment which was significantly higher than the rest of the treatments. It was recorded that highest 1000 seed weight was in T_4 treatment which was statistically similar with T_2, T_3 and T_5 treatment but significantly higher than the T_1 and T_6 treatments. Highest grain yield/plot was found in T_4 treatment which was statistically similar with T_2, T_3 and T_5 but significantly higher than the T_2 and T_6 treatments. Grain yield (t/ha) was highest in T_4 treatment which was statistically similar with other treatments but significantly higher than T_1 and T_6 treatments. More or less similar result was found in case of straw yield.

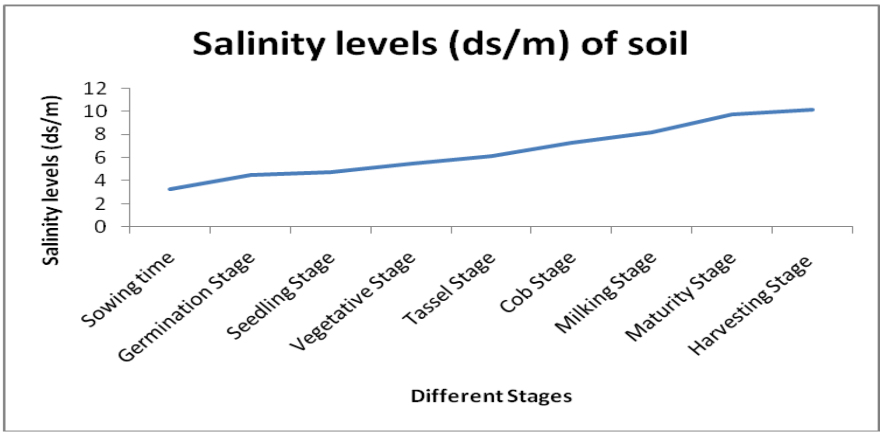

Fig. 1. Salinity levels (ds/m) of soil at different growth stages of maize.

Conclusion

In saline areas seeds of maize should be primed with 1% NaCl and planted in ridge bed to get a higher grain yield (10.07 t/ha).

RELAYING OF SUNFLOWER BY DIBBLING METHOD IN T. AMAN RICE AT VARIABLE PLANT POPULATION IN THE SALINE AREAS

Md. Atikur Rahman, F. Ahmed, M.K. Bashar, P.K. Sarder and Sadia Afrin

Abstract

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2012-13 to find out optimum plant population for higher yield. There were four treatments combinations viz. T_1 = One row sunflower (plant to plant 15 cm) alternate with 3-row rice T_2 = One row sunflower (plant to plant 25 cm) alternate with 3-row rice, T_3 = One row sunflower (plant to plant 15 cm) alternate with 4- row rice and T_4 = One row sunflower (plant to plant 25cm) alternate with 4-row rice. Among the treatments T_1 gave the highest yield (1.36 t/ha) and the lowest yield was found in T_4 (0.85 t/ha) which was inferior to all other treatments. Due to relaying of sunflower there were no negative effect on rice (T1) yield (4.65 t/ha) which was comparable with normal rice yield. The lowest level (3.25 ds/m) of soil salinity was recorded (Fig. 3) in the planting time and the highest level of salinity (8.75 ds/m) was recorded in the harvesting stage.

Introduction

The tidal floodplains in the coastal region under greater Barisal, Patuakhali and Satkhira districts fall under most vulnerable production ecology. Two ecosystems prevailing in Barisal region are tidal saline and tidal non saline (Nasiruffin 1993). The tidal wetland saline comprises the area where the salinity affects during the Boro and Aus seasons. The salinity level is highest during dry span of March-April, which affects Aus at seedling stage and Boro at tillering stage. As a result most of the area remain fallow. Tidal wetland non-saline lands of southern districts are predominantly T. Aman growing areas having rain-fed low land ecosystem. The land remains submerged until the end of November. The major cropping patterns in tidal ecosystem are Fallow-fallow-T.aman. Local varieties of T. Aman are extensively cultivated in the region, which are low yielding. The recedes of flood water from the rice fields in the coastal districts is delayed and after the harvest on T. Aman (December or January). Late T. Aman harvest (in January) and lack of irrigation water are the barriers for Boro or rabi crop cultivation. As a result, vast areas remain fallow. According to BARC (2008) 53% of arable land remains fallow in seven coastal districts during Kharif-1 season and 34% in rabi season. In this situation relay cropping of sunflower by dibbling methods would be in of the ways to bring the fallow land under cultivation. Therefore, the present experiment was conducted to evaluate the feasibility of relaying sunflower in T.aman rice and to find out suitable plant population for higher yield.

Materials and Method

The experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2012-13. The variety BINA-7 for rice and BARI Surjomukhi-2 for sunflower were used as test crops. There were four treatment combinations viz. T_1 = One row sunflower (plant to plant 15 cm) alternate with 3-row rice T_2 = One row sunflower (plant to plant 25 cm) alternate with 3-row rice, T_3 = One row sunflower (plant to plant 15 cm) alternate with 4- row rice and T_4 = One row sunflower (plant to plant 25cm) alternate with 4-row rice in saline area following RCB design with three replications. Unit plot size was 4.5 m×5 m. Seeds were sown on 01 January 2013. The experimental plots were fertilized with 105-30-60-30-1.4-0.6 kg/ha of N P K S Zn B, respectively. Half of the N and all other fertilizer will be applied after emergence of sunflower. Remaining N will be applied in 2 equals split at 20-25 DAS and 40-45 DAS (before flowering). Three irrigations were applied during the growth period. All the intercultural operations were done when necessary. Data on yield and yield attributes were collected and analyzed statistically using MSTAT-C program.

Results and Discussion

Initial plant emergence from seed against soil salinity was influenced. Highest initial plant population was observed in T_1 which was statistically similar with T_2 but significantly higher than the rest of the treatments. Highest plant establishment was observed in T_1 treatment which was significantly higher than the rest of the treatments. Plant height was ranged from 131.93 to 138.33. Inflorescence diameter was highest in T_1 treatment which was statistically similar with T_2 but significantly higher than the rest of the treatments. Highest 1000 seed weight was recorded in T_2 treatment which was statistically similar with T_1 treatment but significantly higher than the rest of the treatment. Highest yield (1.36 t/ha) was observed in T_1 treatment which was significantly higher than the rest of the treatments. Highest Stover yield was observed in T_1 which was statistically similar with T_2 & T_3 treatments but significantly higher than T_4. Due to the relaying of sunflower there were no negative effect on rice (T1) yield (4.65 t/ha) which was comparable with normal rice yield.

Table 3. Yield and yield contributing characters of sunflower in different treatments

Treat.	Initial Plant population/m^2	F.Plant population/m^2	Plant ht.cm)	Diameter of inflorescence (cm)	1000 seed wt (gm)	Yield (kg)/ plot	Yield (t/ha)	Stover (t/ha)	T. Aman rice Yield (t/ha)
T_1	18.33	17.67	138.33	16.90	55.33	3.06	1.36	8.00	4.65
T_2	17.00	16.00	138.07	16.83	56.00	2.84	1.26	6.70	4.37
T_3	16.00	14.00	131.93	15.39	44.67	2.03	0.90	7.70	4.56
T_4	16.33	13.33	136.80	14.94	44.67	1.92	0.85	6.33	4.48
$LSD_{(0.05)}$	1.585	0.994	8.655	1.472	8.784	0.057	0.057	1.449	0.056
CV (%)	5.21	3.62	3.53	5.11	9.74	1.48	1.68	11.22	0.32

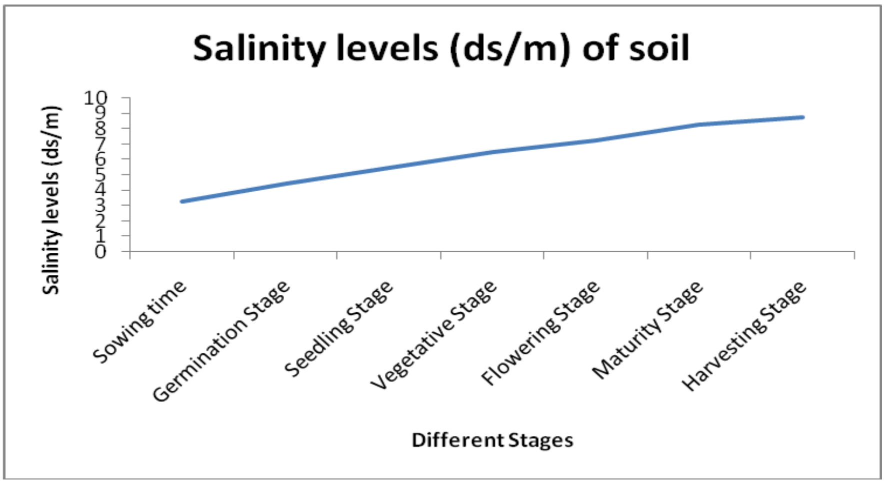

Fig. 3. Salinity levels (ds/m) of soil at different growth stages of sunflower

Conclusion

Relay cropping of sunflower with T. aman would be possible and 3 row rice and one row sunflower (plant to plant distance 15 cm) would be optimum in saline areas to have a good sunflower yield.

STUDY ON SESAME SUNFLOWER INTERMIXED CROPPING IN THE SOUTHERN DISTRICTS OF BANGLADESH

H.M.K Bashar, G.N. Hasan and F. Ahmed

Abstract

The experiment was conducted at MLT site, Kalapara, Patuakhali and MLT site Amtali, Barguna during rabi season of 2012-2013 with BARI Til 4 and BARI Surjomukhi 2 to increase the total productivity, reduce the risk of total crop failure and to increase crop diversity in the southern area of Bangladesh. Five treatments: T_1: Sole sesame T_2: One row Sunflower alternate with 2 row sesame T_3: One row sunflower alternate with 3-row sesame T_4: 100% sesame (broadcast) + 25% sunflower (broadcast) and T_5: 75% sesame (Broadcast) + 25% sunflower (broadcast) were used in the study. Sole sesame gave the highest seed yields those were 1275 kg/ha and 1200kg/ ha in Kalapara and amtali location, respectively. Although intercropping reduced sesame yield, with the addition of sunflower yield total productivity was increased in both the locations. Total productivity which is expressed in sesame equivalent yield (SEY) was highest (1990.42 kg/ha) in T_2: one row sunflower alternate with 2-row sesame treatment and this treatment also gave the highest benefit cost ratio (1.76).

Introduction

The tidal floodplains in the districts fall under most vulnerable production ecology. Soil salinity and delaying recession of flood water are the major constrains of crop production. Fallow-Fallow-T.aman is the major cropping pattern in this region. As a result the cropping intensity of this region is lower than other parts of Bangladesh. Intermixed cropping may be one of the options to increase cropping intensity as well as reduce the risk of total crop failure. Therefore, the experiment was carried out to find out the suitable planting systems of sesame and sunflower under intermixed cropping for higher productivity. Therefore the experiment was undertaken to increase the total productivity and to reduce the risk of total crop failure; and increase crop diversity.

Materials and Methods

The experiment was conducted at MLT site, Kalapara, Patuakhali and MLT site Amtali, Barguna during rabi in 2012-2013.BARI Til 4 and BARI surjomukhi 2 were used for this experiments. Five treatments were: T_1: Sole sesame T_2: One row Sunflower alternate with 2 row sesame T_3: One row sunflower alternate with 3 row sesame T_4: 100% sesame (broadcast) + 25% sunflower (broadcast) and T_5: 75% sesame (Broadcast) + 25% sunflower (broadcast). The experiment was laid out in a randomized complete block design having unit plot size 8m × 5m with six dispersed. Seeds were sown on 04 February 2013 at Kuakata site and on 20 January 2013 in Amtali site. Harvesting was done on 10 May and 08 May in Kuakata and Amtali site respectively. Prior to harvest, yield contributing characters were collected from 10 randomly selected plants and yield data was recorded plot wise. The data were analyzed statistically and mean was separated by LSD test.

Results and Discussion

The results indicated that most of the yield attributes of sesame were influenced due to intercropping with sunflower (Table 1 & 2). In both locations the maximum plant height was observed in T_4: 100% sesame (broadcast) + 25% sunflower (broadcast) that was statistically identical to T_1 & T_3 treatments. Number of capsules/plant varied significantly due to intercropping in both the locations and it ranged from 24.9 to 26.95 at Kalapara and 22 to 26 at Amtali. Number of seeds/capsule in different treatments was statistically similar over the locations. It ranged from 90 to 92.5 at Kalapara and 82 to 85 at Amtali. Thousand seed weight in different treatments were identical which ranged from 2.95 to 3.0 g. Sesame yield was significantly reduced due to intercropping. The highest seed yield (1275 kg/ha at Kalapara, 1200 kg/ha at Amtali) was obtained from sole sesame while the lowest (925 kg/ha and 700 kg/ha) in T_5: 75% sesame (Broadcast) + 25% sunflower (broadcast) treatment over the locations. Intercropping increased total productivity. The highest SEY (1990.42 kg/ha) was found in T2 treatment and this treatment gave the highest BCR (1.76). The second highest SEY and BCR was observed in T3 treatment and the lowest SEY and BCR was found in T5 treatment over the locations.

Table 1. Yield and yield attributes of sesame at MLT site, Kalapara, Patuakhali

Treatments	Plant height (cm)	No. of capsules plant^{-1}	No. of seeds capsule^{-1}	1000-seed wt. (g)	Seed yield (kg/ha)
T1 :Sole sesame	69.0	26.95	90.0	3.00	1275
T_2: One row Sunflower alternate with 2 row sesame	61.0	24.00	89.0	3.05	1050
T_3: One row sunflower alternate with 3 row sesame	69.0.	26.75	91.0	3.00	1215
T_4: 100% sesame (broadcast) + 25% sunflower (broadcast)	70.0	24.9	91.0	2.95	1150
T_5: 75% sesame (Broadcast) + 25% sunflower (broadcast).	61.0	25.0	92.5	3.00	925
LSD (0.005)	4.12	NS	NS	NS	9.12
CV (%)	5.58	8.13	6.12	2.41	10.25

Table 2. Yield and yield attributes of sesame at MLT site, Amtali, Barguna

Treatments	Plant height (cm)	No. of capsules plant^{-1}	No. of seeds capsule-1	1000-seed wt. (g)	Seed yield (kg/ha)
T1 :Sole sesame	64.5	26	85.0	3.0	1200
T_2: One row Sunflower alternate with 2 row sesame	62.6	23	83.0	2.9	800
T_3: One row sunflower alternate with 3 row sesame	65.0	25	85.0	2.8	980
T_4: 100% sesame (broadcast) + 25% sunflower (broadcast	66.0	24	82.0	3.0	950
T_5: 75% sesame (Broadcast) + 25% sunflower (broadcast).	63.0	22	80.0	2.8	700
LSD (0.005)	NS	NS	NS	NS	9.11
CV (%)	5.51	8.11	5.12	2.24	10.15

Table 3. Yield and yield attributes of sunflower at MLT site, Kalapara, Patuakhali

Treatments	Plant height (cm)	Diameter of head (cm)	No. of seeds head $^{-1}$	1000-seed wt. (g)	Seed yield (kg/ha)
T_2: One row Sunflower alternate with 2 row sesame	122.5	33.5	686	51	1137
T_3: One row sunflower alternate with 3 row sesame	125.0	32.5	619	48	875
T_4: 100% sesame (broadcast) + 25% sunflower (broadcast)	120.5	29.0	462	49	525

Treatments	Plant height (cm)	Diameter of head (cm)	No. of seeds head $^{-1}$	1000-seed wt. (g)	Seed yield (kg/ha)
T_5:75% sesame (Broadcast) + 25% sunflower (broadcast)	116.0	28.0	437	45	462
LSD $_{(0.05)}$	5.12	8.08	14.42	NS	60.45
CV (%)	3.21	4.28	1.65	5.56	4.08

Table 4. Yield and yield attributes of sunflower at MLT site, Amtali, Barguna

Treatments	Plant height (cm)	Head diameter (cm)	No. of seeds head $^{-1}$	1000-seed wt. (g)	Seed yield (kg/ha)
T_2: One row Sunflower alternate with 2 row sesame	128	39.2	740	48.0	1420
T_3: One row sunflower alternate with 3 row sesame	126	38.0	650	47.0	900
T_4: 100% sesame (broadcast) + 25% sunflower (broadcast	127	34.0	506	44.0	553
T_5: 75% sesame (Broadcast) + 25% sunflower (broadcast).	126	33.0	470	44.0	480
LSD $_{(0.05)}$	5.18	7.98	14.14	NS	59.15
CV (%)	3.29	4.18	1.56	5.51	4.04

Table 5. Average yield and economic return in both locations of Sesame Sunflower intermixed cropping

Treatment	Yield (kg ha^{-1})		SEY (kg ha^{-1})	Gross return (Tk ha^{-1})	Cultivation cost (Tkha^{-1})	Gross margin (Tk ha^{-1})	BCR
	Sesame	Sunflower					
T1	1237.5	-	1237.50	74250	54675	19575	1.36
T_2	925	1278.5	1990.42	119425	67715	51710	1.76
T_3	1097.5	887.5	1837.08	110225	67365	42860	1.64
T_4	1050	539	1499.17	89950	67515	22435	1.33
T_5	812.5	471	1205.00	72300	67365	4935	1.07

Note: sesame@ 60 Tk/kg and Sunflower @ 50 Tk/kg, SEY= Sesame equivalent yield

Conclusion

Considering the yield and economic return it might be concluded that one row sunflower alternate with 2-row sesame would be the most profitable combination as compared to other combinations in intermixed cropping. From the result of this experimentation it was revealed that, mixed cropping is more profitable than the sole cropping and risk of cultivation of one crop could be reduced by mixed cropping, for conformation of the result the experiment should be repeated in the next year.

Farmers Opinion: It’s a very good practice but it is difficult to irrigate to the crops.

Table 6. Salinity levels in the experimental plots at MLT site, Kalapara, Patuakhali during rabi, 2012- 2013

Date	Salinity level (dS/m)	
	R1	R2
4 February 2013	2.86	3.07
19 February 2013	3.82	4.13

Date	Salinity level (dS/m)	
	R1	R2
6 March 2013	4.2	5.79
31 March 2013	4.93	6.43
5 April 2013	5.76	7.21
20 April 2013	7.01	8.55
5 May 2013	7.78	8.86
11 May 2013	8.64	9.50

Table 7. Salinity levels in the experimental plots at MLT site, Amtali, Barguna during rabi, 2012-2013

Date	Salinity level (dS/m)
	R1
30 January 2013	5.35
15 February 2013	6.06
28 February 2013	6.9
15 March 2013	7.10
30 March 2013	7.75
15 April 2013	8.20
30 April 2013	8.90

EFFECT OF POST-FLOWERING SALINITY AND WATER STRESS ON DRY MATTER PRODUCTION AND YIELD OF SOYBEAN

M.S.A. Khan and M.A. Aziz

Abstract

The experiment was conducted in a vinyl house of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during robi season of 2013-2014 to find out the most severe post-flowering growth stage of soybean and to assess the yield reduction under salinity and water stresses by imposed salt stress (100 mM NaCl) and water stress (70% depletion of available water) at different post flowering stages of 4th to 6th , 6th to 8th , 8th to 10th and 10th to 12th weeks after emergence. Shoot dry weight under salt stress was identical with control but under water stress significantly differed from control at 4th to 6th weeks after emergence. The results became reverse in terms of seed yield. Among the stages, 4th to 6th weeks after emergence of soybean was found the most severe to salt for seed yield reduction (82.71%). Both the salt stress and water stress at 6th to 8th and 8th to 10th weeks after emergence also alarming for seed yield.

Introduction

Soil salinity and water stresses are the dominant abiotic stresses that limiting crop production after T. aman rice in the southern region. Soybean (*Glycine max* L.) is one of the most economic and nutritious crop in the world with high protein content (Mondal *et al*., 2002). In Bangladesh it is mostly used as poultry and fish feed. Soybean cultivation is mostly concentrated in the coastal southern area specifically in greater Noakhali district. This crop is often grown after T. aman and sowing done within mid January.

Since, the soybean seed sowing is done in late Robi season near the coastal belt, the crop often exposed to soil salinity and water stress at terminal stages of crop and these stresses may be most severe at certain post flowering growth stages. Therefore, post-flowering salinity and water stress effect on soybean has been under taken to find out the most severe post-flowering growth stage of soybean and to assess the yield reduction under salinity and water stresses at different growth stages.

Materials and Methods

The experiment was conducted in a vinyl house of the Agronomy Division at Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during robi season of 2013-2014. BARI Soybean-6 was used for testing salt and water stress tolerance at different post flowering stages. Seeds were washed several times with tap water for surface cleaning then sown in soil medium on 22 January 2014 in plastic pots having 30 cm in height and 24 cm inner diameter. Each pot contained 12 kg air dried sandy loam soil. Chemical fertilizers of 0.30 g urea, 0.90 g TSP, 0.60 g MOP and 0.60 g Gypsum per pot were also incorporated into the soil before sowing. The pots were watered daily for easy germination. Soybean plants were emerged on 30 January. After the emergence and establishment, two uniform healthy seedlings per pot were allowed to grow for four weeks (28 DAE) in equal environment. After four weeks of emergence, all the growing plants in pots were than submitted to the treatments. The treatments were; Control (T_1), Salt stress with irrigated 100 mM NaCl at 4th to 6th weeks after emergence (T_2), Water shortage (irrigated with 70% depletion of available soil water when wilting sign developed) at 4th to 6th weeks after emergence (T_3). Salt stress with irrigated 100 mM NaCl at 6th to 8th weeks after emergence (T_4), Water shortage at 6th to 8th weeks after emergence (T_5). Salt stress with irrigated 100 mM NaCl at 8th to 10th weeks after emergence (T_6), Water shortage at 8th to 10th weeks after emergence (T_7). Salt stress with irrigated 100 mM NaCl at 10^{th} to 12^{th} weeks after emergence (T_8), Water shortage at 10^{th} to 12^{th} weeks after emergence (T_9). The control groups of plants were irrigated with tap water only. The experiment was arranged in Completely Randomized Design (CRD) with 8 replications. Admire 200SL @ 1 ml/liter of water was sprayed at 10 and 25 DAE to control Jassids and white flies. Ripcord 10 EC @ 1 ml/liter of water was sprayed at 45 and 60 DAE to control leaf roller and pod borer. After the completion of the treatments imposed plant samples were collected from 4 replications and remaining 4 were allowed to grow up to maturity with irrigated fresh water. Different plant parts of the collected samples were separated and then oven dried at 70 ºC for 4 days to measure the dry matter. Yield and yield contributing characters of the soybean plants under different treatments were recorded from the remaining pots after maturity. Data were analyzed by MSTAT-C program and the treatment means were compared by using Least Significant Difference (LSD).

Results and Discussion

Shoot and root dry matter

Shoot dry matter of soybean genotypes was significantly differed by salinity and water stress treatments at different weeks after emergance (Fig. 1). At Salt and water stress at 4^{th} to 6^{th} weeks after emergence, shoot dry weight under salt stress was identical with control but under water stress significantly differed from control. Shoot dry weight both under salt and water stress were identical. Similar results were also observed at 6^{th} to 8^{th} weeks after emergence. Shoot dry weight under salt stress and water stress significantly differed from control when salt and water stress imposed at 8^{th} to 10^{th} and 10^{th} to 12^{th} weeks after emergence. Both under salt and water stress shoot dry matter were identical at these two post flowering growth stages. Shoot dry matter was found more sensitive to salt and water stress than root dry matter at all post flowering growth stages. Root dry matter slightly decreased under salt and water stress at all post flowering growth stages

Shoot and root dry matter

The relative shoot dry weight drastically reduced under salt and water stress imposed at different weeks after emergance (Fig. 2). Relative shoot dry weight under salt stress and water stress significantly differed from control when salt and water stress imposed at post flowering growth stages of 4^{th} to 6^{th} (S1), 6^{th} to 8^{th} (S2), 8^{th} to 10^{th} (S3) and 10^{th} to 12^{th} (S4) weeks after emergence. Relative shoot dry weight under salt stress also differed significantly from water stress at S1, S2 and S3 stages, but identical at S4 stage. Under water stress only, when soil became dries the matric potential decreases, therefore increases the resistance of water flow to the roots. Application of salt water increased soil salinity; at a given level reduced the soil water potential but does not reduced water flow to the roots. Root cortical cells can osmotically adjust to some extent allowing water to readily move into the root. Therefore, shoot dry weight of soybean was affected more in water stress condition than only in salt stress condition. The relative root dry weight significantly reduced under salt and water stress imposed at all post flowering growth stages (Fig. 2). Root dry weight under salt stress and water stress significantly differed from control when salt and water stress imposed at the post flowering growth stages of 4^{th} to 6^{th} (S1) weeks after emergence. Relative root dry weight of salt stress were identical with control at the post flowering growth stages of 6^{th} to 8^{th} (S2) and 8^{th} to 10^{th} (S3) weeks after emergence, but significantly differed at 10^{th} to 12^{th} (S4) after emergence. Both under salt and water stress relative root dry weight were identical at the stages of 4^{th} to 6^{th} (S1), 8^{th} to 10^{th} (S3) and 10^{th} to 12^{th} (S4) weeks after emergence.

Dry matter distribution

Dry matter distribution in different plant parts of soybean as affected by salt stress and water stress at the different post flowering growth stages are presented in Fig. 3. Dry weight of all plant parts were reduced under salt stress and water stress environment at all post flowering growth stages. Stem dry weight significantly reduced from control under salt stress at 4^{th} to 6^{th} (S1), 8^{th} to 10^{th} (S3) and 10^{th} to 12^{th} (S4) weeks after emergence. Under water stress, stem dry weight significantly reduced from control at all stages of growth. Petiole dry weight significantly reduced from control under water stress imposed at all post flowering growth stages. Under salt stress, petiole dry weight were identical with control at all post flowering stages, except at 10^{th} to 12^{th} (S4) weeks after emergence. Similar results were also observed in case of leaf dry weight under both salt and water stress. At 10^{th} to 12^{th} (S4) weeks after emergence, no leaf was found due to early senescence and defoliation under salt and water stress. It might be due to salt toxicity in the cytoplasm of the cell and avoidance strategy of the plant under water stress. Flower and pod dry weight significantly reduced from control under salt stress and water stress imposed at the post flowering growth stages of 4^{th} to 6^{th} (S1), 6^{th} to 8^{th} (S2) and 8^{th} to 10^{th} (S3) weeks after emergence. Salt stress at 10^{th} to 12^{th} (S4) weeks after emergence, pod dry weight showed identical with control whereas under water stress pod dry weight significantly reduced from control and also from salt stress.

Yield attributes and yield

Yield contributing characters and seed yield of soybean plant under salt and water stress are presented in Table 1. Salt stress and water stress imposed at the post flowering growth stages significantly reduced number of filled pods, 100-seed weight, seed yield and days to maturity. The highest number of filled pods was obtained from control (109.7 plant^{-1}) followed by water stress at 10^{th} to 12^{th} weeks after emergence (85.3 plant^{-1}). Number of filled pods obtained from water stress at 10^{th} to 12^{th} weeks after emergence and was identical with salt stress at the same stage (67.7 plant^{-1}) and water stress at 4^{th} to 6^{th} weeks after emergence (68.0 plant^{-1}). The least number of pods was recorded from salt stress imposed at the post flowering growth stage of 4^{th} to 6^{th} weeks after emergence (31.0 plant^{-1}). Number of unfilled pod was not significantly differed by salt stress and water stress. Significantly the highest 100-seed weight of 10.72 g was obtained from control which was identical with the seed weight of 10.66 g under water stress at 4^{th} to 6^{th} weeks after emergence. The lowest seed weight of 6.41 g was obtained from salt stress imposed at the post flowering growth stages of 6^{th} to 8^{th}. The highest seed yield of 25.45 g plant^{-1} was obtained from control followed by seed yield under water stress at 4^{th} to 6^{th} weeks after emergence (14.48 g plant^{-1}) and both at the salt stress (12.85 g plant^{-1}) and the water stress (12.75 g plant^{-1}) at 10^{th} to 12^{th} weeks after emergence. The lowest seed yield of 4.40 g plant^{-1} was obtained from salt stress imposed at 4^{th} to 6^{th} weeks after emergence. It might be due to salt residual effect that prevailing in the soil from flowering to maturity. The reduction in seed yield of soybean plants subjected to salt stress at 4^{th} to 6^{th} weeks after emergence may be due to an increased uptake of toxic sodium that accumulated in cells and become toxic to the plant. NaCl readily dissolved in water solvent yielded toxic Na^+ that may absorbed into root tissues and transport throughout plant organs, leading to toxic ion damage, osmotic stress and nutritional imbalance (Cha-um *et al*., 2007; Siringam *et al*., 2009) resulting low seed yield. The control plant took maximum days to maturity (117 days) which followed by the plant under water stress imposed at the post flowering growth stages of 4^{th} to 6^{th} (115 days), 6^{th} to 8^{th} weeks after emergence (115 days). The plant under salt stress imposed at 10^{th} to 12^{th} weeks after emergence took minimum days to maturity (100 days). The minimum yield reduction was observed in water stress imposed at 4th to 6th after emergence (43.12%) which was followed by salt stress (49.52%) and water stress (49.90%) imposed at 10th to 12th weeks after emergence. The highest seed yield reduction recorded in salt stress imposed at 4th to 6th after emergence (82.71%) followed by salt stress imposed at 6th to 8th weeks after emergence (78.27%).

Conclusion

From the above findings, it may be concluded that 4th to 6th weeks after emergence of soybean was the most severe post- flowering growth stage to salt for seed yield. Both the salt stress and the water stress at 6th to 8th and 8th to 10th weeks after emergence also alarming for seed yield.

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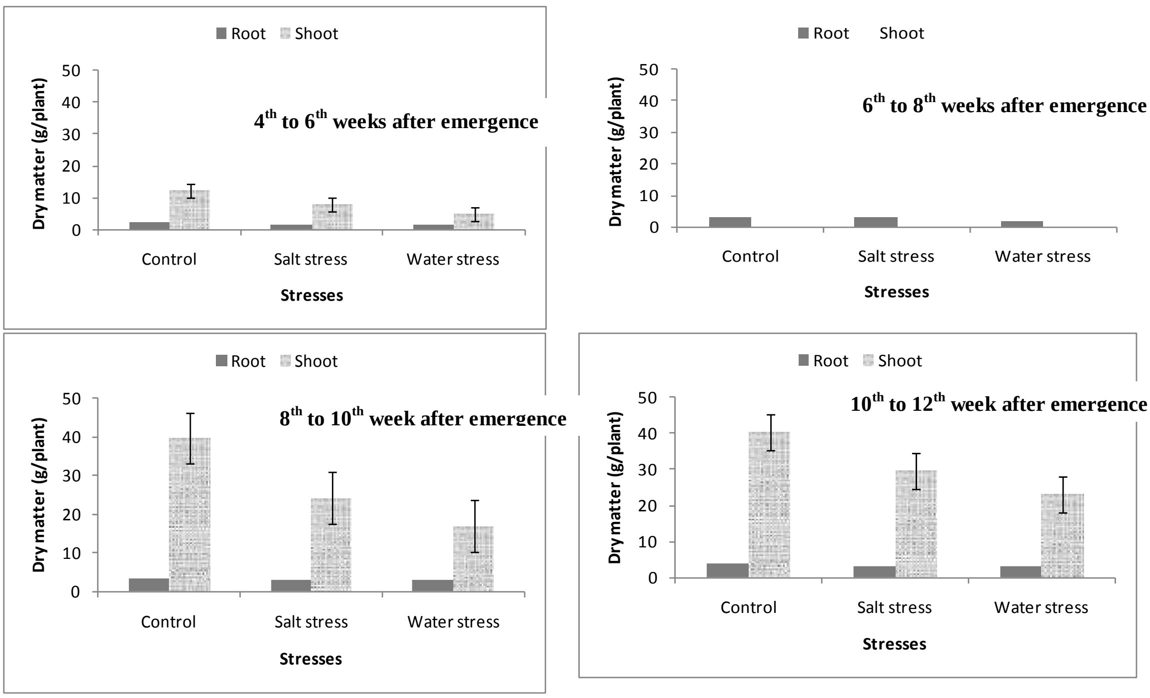


Fig.1. Dry matter production in root and shoot at different weeks after emergance under salt and water stress condition.

Salinity Stress

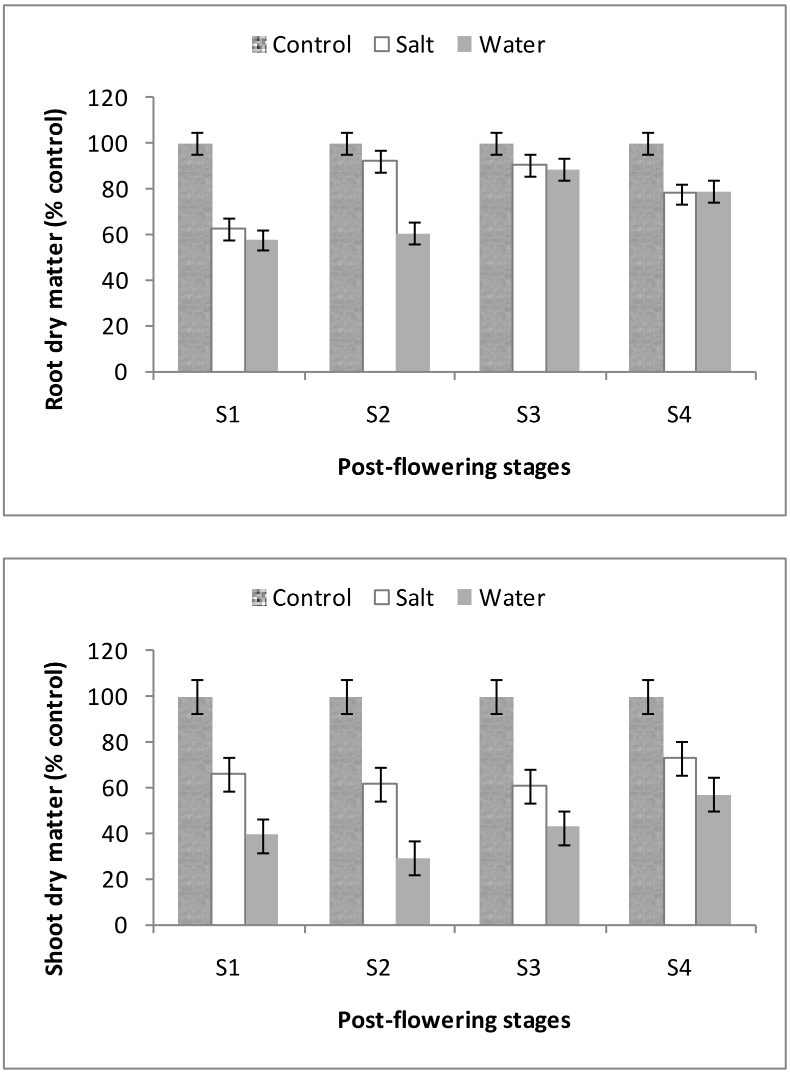
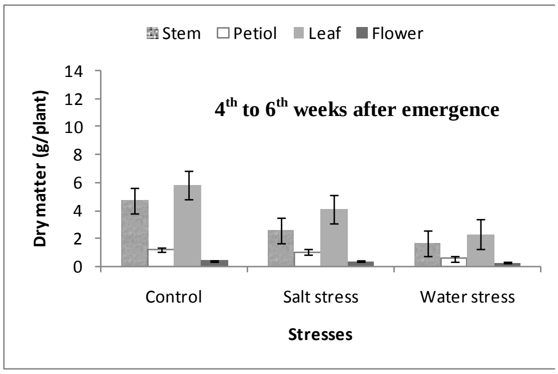
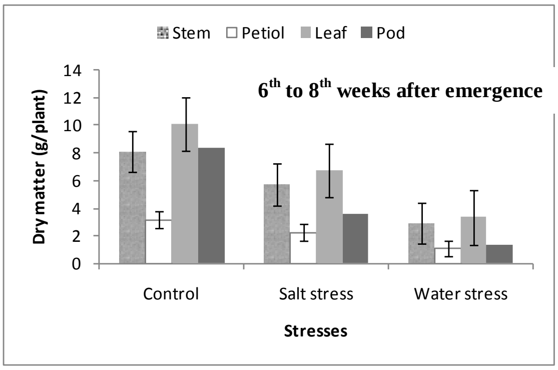


Fig.2. Root and shoot dry matter production at different weeks after emergance under salt and water stress condition.





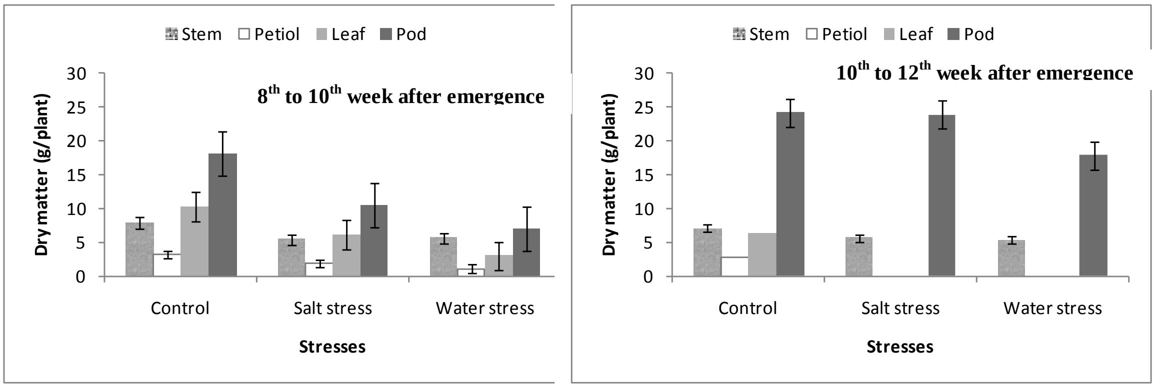


Fig.3. Dry matter distribution in different parts of shoot at different weeks after emergance under salt and water stress environment.

Table 1. Yield contributing characters and yield of soybean under salt and water stress at different weeks after emergance

Treatment	Filled pods plant^{-1} (no.)	Unfilled pods plant^{-1} (no.)	100-seed weight (g)	Seed yield (g plant^{-1})	Days to maturity	Yield reduction (%)
Control	109.7	6.8	10.72	25.45	117	-
Salt stress at 4th to 6th WAE	31.0	16.7	6.82	4.40	101	82.71
Water stress at 4th to 6th WAE	68.0	10.2	10.66	14.48	115	43.12
Salt stress at 6th to 8th WAE	40.8	20.8	6.41	5.53	101	78.27
Water stress at 6th to 8th WAE	42.0	11.0	8.41	7.42	115	70.83
Salt stress at 8th to 10th WAE	56.3	31.5	7.15	8.53	101	66.47
Water stress at 8th to 10th WAE	43.7	27.8	9.27	7.46	106	70.70
Salt stress at 10th to 12th WAE	67.7	20.5	8.92	12.85	100	49.52
Water stress at 10th to 12th WAE	85.3	18.2	7.64	12.75	103	49.9
LSD(0.01)	20.76	NS	1.43	3.48	1.34	
CV(%)	14.39	50.67	7.07	13.28	0.53	

EFFECT OF DATE OF SOWING ON PLANT STANDS, GROWTH AND YIELD OF COWPEA IN COASTAL AREA

M.A. Razzaque, M.A. Aziz, G N Hasan and M.I.A Howlader

Abstract

An experiment was conducted at MLT site Kuakata, Patuakhali in the rabi season of 2013-2014 to verify the effect of Cowpea varieties under different sowing dates in saline area of Patuakhali under farmers field condition. Three treatments: T_1: Early sowing (15.12.2013), T_2: Midterm sowing (25.12.2013), T_3: Late sowing (05.01.2014). It revealed that higher seed yield (1.4t/ha) of cowpea was produced from the early sowing. The lowest seed yield was recorded from late sowing. The results revealed that early sowing (mid December) would be the optimum time for cowpea in patuakhali region. This experiment needs to be repeated in the next year for final confirmation.

Introduction

Cowpea is a promising crop for saline area. It is tolerant to 4-10 dS/m of soil salinity (Tsdale et al., 1992). Farmers grow it as relay crop with T. aman rice in large scale without care. For this reason, cowpea could not express its yield potentiality. On the other hand, tillage practices require higher production cost. Farmers of this region grow rabi crops as an optional. Date of sowing may influence yield to some extent. With this point of view different dates of sowing of cowpea was evaluated. Therefore, the experiment was done to find out suitable sowing date of cowpea and to evaluate farmers' reaction in terms of economic return.

Materials and Methods

The experiment was conducted at MLT site Kuakata, Patuakhali in the rabi season of 2013-2014 in saline area of Patuakhali under farmers field condition. Three treatments: T_1: early sowing (15.12.2013), T_2: midterm sowing (25.12.2013), T_3: late sowing (05.01.2014) were tested for evaluation. BARI Felon -1 was used as test crop. The experiment was done with RCBD having unit plot size of 4 m × 3m. Plant spacing of 30 cm × 20 cm were maintained. Date of sowing was started from 15 December 2013 and harvesting started from 02 April 2014. Fertilizers were applied as recommended in FRG 2012. Weeding and other intercultural operation were done as and when necessary. Data on yield and yield attributes were recorded and analyzed statistically.

Results and Discussion

Yield and yield contributing characters were given in Table 1. Plant height, number of branches per plant, number of pods per plant, pod length, number of grains per pod, 1000- seed weight and seed yield were significantly differed by sowing dates. Yield and all yield contributing characters were maximum at 1^{st} sowing. The highest seed yield of 1.4 t/ha was recorded in early sowing and the lowest 0.4 t/ha was recorded in late sowing. Soil salinity of the experimental plots ranges from 4-10 (Table 2).

Conclusion

The results revealed that early sowing (mid December) would be the optimum time for cowpea in patuakhali region. This experiment needs to be repeated in the next year for final confirmation.

Farmer's opinion

Farmers' of the experimental area choose early sowing of cowpea due to maximum seed production.

Table 1. Effect of time of sowing on yield and yield contributing characters of cowpea in the saline area in 2013-14

Treatments	Plant pop^n (m^{-2})	Plant height (cm)	Branch plant^{-1} (no.)	Pods plant^{-1} (no.)	Pod length (cm)	Grain pod^{-1} (no.)	1000 seed wt (g)	Yield (kg/ha)
15/12/2013	14.7	70.5	4.2	9.4	15.1	11.5	103.3	1.4
25/12/2013	14.7	63.7	4.1	7.8	13.1	11	102.3	1.3
05/01/2014	13.7	46.5	3.2	3.4	12.4	8.8	90	0.4
LSD	NS	***	***	***	**	*	***	***
CV (%)	9.87	2.91	4.97	11.53	4.74	8.25	8.90	8.17

Table 2. Salinity levels in the experimental plots of cowpea at MLT site, Kuakata, Patuakhali during rabi, 2013-14

Date	Salinity level (dS/m)		
	T1	T2	T3
15-12-13	4.02	-	-
25-12-13	4.34	4.28	-
05-01-14	4.65	4.63	4.54
15-01-14	5.07	5.01	4.93
25-01-14	5.22	5.21	5.13
04-02-14	5.56	5.7	5.67
14-02-14	6.06	6.11	6.01
24-02-14	6.57	6.44	6.34
06-03-14	6.97	7.20	7.25
16-03-14	7.98	8.12	8.24
26-03-14	9.76	9.62	8.95
05-04-14	10.04	9.85	9.86
15-04-14		10.2	10.00

STUDY ON SESAME SUNFLOWER INTERMIXED CROPPING IN THE SOUTHERN DISTRICTS OF BANGLADESH

G. N. Hasan, M.A. Aziz, F. Ahmed and M.I.A. Howlader

Abstract

The experiment was conducted at MLT site, Kalapara, Patuakhali during rabi season of 2013-2014 with intermixed cropping of BARI Til 4 and BARI Surjomukhi 2 to increase the total productivity, reduce the risk of total crop failure and to increase crop diversity in the southern area of Bangladesh. Five treatments: Sole sesame, One row Sunflower alternate with 2 rows sesame, One row sunflower alternate with 3 rows sesame, 100% sesame (broadcast) + 25% sunflower (broadcast) and 75% sesame (Broadcast) + 25% sunflower (broadcast) were used in the study. Sole sesame gave the highest seed yield of 1350 kg/ha. Although intercropping reduced sesame yield, the addition of sunflower yield increased total productivity over the location. The sesame equivalent yield (SEY) was highest (1968 kg/ha) in T_2, where one row Sunflower alternate with 2 rows sesame treatment and this also gave the highest benefit cost ratio (1.74). It might be concluded that one row Sunflower alternate with 2 rows sesame would be most profitable as compared to other treatment combinations. For confirmation of the results, the experiment should be repeated in the next year.

Introduction

Crop production under tidal flood prone areas are most vulnerable in the southern ecology. Soil salinity and delaying recession of tidal flood water are the major constrains of crop production. Fallow-Fallow-T.aman is the major cropping pattern in this region. Most of the fields remain fallow due to delay harvest of T. aman rice. As a result the cropping intensity of this region is lower than other parts of Bangladesh. There is a great potentiality to produce sesame or sunflower after T.aman. Intermixed cropping of sesame and sunflower may be one of the options to increase cropping intensity as well as to reduce the risk of total crop failure. Therefore, the experiment was carried out to find out the suitable planting systems of sesame and sunflower under intermixed cropping for higher productivity of the land and to reduce the risk of total crop failure.

Materials and Methods

The experiment was conducted at MLT site, Kalapara, Patuakhali during rabi in 2013-2014. BARI Til 4 and BARI surjomukhi 2 were used for this experiment. Five treatments were: Sole sesame (broadcast), One row Sunflower alternate with 2 row sesame, One row sunflower alternate with 3 row sesame, 100% sesame (broadcast) + 25% sunflower (broadcast) and 75% sesame (Broadcast) + 25% sunflower (broadcast) were used to evaluate sesame sunflower intermixed cropping. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 3m × 4m. Seeds were sown on 22 January 2014. Harvesting was done on 25 April to 29 May 2014. Prior to harvest, data on yield contributing characters were collected from 10 randomly selected plants and yield data was recorded plot wise. The data were analyzed statistically and mean was separated by LSD test.

Results and Discussion

Yield and yield attributes of sesame are presented in Table 1. It was observed that most of the yield attributes of sesame were influenced due to intercropping with sunflower. The maximum plant height was recorded in 100% sesame followed by one row sunflower alternate with two rows sesame and the shortest was recorded from 100% sesame with 25% sunflower in broadcast. Number of pods/plant did vary significantly due to intercropping and it ranged from 24.73 to

33.93. Number of seeds/pod, seeds/pod and 1000 seed weight were not significantly differed due to intercropping of sesame and sunflower. Sesame yield was significantly reduced due to intercropping. The highest seed yield (1350 kg/ha) was obtained from sole sesame while the lowest (916 kg/ha) from 75% sesame with 25% sunflower in broadcast.

Intercropping significantly affected yield and yield component of sunflower (Table 2). Number of seeds/head was reduced due to intercropping. The maximum number of seeds/head was recorded in T_2 treatment (506 seed/head) which was identical with T_3 (503 seed/head). The lowest number of seed/head was recorded in T_5 treatment (328 seed/head). Significantly the highest sunflower yield (1150 kg/ha) was obtained from one row sunflower alternate with two rows sesame (T_2) while the lowest (830 kg/ha) from 75% sesame with 25% sunflower in broadcast (T_5).

Intercropping of sesame and sunflower increased total productivity. The highest sesame equivalent yield (SEY) of 1968 kg/ha was recorded in one row sunflower alternate with two rows sesame (T_2). This treatment also gave the highest BCR (1.74). The lowest SEY and BCR was recorded from 75% sesame with 25% sunflower in broadcast (T_5).

Conclusion

Considering the yield and return, it may be concluded that one row Sunflower alternate with 2 rows sesame would be most profitable as compared to other treatment combinations when grown as mixed crop. For confirmation of the results, the experiment should be repeated in the next year.

Farmers Opinion

Farmers showed their interest to practice intercropping, but the difficulty was in irrigation.

Table1. Yield and yield attributes of sesame at MLT site, Kalapara, Patuakhali during rabi in 2013-2014

Treatments	Plant height (cm)	Pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	1000-seed wt.(g)	Seed yield (kg/ha)
T_1	87.6	32.90	85.80	2.56	1350
T_2	81.0	33.93	81.16	2.53	1030
T_3	78.3.	32.93	86.86	2.50	1060
T_4	57.23	24.73	86.33	2.50	950
T_5	60.83	28.67	89.33	2.50	936
LSD (0.005)	4.12	NS	NS	NS	9.12
CV (%)	5.58	8.13	7.21	3.67	10.52

Table 2. Yield and yield attributes of Sunflower at MLT site, Kalapara, Patuakhali during rabi in 2013-2014

Treatments	Plants /plot (no.)	Plant height (cm)	Seeds head $^{-1}$ (no.)	1000-seed wt. (g)	Seed yield (kg/ha)
T_1	-	-	-	-	-
T_2	49.0	133.26	506	58.6	1150
T_3	39.67	123.16	503	58.16	961
T_4	51.33	99.46	352.6	58	847
T_5	52.67	97.5	328.33	58	830
LSD (0.005)	4.20	5.12	14.42	NS	60.45
CV (%)	3.98	3.21	2.34	8.32	4.68

T_1 =Sole sesame, T_2=One row Sunflower alternate with 2 row sesame, T_3= One row sunflower alternate with 3 row sesame, T_4=100% sesame (broadcast) + 25% sunflower (broadcast) and T_5=75% sesame (Broadcast) + 25% sunflower (broadcast).

Table 3. Average yield and economic return of Sesame Sunflower intermixed cropping during rabi season 2013-2014

Treatment	Yield (kg ha^{-1})		SEY (kg ha^{-1})	Gross return (Tk ha^{-1})	TVC (Tk ha^{-1})	Gross margin (Tk ha^{-1})	BCR
	Sesame	Sunflower					
T_1 :Sole sesame	1350	-	1350	81000	54675	26325	1.48
T_2: One row Sunflower alternate with 2 row sesame	1010	1150	1968	118080	67715	50365	1.74
T_3: One row sunflower alternate with 3 row sesame	1120	961	1920	115200	67365	47835	1.71
T_4: 100% sesame (broadcast) + 25% sunflower (broadcast	950	847	1655	99300	67515	31785	1.47
T_5: 75% sesame (Broadcast) + 25% sunflower (broadcast).	916	830	1607	96420	67365	29055	1.43

Note: sesame@ 60 Tk/kg and Sunflower @ 50 Tk/kg, SEY= Sesame equivalent yield

Table 4. Salinity levels in the experimental plots at MLT site, Kalapara, Patuakhali during rabi, 2013-2014

Date	Salinity level (dS/m)
22.01.14	3.0
01.02.14	3.5
11.02.14	4.6
21.02.14	5.98
04.03.14	6.88
14.03.14	7.8
24.03.14	7.99
03.04.14	8.5
13.04.14	8.97
25.04.14	9.5
29.04.147	10.54

EFFECT OF POST-FLOWERING SALINITY AND WATER STRESS ON DRY MATTER PRODUCTION AND YIELD OF SOYBEAN

M.S.A. Khan and M.A. Aziz

Abstract

The experiment was conducted in a vinyl house of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during *rabi* season of 2014-2015 to find out the most sensitive post-flowering growth stage of soybean and to assess the extent of yield reduction caused by salinity (100 mM NaCl) and water stresses (70% depletion of available water) at different post flowering stages appeared at 4^{th} to 6^{th}, 6^{th} to 8^{th}, 8^{th} to 10^{th} and 10^{th} to 12^{th} weeks after emergence. Shoot dry weight was found more sensitive to salt and water stress than root dry weight at all post flowering growth stages. The highest relative shoot dry weight (91.47%) was recorded from salt stress and the highest relative root dry weight (95.58%) recorded from water stress at 4^{th} to 6^{th} weeks after emergence. The highest seed yield of 10.47 g plant^{-1} was obtained from control followed by seed yield under salt stress at 10^{th} to 12^{th} weeks after emergence (8.68 g plant^{-1}). The lowest seed yield of 0.69 g plant^{-1} was obtained from salt stress imposed at 4^{th} to 6^{th} weeks after emergence. Among the stages, 4^{th} to 6^{th} weeks after emergence of soybean was found the most sensitive to salt in relation to seed yield reduction (93.41%). The salt stress imposed at 6^{th} to 8^{th} weeks after emergence also alarming for seed yield reduction.

Introduction

Soil salinity and water stresses are the dominant abiotic stresses that limiting crop production after T. aman rice in the southern region. Soybean (*Glycine max* L.) is one of the most economic and nutritious crop in the world with high protein content (Mondal *et al*., 2002). In Bangladesh it is mostly used as poultry and fish feed. Soybean cultivation is mostly concentrated in the coastal southern area specifically in greater Noakhali district. This crop is often grown after T. aman and sowing done within mid January. Since, the soybean seed sowing is done in late Robi season near the coastal belt, the crop often exposed to soil salinity and water stress at terminal stages of crop and these stresses become severe at certain post flowering growth stages. Therefore, this study was under taken to find out the most sensitive post-flowering growth stage of soybean to salinity and water stresses.

Materials and Methods

The experiment was conducted in a vinyl house of the Agronomy Division at Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during *rabi* season of 2014-2015. BARI Soybean-6 was used for testing salt and water stress tolerance at different post flowering stages. Seeds were washed several times with tap water for surface cleaning then sown in soil medium on 26 January 2015 in plastic pots having 30 cm in height and 24 cm inner diameter. Each pot contained 12 kg air dried sandy loam soil. Chemical fertilizers of 0.30 g urea, 0.90 g TSP, 0.60 g MOP and 0.60 g Gypsum per pot were also incorporated into the soil before sowing. The pots were watered daily for easy germination. Soybean plants were emerged on 01 February. After the emergence and establishment, two uniform healthy seedlings per pot were allowed to grow for four weeks (28 DAE) in equal environment. After four weeks of emergence, all the growing plants in pots were than submitted to the treatments. The treatments were; Control (T_1), Salt stress with irrigated 100 mM NaCl at 4^{th} to 6^{th} weeks after emergence (T_2), Water shortage (irrigated with 70% depletion of available soil water when wilting sign developed) at 4^{th} to 6^{th} weeks after emergence (T_3). Salt stress with irrigated 100 mM NaCl at 6^{th} to 8^{th} weeks after emergence (T_4), Water shortage at 6^{th} to 8^{th} weeks after emergence (T_5). Salt stress with irrigated 100 mM NaCl at 8^{th} to 10^{th} weeks after emergence (T_6), Water shortage at 8^{th} to 10^{th} weeks after emergence (T_7). Salt stress with irrigated 100 mM NaCl at 10^{th}

to 12th weeks after emergence (T_8), Water shortage at 10th to 12th weeks after emergence (T_9). The control groups of plants were irrigated with tap water only. The experiment was arranged in Completely Randomized Design (CRD) with 8 replications. Admire 200SL @ 1 ml/liter of water was sprayed at 10 and 25 DAE to control Jassids and white flies. Ripcord 10 EC @ 1 ml/liter of water was sprayed at 45 and 60 DAE to control leaf roller and pod borer. After the completion of the treatments imposed plant samples were collected from 4 replications and remaining 4 were allowed to grow up to maturity with irrigated fresh water. Different plant parts of the collected samples were separated and then oven dried at 70ºC for 4 days to measure the dry weight. Yield and yield contributing characters of the soybean plants under different treatments were recorded from the remaining pots after maturity. Data were analyzed by MSTAT-C program and the treatment means were compared by using Least Significant Difference (LSD).

Results and Discussion

Shoot and root dry weight

Shoot dry weight of soybean genotypes was remarkably reduced by salinity and water stress treatments at different post flowering growth stages (Fig. 1). Salt and water stress at 4th to 6th weeks after emergence, shoot dry weight under salt stress (3.97 g plant^{-1}) and water stress (3.76 g plant^{-1}) differed from control (4.34 g plant^{-1}). Shoot dry weight under salt (7.36 g plant^{-1}) and water stress (7.24 g plant^{-1}) was identical but significantly differed from control (11.98 g plant^{-1}) at 6th to 8th weeks after emergence. Similar result was also observed at 8th to 10th weeks after emergence. Significantly the lowest shoot dry weight (12.06 g plant-^{1}) recorded from water stress when salt and water stress imposed at 10th to 12th weeks after emergence. Shoot dry weight under salt stress (17.90 g plant^{-1}) was identical with control (20.10 g plant^{-1}) at 10th to 12th weeks after emergence. Shoot dry weight was found more sensitive to salt and water stress than root dry weight at all post flowering growth stages. Root dry weight slightly decreased under salt and water stress at all post flowering growth stages. Among the stresses, root dry weight decreased more in salt stress than water stress at 4th to 6th weeks, 6th to 8th weeks and 8th to 10th weeks after emergence. But at 10th to 12th weeks after emergence, root dry weight decreased more in water stress (2.62 g plant^{-1}) than salt stress (3.01g plant^{-1}).

Relative shoot and root dry weight

The relative shoot and root dry weight drastically reduced under salt and water stresses imposed at all post flowering growth stages (Fig. 2). Relative shoot dry weight significantly differed from control when salt and water stress imposed at different growth stages. The highest relative shoot dry weight (91.47%) recorded from salt stress at 4th to 6th weeks after emergence which was identical with water stress at the same growth period (86.64%) and salt stress at 10th to 12th weeks after emergence (89.05%). The lowest relative shoot dry weight recorded from water stress (59.90%) at 10th to 12th weeks after emergence.

Relative root dry weight significantly differed from control when salt and water stress imposed at the post flowering growth stages. The highest relative root dry weight (95.58%) recorded from water stress at 4th to 6th (S1) weeks after emergence which was identical with salt stress at the same period (93.37%). The lowest relative root dry weight recorded from water stress (69.87%) at 10th to 12th weeks after emergence.

Under water stress only, when soil became dries the matric potential decreases, therefore increases the resistance of water flow to the roots. Application of salt water increased soil salinity; at a given level reduced the soil water potential but does not reduced water flow to the roots. Root cortical cells can osmotically adjust to some extent allowing water to readily move into the root. Therefore, shoot dry weight of soybean was affected more in water stress condition than only in salt stress imposed at different post flowering growth stages.

Yield attributes and yield

Yield contributing characters and seed yield of soybean plant under salt and water stress are presented in Table 1. Salt stress and water stress imposed at the post flowering growth stages significantly reduced number of filled pods, 100-seed weight, seed yield and days to maturity. The highest number of filled pods was obtained from control (53 plant^{-1}) which was identical with water stress at 6th to 8th (49 plant^{-1}) and 8th to 10th (48 plant^{-1}) weeks after emergence and salt stress at 10th to 12th weeks after emergence (49 plant^{-1}). The least number of pods was recorded from salt stress imposed at the post flowering growth stage of 4th to 6th weeks after emergence (4 plant^{-1}). Number of unfilled pod was significantly differed by salt stress and water stress. The highest number of unfilled pod (16 plant^{-1}) was recorded from water stress at 10th to 12th weeks after emergence and the lowest recorded from salt stress at 8th to 10th (4 plant^{-1}) weeks after emergence. Significantly the highest 100-seed weight of 10.62 g was obtained from control which was identical with the seed weight of 10.52 g under water stress at 4th to 6th weeks after emergence and 9.74 g under water stress at 6th to 8th weeks after emergence. The lowest seed weight of 5.77 g was obtained from salt stress imposed at 4th to 6th weeks after emergence. The highest seed yield of 10.47 g plant^{-1} was obtained from control followed by seed yield under salt stress at 10th to 12th weeks after emergence (8.68 g plant^{-1}). The lowest seed yield of 0.69 g plant^{-1} was obtained from salt stress imposed at 4th to 6th weeks after emergence. It might be due to salt residual effect that prevailing in the soil from flowering to maturity. The reduction in seed yield of soybean plants subjected to salt stress at 4th to 6th weeks after emergence may be due to an increased uptake of toxic sodium that accumulated in cells and become toxic to the plant. NaCl readily dissolved in water solvent yielded toxic Na^+ that may absorbed into root tissues and transport throughout plant organs, leading to toxic ion damage, osmotic stress and nutritional imbalance (Cha-um *et al*., 2007; Siringam *et al*., 2009) resulting low seed yield. The control plant took maximum days to maturity (111 days) which was followed by the plant under water stress imposed at 4th to 6th (109 days). The plant under salt stress imposed at 4th to 6th weeks after emergence took minimum days to maturity (92 days). The minimum yield reduction was observed in salt stress imposed at 10th to 12th weeks after emergence (17.10%) which was followed by water stress (22.73%) at the same stage of growth. The highest seed yield reduction was recorded in salt stress imposed at 4th to 6th after emergence (93.41%) followed by salt stress imposed at 6th to 8th weeks after emergence (48.90%).

Conclusion

From the above findings, it may be concluded that 4th to 6th weeks after emergence of soybean was the most sensitive post- flowering growth stage to salt for seed yield. The salt stress at 6th to 8th weeks after emergence was also badly affected plant for seed yield of soybean.

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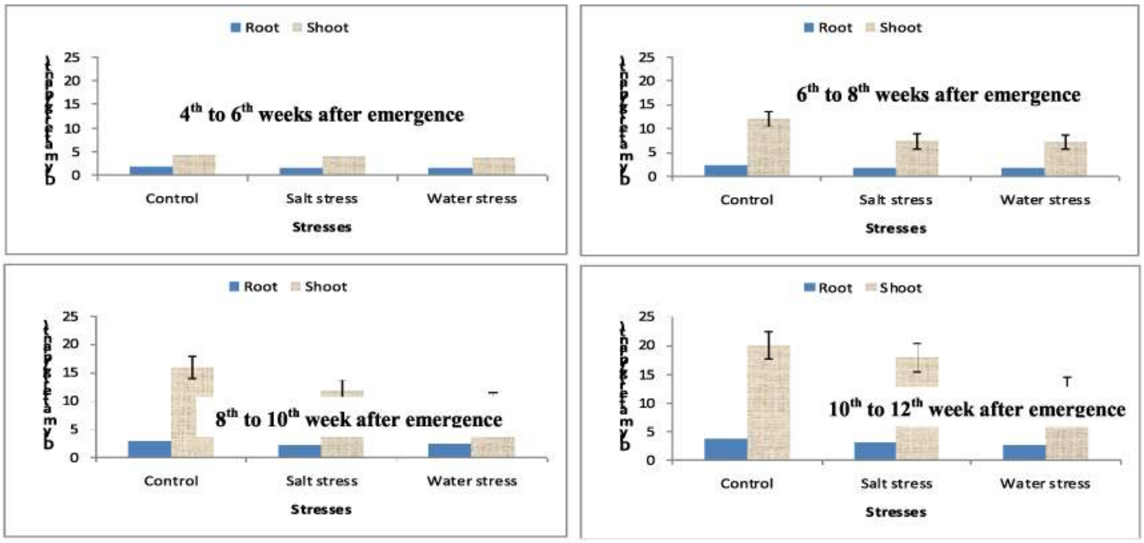

Fig.1. Dry matter production in root and shoot at different post flowering stages of soybean under salt and water stress condition.

Fig.2. Changes of root and shoot dry matter production at different post flowering stages of soybean under salt and water stress condition.

Table 1. Yield contributing characters and yield of soybean under salt and water stress at different post-flowering stages during 2015

Treatment	Filled pods plant^{-1} (no.)	Unfilled pods plant^{-1} (no.)	100- seed weight (g)	Seed yield (g plant^{-1})	Days to maturity	Yield reduction (%)
Control	53.0	10.0	10.62	10.47	111	-
Salt stress at 4th to 6th WAE	3.7	6.3	5.77	0.69	92	93.41
Water stress at 4th to 6th WAE	42.0	8.0	10.52	7.81	109	25.41
Salt stress at 6th to 8th WAE	39.7	13.7	7.95	5.35	94	48.90
Water stress at 6th to 8th WAE	49.3	8.0	9.74	7.48	108	28.56
Salt stress at 8th to 10th WAE	43.0	4.3	7.79	7.75	95	25.98
Water stress at 8th to 10th WAE	47.7	7.0	8.97	7.55	106	27.89
Salt stress at 10th to 12th WAE	48.7	11.3	8.49	8.68	100	17.10
Water stress at 10th to 12th WAE	45.0	16.0	7.29	8.09	103	22.73
LSD(0.01)	7.12	4.52	0.88	1.26	2.44	
CV(%)	9.95	17.78	5.92	10.29	1.38	

EFFECT OF TIME OF SOWING ON PLANT STANDS, GROWTH AND YIELD OF COWPEA IN COASTAL AREA

P. Chokroborty, M. A. Aziz, G. N. Hassan and M. I. A. Howlader

Abstract

An experiment was conducted at MLT site Kuakata, Patuakhali in the *rabi* season of 2014-2015 to verify the effect of sowing times in Cowpea in saline area of Patuakhali under farmers field condition. Three treatments: 17 December, 24 December and 31 December 2014. It was revealed that higher seed yield (1.06t/ha) was produced from the first sowing time i.e. 17 December 2014 followed by second sowing (0.945 t/ha) & lowest (0.738 t/ha) from the late sowing may be due higher ranges of soil salinity affected in the later sowing dates more, than the earliar. From two year results it might be concluded that mid December would be the optimum sowing time for cowpea in the coastal areas.

Introduction

With the advent of wheat, maize and boro rice cultivation in Bangladesh, the area and production of pulse crops have been gradually decreasing (BBS 2004) and as a result, there is deficit of pulse grains in Bangladesh. Thus, it is necessary to increase the productivity of pulse crops in terms of grain yield per unit area. Cowpea is one of the pulse crops with proteinaceous seeds. Although suitable to grow at all regions of Bangladesh, it is extensively grown in the southern part in the rice based cropping systems after the harvest of Transplant aman rice (Rahman 1989). To increase the yield and productivity of cowpea, various agronomic techniques have been tried by many workers (Biswas et al. 1996, Sarker 1994). So the trial has been undertaken to find out the effect of time sowing and to see economic return and farmers reaction.

Materials and Methods

An experiment was conducted at MLT site Kuakata, Patuakhali in the *rabi* season of 2014-2015 to verify the effect of sowing methods on cowpea yield in saline area of Patuakhali under farmers field condition. Three sowing time were comprised as treatments: 17 December, 24 December and 31 December 1014. As planting material, BARI Felon-1 was used. The experiment was laid out in RCB Design with four replications having unit plot size 4 m × 3m. Single seeds were sown in a spacing of 30 cm × 20 cm. Date of sowing was started on 17 December 2014 and harvesting started on 08 April 2015. Fertilizers were applied following FRG 2012. Weeding and other intercultural operations were done as and when necessary. Yield and yield attributes were recorded properly and analyzed statistically.

Results and Discussion

Yield and yield contributing characters were significantly differed among the three sowing time (Table 1). The highest plant population (15.33/m^2) was found in the second sowing time (24 December) followed by 14.66 plant population/m^2 in first (17 December) and third (31 December) sowing time respectively. The longest plant height (67.86 cm) was obtained in first sowing whereas plant height decreased gradually with the advances of sowing time. The highest number of branching (3.96) was observed in the last sowing whereas the lowest (3.2) was in second sowing. Number of pods/plant, pod length, grains/pod and 1000 seed weight are the main responsible parameters for obtaining the yield of a crop variety in different sowing time. The highest number of pod (6.26) was found in first sowing followed by second (5.96) and third sowing (5.36). The longest pod (14.2 cm) was recorded in 17 December sowing and the shortest (10.36 cm) in third sowing. The maximum number of pod (14.23) was obtained from 17 December sowing and lowest (11.66) was in 31 December sowing. The heaviest 1000 seed weight

(85.33 g) was found in first sowing which was followed by second sowing (84 g) and the lightest 1000 seed weight (81.66 g) was observed in the third sowing. Since all the yield contributing characters were observed the highest in first sowing (17 December), so that statistically the highest seed yield (1.06 t/ha) was found in this sowing time which was followed by the second sowing time (0.945 t/ha). The lowest seed yield (0.738 t/ha) was found in third sowing time.

Gradually increasing trend of soil salinity level during the crop growth period was observed in the experimental site (Table 2). The soil salinity range was from 4.56 to 16.3 dS/m during the month of December 2014 to April 2015. The first sowing was started with the soil salinity of 4.56 dS/m whereas the second sowing initiated with above 5 dS/m and the third sowing date about 6.3 dS/m soil salinity level respectively. An inverse relation between sowing date's prevailing soil salinity and the yield of cowpea was observed. The lower the soil salinity level at sowing time, the higher the seed yield of cowpea observed in the experiment.

Table 1. Effect of time of sowing on yield and yield contributing characters of cowpea at MLT site, Kuakata, Patuakhali during 2014-15

Treatments (Sowing Time)	Plant population /m^2	Plant height (cm)	Branches /plant (no.)	Pods/ plant	Pod length (cm)	Grains pod/ (no.)	1000-seed wt. (g)	Seed yield (t/ha)
17 December	14.66	67.86	3.73	6.26	14.2	14.23	85.33	1.06
24 December	15.33	61.63	3.2	5.96	12.26	12.76	84	0.945
31 December	14.66	57.66	3.96	5.36	10.36	11.66	81.66	0.738
$LSD_{(0.05)}$	1.225	6.732	0.336	.367	1.142	0.891	1.538	1.322
CV (%)	4.48	5.73	4.05	3.34	4.94	3.68	0.98	6.62

Table 2. Salinity levels in the experimental plots of cowpea at MLT site, Kuakata, Patuakhali during *rabi*, 2014-15

Date	Salinity level (dS/m)		
	17 December	24 December	31 December
17.12.14	4.56	-	-
24.12.14	5.10	5.23	-
31.12.14	6.5	6.7	6.3
15.01.14	7.29	7.58	7.87
30.01.15	8.11	8.16	8.26
15.02.15	9.13	9.26	9.47
03.03.15	10.33	10.55	10.79
18.03.15	11.59	11.77	11.97
02.04.15	13.11	13.34	13.67
17.04.15	14.97	15.41	15.3
25.04.15	15.9	16.3	16.2

Farmer's opinion

- Early sowing gave higher yield.
- Very low disease and pest attack was observed in the first sowing date than the later sowing dates.

Conclusion

From two year results it might be concluded that mid December would be the optimum sowing time for cowpea in the coastal areas.

INTERCROPPING OF MUNGBEAN WITH CHILLI AT DIFFERENT PLANTING SYSTEM FOR COASTAL AREA

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Abstract

An experiment was conducted at FSRD site Razakhali, Patuakhali in the *rabi* season of 2014-2015 to verify the performance of intercropping of chilli and mungbean at different planting system under farmers field condition. Five treatments were as follows: T_1: 100% chilli, T_2: 100% Mungbean, T_3: One row chilli with one row mungbean, T_4:Two row chilli with one row mungbean, T_5:Two row chilli with two row mungbean. At Razakhali, the highest Mungbean Equivalent Yield (3012 kg/ha) was obtained from from the combination of intercrop treatment (T_4 = Two row chilli with one row Mungbean). It was observed that the highest gross margin (Tk. 66536) was recorded from $T_{1=}$sole chilli and from the combination T_4 = Two row chilli with one row mungbean, higher gross margin (56744 tk/ha) was found. Lowest gross margin Tk. 12841/ha was obtained from $T_{2=}$sole mungbean. Considering the yield and return it may revealed that, two row chilli with one row mungbean was the most profitable as compared to other treatment combination when grown as intercropping system. This is first year result, for more conformation the experiment should be repeated in the next year.

Introduction

Chilli is one of the important spices crops in Bangladesh and has the diversified uses all over the world. It is an indispensable spice in every house on the tropical countries. Mungbean is an important pulse crop also grown in sandy loamy soil in all season of Bangladesh. Plant statures of both the crops are almost similar. Both of these are planted in row and the crops can be grown as intercrop in the same piece of land and the farmers may be benefited economically. Some technique could be applied such as rearrangement of rows, spacing and plant population to increase the yield of intercrop (Mondal *et al*., 2004). Besides adopting appropriate planting geometry in the intercropping system the total productivity can be enhanced (Umrani *et al*., 1984). Therefore the present study was undertaken to find out the suitable crop combination for intercropping chilli with mungbean and to increase the productivity and soil health for higher yield and economic return.

Materials and methods

An experiment was conducted at FSRD site Rzakhali, Patuakhali in the *rabi* season of 2014-2015 to verify the performance of intercropping of chilli and mungbean at different planting system under farmers field condition. It was consisted with five treatments as follows*:* T_1: 100% chilli T_2: 100% Mungbean, T_3: One row chilli with one row mungbean, T_4: Two row chilli with one row mungbean, T_5: Two row chilli with two row mungbean. The experiment was laid out in RCB design with three replications having unit plot size 4 m x 3 m. BARI Mung 6 and Banglanka was used as planting materials. Mungbean was sown 8 January 2015. Chilli seedling was transplanted on 9-10 January 2015. Forty days old seedling was transplanted. Harvesting of Mungbean was started from 5 April 2015 and harvesting of chilli was started from 07 May 2015. Fertilizer application was followed as STB (NPK@ 100-160-100). Standard cultural practices were done as and when necessary. Data were collected plot wise and analyzed statistically.

Results and Discussion

Mungbean:

The result indicates that most of the yield attributes of Mungbean were not significantly influenced due to intercropping with chilli (Table 1), except seed/pod. The longest plant height

(41.30 cm) was observed in T_2. Higher branch/plant, pods per plant were also found from inter cropping system than sole cropping. Higher yield was found from sole cropping (1615.7 kg) fallowed by one row chilli with one row mungbean (T_3).

Table-1.Yield and yield attributes of Mungbean as intercrop with chilli during *rabi* season of 2014-15 at FSRD site, Razakhali, patuakhali.

Treatments	Plants /plot	Plant height (cm)	branch /plant	Pods /plant	Seeds /pod	1000 seed wt. (g)	yield (kg/ ha)
T_1= Sole chilli	-	-	-	-	-	-	-
T_2 = Sole mungbean	691	41.3	4	13.5	8.3	54.65	1615.3
T_3= One row chilli with one row mungbean	260	39.5	4.3	14.2	8.5	54.3	765.7
T_4 = Two row chilli with one row mungbean	150	36	3.7	13.2	7.7	56	470.0
T_5 = Two row chilli with two row mungbean	211	38.6	4.3	15	8.5	52.7	588.7
LSD (0.05)	15.04	NS	NS	NS	0.70	NS	14.04
CV%	2.65	16.21	21.86	17.23	4.92	5.26	4.3

Chilli:

Maximum plant population (58.70) and seed yield (1409.7 kg/ha) was obtained from sole chilli cultivation. Among the yield attributing characters all the characters did not differed significantly except fruits/plant. It was also observed that sole chilli gave the highest yield (1409.7 kg/ha) but in case of intercropping system, two row chilli with one row mungbean gave the highest chilli yield (1100 kg/ha).

Table 2. Yield and yield attributes of Chilli as intercrop with mungbean at FSRD site Razakhali on 2014-15

Treatments	Plants /plot	Plant height (cm)	branch /plant	Fruit /plant	Fruit length (cm)	100 fruit wt. (gm)	yield (kg/ ha)
T_1= Sole chilli	58.7	43.0	3.8	53.1	5.2	58.3	1409.7
T_2 = Sole mungbean	-	-	-	-	-	-	-
T_3= One row chilli with one row mungbean	31.3	42.4	3.8	48.9	5.1	59.7	802.3
T_4 = Two row chilli with one row mungbean	43	42.2	3.4	58.9	5.1	56.7	1100
T_5 = Two row chilli with two row mungbean	39.3	40.2	3.6	45.2	5.4	56.0	1024.7
CV%	9.90	4.39	13.75	11.89	7.82	11.0	4.05
LSD (0.05)	8.3	NS	NS	12.2	NS	NS	18.71

Cost and Return Analysis:

From the combination of intercrop, the highest Mungbean Equivalent Yield (3012 kg/ha) was obtained from two row chilli with one row Mungbean (T_4) followed by two row chilli with two row mungbean. Though BCR is higher (1.69) in sole chilli (T_1) but two row chilli with one row Mungbean offered more benefit such as two crops in a field at a time and also increase soil health adding brown biomass.

Table 3. Cost and return analysis obtained from the experimentation conducted at FSRD site, Razakhali, Patuakhali during *rabi* season 2014-15

Treatments	Yield (kg/ha)		MEY (kg/ha)	Gross return (Tk/ha)	TVC (Tk/ha)	Gross margin (Tk/ha)	BCR
	Mungbean	Chilli					
T_1= Sole chilli	-	1409.7	3858	162036	95500	66536	1.69
T_2 = Sole mungbean	1615.3	-	-	67843	55000	12841	1.23
T_3= One row chilli with one row mungbean	765.7	802.3	2197	124433	78250	46183	1.59
T_4 = Two row chilli with one row mungbean.	470	1100	3012	146244	89500	56744	1.63
T_5 = Two row chilli with two row mungbean	588.7	1024.7	2806	142577	89500	53077	1.59

Note: Chilli @ 115 Tk/kg and Mungbean @ 42 Tk/kg, MEY=Mungbean Equivalent Yield

Conclusion

Considering the yield and return it may revealed that, two row chilli with one row mungbean was the most profitable as compared to other treatment combination when grown as intercropping system. This is first year result, for more conformation the experiment should be repeated in the next year.

Farmer's opinion:

1. Farmers get more yield from sole chilli than intercropping. But from intercropping it is possible to get two crops at a time.
2. In this year the price of mungbean was very low than previous year.
3. Intercultural operations difficult in intercropping system.





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