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Review / Overview Paper

BIO-ECOLOGY AND MANAGEMENT OF COMMON CUTWORM, SPODOPTERA LITURA OF JUTE

M. S. Polan[1] & M. N. Islam[2]

ABSTRACT

An experiment was conducted in the laboratory and field of Entomology Department, Dhaka, and Jute Agriculture Experimental Station, Manikganj of Bangladesh Jute Research Institute (BJRI) to study the life cycle and management of a lepidopteron insect common cutworm (Spodoptera litura Fab.) during the jute season 2016 and 2017. After hatching of egg first molting occurred after 6.0±0.23 days. Then, 2nd, 3rd, and 4th instar larvae lasted for 3.0±0.15, 3.0±0.13 and 2.0±0.20 days respectively and they were more active than the other instars. Fifth instar larvae molted after 4.8±0.20 days of 4th molting and became pupa. Pupation occurred inside the soil and lasted for 7.0±0.21 days. After pupation it became adult moth that remained alive for 6.1±0.28 days. Male and female moths mated after two days of emergence then laid eggs. Single female laid 310.0±12.18 eggs in the laboratory condition. Eggs hatched within 7 days after laid. Total 37.9±1.52 days were required for single life cycle. A 4th instar larva consumed an average 0.72 g leaf and body weight gained 0.166 g day-1. Among the chemical pesticide tested in the laboratory, Carbaryl was most effective (96.67%) followed by Imidacloprid (86.67%).

Keywords: Cutworm, Spodoptera litura, Life cycle, Management

INTRODUCTION

Jute (Corchorus spp.) is the second most important cash crop which has become one of the major foreign currency earning sources of Bangladesh. It belongs to family Tiliaceae. It is an agricultural rapid growing crop and renewable source of biomass. It is a versatile fiber crop having the properties of both soft and hard fiber. Traditional and diversified jute products are biodegradable, photodegradable, thermal degradable, non-plastic, non-toxic, hydrophilic, less

extensible, high water and UV absorbing capacity, easily disposable. Common cutworm, Spodoptera litura (Fabricius) is one of the economically important and regular polyphagous pests on the field and horticultural crops (Shankara Murthy et al., 2006). Common cutworm (S. litura) popularly known as tobacco caterpillar enjoys wide distribution in South-East Asia feeding on 63 plant species belonging to 22 families (Kuldeep et al. 2018). In Bangladesh, it is minor pest of jute that can become a major pest in a specific location under a favorable environmental condition especially during the drought condition. Appropriate use of control measures depends on the different stages of life cycle of insect on which control measure should be taken. Therefore, it had been necessary to study bio-ecology of this insect. Study of biology will help us to know the most devastating stage of cutworm when the control measures must be taken. For the last few years of Spodoptera litura has become a problem of jute cultivation in Bangladesh, especially in Cumilla, Faridpur, Rangpur, Jashore and Jamalpur regions. It feeds on young leaves and stem and may cause death to seedling. Therefore, management of this insect is necessary to protect the yield loss of our crops. Use of insecticides for controlling this pest is on the rise and it has the ability to develop resistance to many insecticides (Kuldeep et al. 2004 and Srivastava et al. 2007). New molecules of insecticides are highly effective against many lepidopteran pests, though sensibility of the

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[2] Chief Scientific Officer, BJRI.

targeted species varies a lot depending on the mode of exposure. Therefore, more insecticides need to be tested to know their effectivities. Considering the above facts an experiment was conducted to study the biology and evaluate some insecticides against larval stage of this obnoxious pest.

MATERIALS AND METHODS

The experiment was conducted at the laboratory of Entomology Department, Dhaka and at the field of JAES, Manikganj of Bangladesh Jute Research Institute during the jute growing season 2016 and 2017. A jute variety O-9897 was grown in the field of JAES, Manikganj and in the pot in the laboratory premises of the Entomology Department, Dhaka every year to get natural infestation of cutworm and source of leaves for feeding and evaluation of insecticide.

Collection of insects and mass rearing

When the field was infested by cutworm naturally, eggs and first instar larvae were collected from the field of JAES, Manikganj and reared in the laboratory of Entomology Department, Bangladesh Jute Research Institute (BJRI) on jute leaves. Initially, collected larvae were kept in 2000ml size 20 plastic boxes. Some pores were made on the lid of these plastic boxes to facilitate aeration. Insects were fed by fresh jute leaves twice in a day. Ten randomly selected individual larva were transferred to ten glass petri dishes for studying life cycle.

Different developmental stages and oviposition

Initially, eggs were collected from the jute field of JAES, Manikganj. Single larvae were kept in a 9 cm × 1.5 cm single glass petri dish with ten replications for recording developmental stages. A 9 cm diameter blotting paper was placed on the bottom of each petri dish before releasing cutworm larva. The larvae's head and skin were observed daily using magnifying lens to record time and date of each molting for knowing the duration required for each instar. Fresh leaves were weighted along with petri dish, blotting paper, with feces and without feces before and after 24 hours of feeding. Body weight of 4th instar larva was measured daily. Fifth instar larvae were released in the oven dried soil in plastic box for pupation and observed daily to record pupation time. Newly emerged single male and single female moths were released in a potted plants covering with a mosquito net for mating and kept in the corridor providing light facilities at night. Afte laying, eggs of each egg cluster were counted using binocular microscope. Total pupation period, adult period and number of eggs per egg cluster laid by a single female were recorded. Environmental data such as temperature and humidity of the laboratory of entomology department, BJRI, Dhaka were also recorded. The average room temperature was 29±30C and relative humidity was 78±10%. Another experiment was done in the laboratory of Entomology Department, BJRI, Dhaka in 2017 to evaluate insecticide against them. In this experiment ten 2nd instar larvae were released in a single 2000ml plastic box for evaluating efficacy of pesticides. Three replications (box) were used for each treatment. The treatments were T1-Lamda-cyhalothrin, T2-Carbaryl, T3- Imidacloprid, T4- Dinotefuran, T5- Cypermethrin, T6- Control with doses suggested by the respective companies. When the insects become 3rd instar three puffs of each insecticide solution were applied on each box containing 3 fresh jute leaves and 10 live insects. Live insects were counted after 24hr, 48hr and 72hr of spray to calculate percent mortality using the formula given bellow.

$$\% \text{ Mortality} = \frac{\text{Live insects before spray} - \text{Live insect after spray}}{\text{Live insects before spray}} \times 100$$

RESULTS AND DISCUSSION

Common cutworms of jute showed complete metamorphosis having four stages such as egg, larvae, pupa and adult in its life cycle. Brownish round shelled eggs were deposited underneath the middle leaves (Figure 1). After hatching, 1st instar green colored larva (Figure 2) came from brown puffy egg mass and first molting occurred after 6.1±0.23 days (Table 1). After first molting some 2nd instar larva became blackish color. Second molting occurred after 3.7±0.15 days of 1st molting. Then, 3rd, and 4th instar larvae lasted for 3.2±0.13 and 2.8±0.13 days, respectively. These 2nd, 3rd, and 4th instar larvae were more active than the other stages. Some 2nd and 3rd instar larva turned into white color cutworm (Figure 3) and remained inactive. They did not walk and even they did not eat. It seemed that they started overwintering due to lack of food and favorable environment. Fifth instar larvae (Figure 4) molted after 3.8±0.20 days of 4th molting and became pupa (Figure 5). Five molting's were occurred and matured larvae formed soil case for pupation. Total larval duration was 19.6 days. Pupation occurred inside the soil and lasted for 7.3±0.21 days. After pupation it became adult moth that remained alive for 6.1 days. Total duration of each life cycle was 37.9±1.52 days. Adult moths were mated at night and female moth laid eggs after 2 days of adult emergence. Single female laid about 310.00±12.18 eggs which were hatched after 4.9±0.18 days. Carasi et al. (2014) studied life cycle of common cutworm in mulberry and found 1st instar 4.08, 2nd instar 3.24, 3rd instar 3.48, 4th instar 2.44 5th instar 3.64, pupa 8.29, adult 7.8 and egg required 2.36 days. They also observed 19.36 and ±35.33 days, respectively as pupal period and total duration of life cycle. Amin MR et al. (2016) studied larval development of S. litura on different cotton varieties

Table 1: Duration required for different stages in the life cycle of cutworm

Stage wise duration (days)								
1st instar	2nd instar	3rd instar	4th instar	5th instar	Pupa	Adult longevity	Number of eggs laid by single female	Incubation period
6.1±0.23	3.7±0.15	3.2±0.13	2.8±0.13	3.8±0.20	7.3±0.21	6.1±0.28	310.0±12.18	4.9±0.18
Total larval duration = 19.6 days								
Total duration of life cycle = 37.9±1.52 days								

Figure 1: Egg cluster of cutworm

Figure 2: 1st instar caterpillar of cutworm

Figure 3: White color cutworm

Figure 4: Adult 5th instar caterpillar

Figure 5: Pupa of cutworm in a soil cage

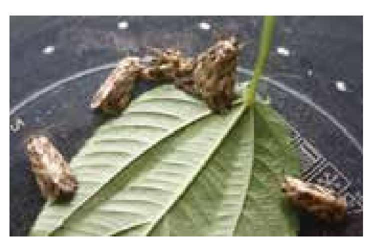

Figure 6: Adult moth of cutworm

Ten 4th instar larvae were fed with fresh jute leaves once in a day. Leaves were weighed before and after eating. It was found that a 4th instar larva consumed in average 0.722g fresh leaf daily. Body weight of a 4th instar single cutworm was increased in average 0.166g in a day. Ming Xue et al. (2010) found larval growth rate 0.43±0.01 and leaf consumption rate 1.51±0.1 in tobacco. Amin MR et al. (2015) studied growth response of S. litura as a result of feeding on the tested cotton varieties and found that larval instars, pupae and adult moths attained the highest body weight on CB8, followed by CB5, and the lowest weight on CB12.

Table 2: Feeding behavior and growth of 4th instar cutworm in 2016

Sl. No.	Initial leaf weight (g)	Leaf weight (g) after 24hrs	Leaf consumed by single insect (g)	Initial body weight (g)	Body weight after 24hrs (g)	Body weight gained (g)
1.	3.990	3.690	0.300	0.560	0.716	0.156
2.	3.000	2.352	0.648	0.706	0.940	0.234
3.	3.210	2.143	1.067	0.903	1.090	0.187
4.	3.190	2.324	0.866	0.838	0.927	0.089
5.	3.220	2.700	0.520	0.930	1.100	0.170
6.	3.430	2.550	0.880	0.740	0.930	0.190
7.	3.150	2.430	0.720	0.830	0.950	0.120
8.	2.950	2.150	0.800	0.760	0.890	0.130
9.	3.200	2.650	0.550	0.810	0.990	0.180
10.	3.310	2.440	0.870	0.980	1.180	0.200
		Average =	0.722		Average =	0.166

Five insecticides were tested to control Spodoptera litura in the laboratory of entomology department of BJRI. The insecticides were Lamda-cyhalothrin, Carbaryl, Imidacloprid, Dinotefuran, and Cypermethrin. Carbaryl was found most effective (mortality 96.67%) against cutworm followed by Imidacloprid (mortality 86.67%) that were statistically different each other (Table 3). Irshad et al. (2011) found that after 72 hours by topical application LC50 values of cypermethrin and carbaryl in susceptible strain were 0.003 and 0.011 when compared to parental strain with 0.010, 0.044 respectively. This substantiate the findings of Kapoor et al. (2005) who reported LC50 values for cypermethrin to be 0.0029 against field collected third instar larvae of this pest in Punjab after 72 hours of exposure. Othman et al. (2020) studied LC50 and toxicity index (TI) value of lambda-cyhalothrin at 72h post-treatment on the second instar larvae of S. lituralis and found LC50 value for lambda-cyhalothrin was 69.21 mg/l, and toxicity index (TI) values was 0.059

Table 3: Effect of different groups of insecticide on cutworm in 2017

	Generic name	Trade name	Dose	Average no. of insect before spray	% Mortality		
					24hrs	48hrs	72hrs
1.	Lamda-cyhalothrin	Loc 2.5 EC	$3mlL^{-1}$	10	16.67cd	20.00d	23.33d
2.	Carbaryl	Orogold 85WP	$3.4gL^{-1}$	10	90.00a	96.67a	96.67a
3.	Imidacloprid	Bondhudar 70WG	$0.2gL^{-1}$	10	56.67b	60.00	86.67b
4.	Dinotefuran	Dinote 20	$0.4gL^{-1}$	10	26.67c	30.00c	33.33c
5.	Cypermethrin	Fair Kill 10EC	$1.1mlL^{-1}$	10	13.33d	16.67d	16.67d
6.	Control	--	--	10	0.00e	0.00e	0.00e
			LSD (5%)		11.82	6.36	4.30

From the findings it is suggested that Carbaryl and Imidacloprid insecticides may be sprayed during 2nd, 3rd, and 4th instar larva to control cutworm effectively.

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Review / Overview Paper

COMPARISON OF TRADITIONAL SCOURING AND BIO-SCOURING PROCESS ON KNITTED FABRIC

Md. Mehedi Zahan Pulok[1], Ashraful Alam[2], Mohammad Maniruzzaman[2], Nazia Shirin[3], Israt Jahan[4] & Sharmin Farzana Jamal[5]

ABSTRACT

Textile fabrics were undergoes chemical processing since ancient time. Human ingenuity and imagination, craftsmanship and resourcefulness are evident in textile products throughout the ages. This experiment was mainly focused on bio-scouring process, significant comparison between enzymatic and traditional scouring processes. This study was attempted to evaluate the eco-friendly bio-scouring and the conventional chemical (mainly NaOH) scouring processes of cotton & comparison between the effectiveness of both types of scouring process on cotton fibers and fabrics in the Textile industries. Less developed countries, did not set strict rules and regulations to discharge waste water from textile mills after wet processing fibers, yarns or fabrics which contains large amount of adverse and hazardous chemicals. In conventional scouring and bleaching, it was easier to produce light-colored shades dyed fabrics. Though both processes had some merits and demerits, eco-friendly and cheaper bio-scouring process, though it some complexities in operation, had a good prospect to be substituted of conventional scouring.

Keywords: Bio-scouring, Knitted fabrics

INTRODUCTION

Raw fibers, yarns or fabrics have various kinds of impurities like motes, seed coat fragments, pesticides, dirt, chemical residues, metallic salts of various kinds and immature fibers (Korabayev et al., 2018). External impurities are removed in the blow room processing while internal impurities of cotton fibers removed by scouring processes. Cotton fiber is constituted with different layers in its body (Atakhanov et al., 2019). The main target of scouring is to remove waxes, pectin's, hemi-celluloses and minerals from the raw cotton fibers during the early stage of textile wet processing to make the fibers highly absorbent, which is necessary for the subsequent processes such as mercerizing, bleaching, dyeing, printing and finishing (Amanuel, 2022). For this purpose, Caustic soda (NaOH) treatment is used in conventional scouring, whereas, Enzymes (Cutinizes, Pectinase etc.) treatment is applied in bio scouring process. Though different scouring materials are used in the textile industry like NaCO3, Ca(OH)2 etc., alkaline (NaOH-sodium hydroxide) are used mostly for the scouring.

Conventional chemical scouring is done in hot (900C-1000C) NaOH solution for 45-60 minutes safe (Aggarwal et.al., 2008).. The conditions depend on the quality of scoured fabric required. Moreover, different agents are used such as reducing agents, detergent, sequestering agent (also called chelating agents), and wetting agent. Sequestering agent reduces the water hardness, reducing agent prevent oxidation of cellulose by air oxygen at high pH, detergent acts as emulsifier to assist in removing waxy substances and wetting agent reduces the surface tension of water helps fibers to swell. The fabrics treated with harsh chemicals are also unsafe for human health (may affect on human skin) but bio

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scoured fabrics are completely safe (Aggarwal et.al., 2020).

MATERIALS & METHOD

Materials

Enzymes were collected trough an assisted visit in Knit Industry in Gazipur region. Plain Knit fabric with following details was used for the bio-scouring.
Fabric types: 100% Cotton (Grey)
Count: 26^s Ne
GSM: 130 g/m^2

The chemicals and reagents used for this research work were analytical grade and certified by the research laboratory with the proper specification. Equipment (Apparatus) and Machinery used to collect raw material are a scissor, knife, weight balance, beakers, sample dyeing machine.

Methods

Though this study is based on the effectiveness scouring comparison, performances should also be judged after subsequent processes so that their overall efficacy can be compared. For this purpose, effectiveness and performance are evaluated after different steps, even after dyeing and finishing.

Mechanism of Conventional scouring

In the conventional scouring, dilute sodium hydroxide (NaOH) solution is used which swells the cotton fibers and opens up the cell of the fibers to access H_2O_2 (Hydrogen peroxide) in the subsequent process bleaching. In conventional scouring NaOH also cleans outer chemicals residue and impurities by dissolution. Some of the waxy substances melt in the high temperature and other parts make water soluble compounds with NaOH. Non-cellulosic substances like pectin, proteins and hemi-celluloses, are also converted into water soluble compounds. Caustic soda (NaOH) neutralizes the fibers which contain some acidic compounds in it such as amino acids, pectic acids etc. Since some of the NaOH is absorbed by fibers, the intra and intermolecular hydrogen bonds becomes stronger in the cellulosic fiber.

Conventional Scouring Process

In this experiment, the following recipe is used to conduct the study:

Table 1: Recipe of Traditional Scouring for Cotton Fabric

Sample no	Coenzyme dl g/L	Wetting agent g/L	Emulsion	Detergent g/L	Temp ^{0}C	Time min	p^H	M:L	Sample weight gm
1	1	0.5	0.5	0.5	100^{0}C	45	10.5	1:15	10
2	1.50	0.75	0.75	0.75	100^{0}C	45	10.5	1:15	10
3	2	1	1	1	100^{0}C	45	10.5	1:15	10
4	2.5	1.5	1.5	1.5	100^{0}C	45	10.5	1:15	10
5	3	2	2	2	100^{0}C	45	10.5	1:15	10
6	3.5	2.5	2.5	2.5	100^{0}C	45	10.5	1:15	10
7	4	3	3	3	100^{0}C	45	10.5	1:15	10
8	4.5	3.5	3.5	3.5	100^{0}C	45	10.5	1:15	10
9	5	4	4	4	100^{0}C	45	10.5	1:15	10
10	5.5	4.5	4.5	4.5	100^{0}C	45	10.5	1:15	10

Bio - scouring Process

In this experiment, the following recipe is used to conduct the study

Table2: Recipe of Traditional Scouring for Cotton Fabric

Sample no	Coenzyme dl g/L	Wetting agent g/L	Emulsion	Detergent g/L	Temp ^0C	Time min	p^H	M:L	Sample weight gm
1	1	0.5	0.5	0.5	55^0C	30	4.5 - 5	1:15	10
2	1.50	0.75	0.75	0.75	55^0C	30	4.5 - 5	1:15	10
3	2	1	1	1	55^0C	30	4.5 - 5	1:15	10
4	2.5	1.5	1.5	1.5	55^0C	30	4.5 - 5	1:15	10
5	3	2	2	2	55^0C	30	4.5 - 5	1:15	10
6	3.5	2.5	2.5	2.5	55^0C	30	4.5 - 5	1:15	10
7	4	3	3	3	55^0C	30	4.5 - 5	1:15	10
8	4.5	3.5	3.5	3.5	55^0C	30	4.5 - 5	1:15	10
9	5	4	4	4	55^0C	30	4.5 - 5	1:15	10
10	5.5	4.5	4.5	4.5	55^0C	30	4.5 - 5	1:15	10

Bleaching recipe for traditional scoured and bio – scouring Sample

In this experiment, the following recipe is used to bleached the traditional scouring and bio- scouring sample the study:

Table –3: Bleaching recipe for traditional scoured and bio –scouring Sample

Sample no	H_2O_2 %	NaOH g/L	Stabilizer (sodium silicate) g/L	Wetting agent g/L	Detergent g/L	Sequestering agent g/L	Temp ^0C	Time min	p^H	M:L	Sample weight gm
1	3	0.5	0.2	1	1	0.2	95^0C	45	10 - 11	1:30	5
2	3.50	1.0	0.3	1.5	1.5	0.3	95^0C	45	10 - 11	1:30	5
3	4	1.5	0.4	2	2	0.4	95^0C	45	10 - 11	1:30	5
4	4.50	2.0	0.5	2.5	2.5	0.5	95^0C	45	10 - 11	1:30	5
5	5	2.5	0.6	3	3	0.6	95^0C	45	10 - 11	1:30	5
6	5.50	3.5	0.7	3.5	3.5	0.7	95^0C	45	10 - 11	1:30	5
7	6	4.0	0.8	4	4	0.8	95^0C	45	10 - 11	1:30	5
8	6.50	4.5	0.9	4.5	4.5	0.9	95^0C	45	10 - 11	1:30	5
9	7	5.0	1.0	5	5	1.0	95^0C	45	10 - 11	1:30	5
10	7.50	5.50	1.1	5.25	5.25	1.1	95^0C	45	10 - 11	1:30	5

Dyeing Recipe for traditional scoured and bio – scoured sample

In this experiment, the following recipe is used to dyeing the traditional scouring and bio-scouring sample the study:

Table 4: Dyeing recipe for traditional scoured and bio – scouring Sample

Sample no	Dyes %	Salt g/L	Soda Ash g/L	Anti-foaming Agent g/L	Wetting agent g/L	Lubricating g/L	Sequestering agent g/L	Temp ^0C	Time min	p^H	M:L	Sample weight gm
1	0.5	20	5	0.5	0.2	0.5	0.5	95^0C	30	10.5	1:15	5
2	1.0	40	10	0.6	0.3	0.8	0.8	95^0C	45	10.5	1:15	5
3	1.5	45	12	0.7	0.4	1.2	1.2	95^0C	45	10.5	1:15	5
4	2.0	50	14	0.8	0.5	1.5	1.5	95^0C	45	10.5	1:15	5
5	2.5	60	15	0.9	0.6	1.8	1.8	95^0C	45	10.5	1:15	5
6	3.5	63	16	1.0	0.7	2.1	2.1	95^0C	45	10.5	1:15	5
7	4.0	65	17	1.5	0.8	2.4	2.4	95^0C	60	10.5	1:15	5
8	4.5	70	18	2	1.0	2.7	2.7	95^0C	60	10.5	1:15	5
9	5.0	75	19	2.5	1.5	3.0	3.0	95^0C	60	10.5	1:15	5
10	5.5	80	20	3	2	3.3	3.3	95^0C	60	10.5	1:15	5

RESULTS

Comparison between Bio-Scoured & Conventional scoured in terms of weight loss%

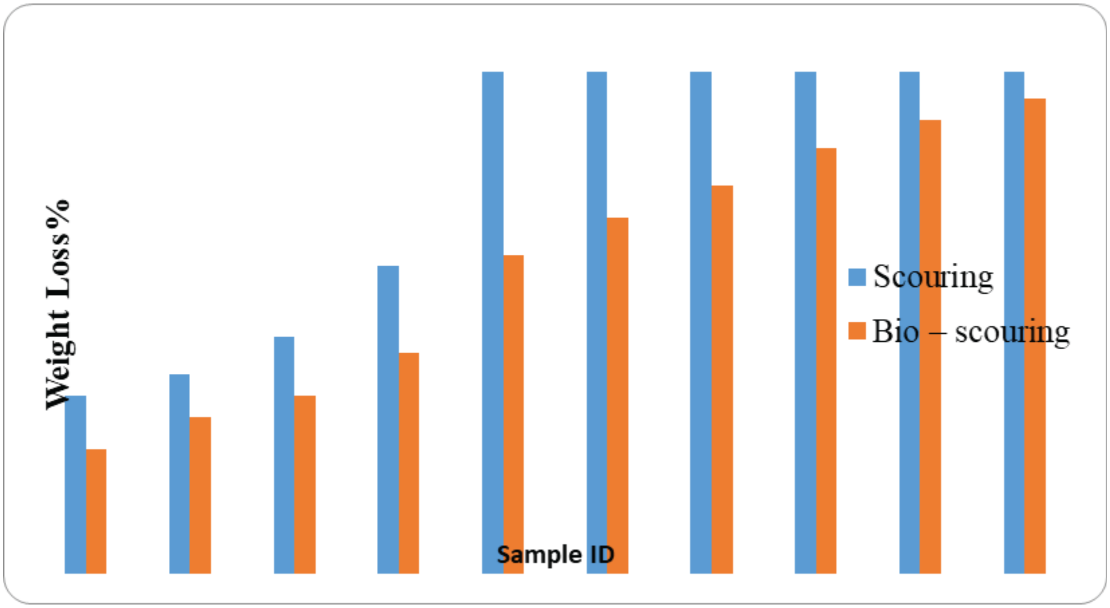

Figure 1: Comparison between Bio-Scoured & Conventional scoured in terms of weight loss

From the above figure, it is observed that the weight loss % is higher in conventional process compared to the bio-process. So it is assumed that more impurities have been removed from the fabric treated by conventional alkaline process and more effective in this case than the bio-process (particularly in removing motes).

Table 5: Assessment of pretreatment by absorbency test

Verdict		Spot Test	Wicking Test		Wicking Test		
			5 minutes	10 minutes	1 cm	2 cm	3 cm
Bio-Scouring	Good Pretreatment	1-5 second	30-50 mm	50-90 mm	3-5 second	10-30 second	40-70 second
Traditional Scouring	Poor Pretreatment	More than 10 seconds	Less than 30 mm	Less than 50 mm	More than 10 seconds	More than 30 seconds	More than 100 seconds

Spot Test:

A standard scoured sample will take 1- 5 sec for absorption of the drop. We see the absorbed area forms a uniform circle and less area of spreading- indicates even but incomplete scouring. On the other hand absorbed area forms a bigger and uniform circle – indicates even and complete scouring. If the spot is irregular – indicates uneven scouring.

Wicking Test:

In this table we show that the length of fabric is observed in solution .we treatment the sample absorption rise up as high as 30 mm then the fabric has good scouring .on the other hand the absorption rises up as high as 50 mm then it may be said that the fabric has excellent scouring.

Comparison between Bio-Scoured & Conventional scoured colorfastness to wash test

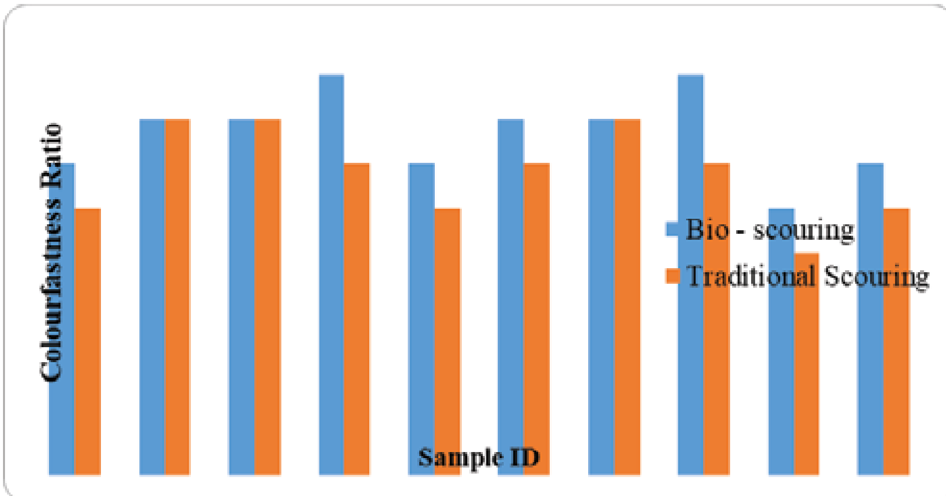

Figure 2: Comparison between bio-scoured & conventional scoured colorfastness to wash test

This figure shows the results in terms of color staining. These results show us that depending on the nature of color fastness to wash sample was vary in traditional scoured sample and bio – scoured sample. It is observed that, in the graphs that within the same hue color fastness to wash doesn't shows a significant change but the differences are well observed.

Energy saving:

Table 6: Compression of Engergy saving

Traditional Scouring	Bio - Scouring	Temp. Saving
100^0C	55^0C	45^0C

From table 6, it is observed that in bio scouring process, enzymes work properly at a temperature of 550C on the other hand to work out the scouring process traditional scouring needs a temperature of 1050C. Now if we applied bio–scouring process over traditional one than we save 45% energy.

Time saving:

In traditional scouring process to completes scouring process chemicals a total time of four hour. On the other hand, in bio – scouring process in took only one and half hour to complete the entire coloring process. So, it clearly a huge time saves if we take the bio – scouring process instead of traditional scouring process.

Less Water Consumption:

In traditional scouring we use a numerous chemical to complete the process. As a result, we also need a lot of water for rinsing. On the other hand, on traditional scouring we use enzyme instead of using chemicals. It results a less water use in this process. In the experiment we found that we need less water in fact half the amount we used in traditional scouring if we used bio – scouring. This is helps us to maintain the environmental balance and protects it from being polluted.

Weight loss:

Due to attacking also the secondary cell wall and high removal of pectin, though removal of pectin is not important for improving hydrophilicity or absorbency, fabrics weight loss (about 3-10%) is higher. For these loosed fabrics, manufacturer has to pay extra cost.

Energy and time required:

Bio – scouring needs not as high temperature as conventional scouring needs. Bio-scouring is done below 700C but conventional caustic scouring is done around 900C-105°C temperature and to provide this higher temperature, higher heat production is needed. Thus high heat energy production increases cost in scouring. Moreover, after conventional scouring, two step washing is required for neutralizing high alkalinity. Which also increases additional time and cost.

Color fastness:

Color fastness of the dyed fabrics after bio – scouring and conventional has nearly same though it varies from types of dyestuff, dyeing process, depth of shade, finishing process and other factors.

DISCUSSION

Though the conventional scouring process is widely using now-a-days, it has great bad effect on environment. Therefore, many of the developed countries are avoiding the conventional scouring process replacing enzymatic, eco-friendly, scouring processes. Since bio – scouring is an eco-friendly scouring process it has great future. The new enzymatic procedure is corresponding with a significant role in minimizing the demand of energy, water, chemicals, time and therefore costs. After bio – scouring, fabric can be dyed directly without bleaching, which also reduces additional cost in this step. But in this process, light-colored shades cannot be produced or very difficult match. Whereas, in conventional scouring and bleaching, it is easier to produce light-colored shades dyed fabrics. Though both processes have some merits and demerits, eco-friendly and cheaper bio – scouring process, though it some complexities in operation, has a good prospect to be substituted of conventional scouring in next world textile wet processing.

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Review / Overview Paper

DEVELOPMENT OF MANAGEMENT APPROACH AGAINST THRIPS (RHIPIPHORTHRIPS CRUENTAUS) OF ROSES FLOWER

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ABSTRACT

The experiment was conducted at rose garden of Regional Agricultural Research Station, Jashore during November-April in 2020-21 to 2021-22. For mechanical control hand picking was done and harmful insects were also classified as the most direct and the quickest way to remove clearly visible pests. Mechanical control and white color sticky trap were set up in treatment-1, 2, 3 and 4. The lowest number of rose thrips was found in mechanical control + white sticky trap + spraying of Chlorphenapyr 10 SC) @ 1 ml/L of water (1.80) and the highest percent reduction over untreated control (97.13%) and the highest thrips in untreated control (81.99%) after 3rd spray. The lowest percent flower infestation of rose was recorded in mechanical control + white sticky trap + spraying of Chlorphenapyr 10 SC (2.33%) and the highest percent flower infestation reduction over untreated control (88.88%) and the highest percent flower infestation of rose was observed in T5 (15.41%). The highest yield (406306 flowers/ha) and net return (Tk 399866) was recorded from mechanical control + white sticky trap + spraying of Chlorphenapyr 10 SC and the lowest in T5 (210683 flowers/ha). The results revealed the highest MBCR was observed in mechanical control + white sticky trap + spraying of Chlorphenapyr 10 SC 1 ml/L of water treated plot (11.27).

Keywords: Development, Management, Approach, Thrips, Roses

INTRODUCTION

Commercial floriculture has a remarkable positive impact on increasing total household income of farmers and traders in Bangladesh. The farmers are showing keen interest in floriculture and flower business as a high value of agricultural corps and favorable climatic condition in this country. Hence, About 5,000 resilient farmers are growing flower and foliage in the country and 80,000-90,000 people are directly or indirectly involved in floriculture business (Islam et al. 2019 and Chowdhury, 2010). Rose (Rosa species), a universally celebrated flower, has been used as a garden plant since the dawn of civilization. Rose is a symbol of perfection, elegance, romance and love (Elgimabi, 2011). It is used in different type of personal, social, marriage ceremony, national days, and official inaugurations. Generally, rose could be cultivated in pot, in a home garden, and commercially in the farmer's field. Farmers of these areas grow different types of flowers including rose. Several insects and mite pests were found to attack and considerable losses during rose cultivation in different region of Bangladesh. Pest species abundance and infestation differ from place to place with the variation in the agro-climatic conditions of the locality. Information on pest complex in a specific agro-ecosystem is very much essential in developing pest management strategies, which would be economically feasible and sound (Islam et al., 2019, Handayati and Sihombing, 2017). However, In Bangladesh, very little information is available about the insects and mite in roses. Several types of pests and diseases such as aphids, thrips, scale insects, spider mites, black spot, powdery mildew and crown gall disease were recorded during

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rose cultivation in different region of Batu East Java (Handayati, and Sihombing, 2017). These pests could damages flower in different ways and deteriorated flowers quality (Park, et al. 2002). In Bangladesh, the insect pests of rose were recorded by several scientists Islam et al., (2019), Ali et al., (2016), Amin et al., (2018). But rose slug, flea beetle and whitefly were listed in this study which was not recorded by Islam et al. (2019). Pal and Sarker (2009), and Sohi and Singh (1995) reported 24 and 36 insect species were found to infest ornamental crops in India which was almost accordance with the present records. Many insect and mite pest species have appeared in ornamental plants in Bangladesh due to favorable climatic condition. Comparatively higher temperature and lower relative humidity increased hopper population (Joshi and Kumar, 2012). Thrips are tiny elongate insects with fringed wings that can range in size from 0.5 mm to up to 14 mm when fully mature (Mound, 2005), although most are only about 1mm in length with slender bodies. Immature thrips are usually light yellow to lemon-colored and are spindle-shaped, and leaves are required to precisely detect and identify them. Thrips are a diverse group of hemi metabolous insects that have a range of diets consisting of both plant and animal prey, depending on the species in question. These tiny insects feed on prey items with rasping-sucking mouthparts that resemble a soda straw. Although thrips possess two mandibles, or jaw-like structures, the right mandible is greatly reduced and vestigial (Grimaldi, et al., 2004). The left mandible is predominant, and is used to pierce the cell wall of plant tissues (Childers and Achor, 1989). Some species inject an enzyme into food tissues that is used for extra-oral digestion from tubes called stylets in their mandibles (Hunter, et al., 1994). Their bodies are elongate and slender. Some species have fringed wings, making them capable of flight. Thrips undergo incomplete development in which they begin their lives as an egg, which may take several weeks to develop, but can hatch in as little as a day (Mound, 2005). Sexual reproduction seldom occurs in all species of thrips. Thrips are difficult to spot on a rose blossom, as they are generally located at the base of the petals (Scott, 2009). This damage is generally characterized by deformed buds that may only partially open, or even fall from the plant before full bloom. Thrips feeding on rose petals may also result in a flecking pattern on leaves near the affected buds. The physical control of thrips in rose garden, or any agricultural setting for that matter, is often quite difficult. Below that you might take to prevent the further spread of Thrips infestation in your rose garden: remove damaged buds and blooms and dispose of them well away from the planting area keep weeds and grass trimmed back and away from the base of your rose plants in the case of extensive bloom damage, a periodic spray of insecticide prior to thrips entering the rose blooms can be used to suppress Thrips infestations. Economic impact many thrips species are considered agriculture crop pests due to herbivory of flowers, fruits, leaves and stems of plant commodities of economic importance. Many species are also known to be the only insect vectors of plant Tospoviruses (Mound, 2005), which can cause spotting and wilting of the fruit and leaves, reducing market value of the crop in question. The western flower thrips, Frankliniella occidentalis (Pergande) is considered a widespread plant pest worldwide, and is the primary vector of plant Tospoviruses (Mound, 2005). In a two-year North Carolina State University study on the effect of thrips on peanut plants in Virginia, of symptomatic plants tested for Tomato Spotted Wilt Virus (TSWV, a type of plant Tospovirus), more than 98% of plants tested positive for infection (Hurt, et al., 2005). Management strategy due to the small size of thrips and the confined space of their natural habitat (the inside parts of flowers and tight spaces of plants), control strategies are often limited to chemical pesticides, such as aldicarb and phorate (Hurt, et al., 2005). Some biological pesticides, such as Beauveria bassiana, have been tested as well, but with limited efficacy. Biological control agents are also used, including species of parasitoid wasps, but these insect control agents must be small enough to fit into confined spaces to exhibit active predation. Often, outbreaks of thrips within a host plant species are left unchecked until a point of economic threshold is reached (Mound, 2005). Mechanical control hand picking was done and harmful insect also classified as the most direct and the quickest way to remove clearly visible pests. Two color stiky trap (white and blue) were set up in each line. The lowest number of rose thrips was found in IPM package 2 (6.36 in 2017-18 and 3.03 in 2018-19) and highest in farmer's practices (14.36 in 2017-18 and 12.40 in 2018-19).

The lowest percent flower infestation of rose was recorded in IPM package 2 (9.98 to 17%) and the highest in Farmers practice (19.72 to 32.66%). The highest yield (864000 no./ha in 2017-18 and 535932 no./ha) was recorded from IPM package 2 and the lowest in farmers practice (438750 no./ha in 2017-18 and 388857 no./ha). The results revealed the highest MBCR was observed in IPM package-2 (Mechanical control+ Sticky trap (Blue and White) + spray of Thiamethoxam 20% (Virtako 40SC) @ 1.5 ml/L of water.) treated plot (17.2 to 49.7) in both the year Munmun, et al., 2020). This is very pathetic to farmer and drastically hampers the production of rose. So our farmers urgently needed to an environment friendly management approach against insect pest of rose's. Keeping this view in mind, the present research work has been undertaken to develop a bio-rational based management package for thrips attacking roses.

MATERIALS AND METHODS

The experiment was conducted during winter season (November-April) in 2020-2021 and 2021-22 two consecutive years at established rose garden of Regional Agricultural Research Station Jashore. The experiment was laid out in a randomized complete block design with five dispersed replications. Ten plants were selected from each line. Plant to plant distance was 1m and line to line distance was 3m. The normal intercultural operations were done as and when necessary. For mechanical control hand picking was done and harmful insects were also classified as the most direct and the quickest way to remove clearly visible pests. Five flowers from 3 plants were considered for data collection. Mechanical control + white color sticky trap were set up in each line. The treatments were as follows: T1 = Mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water), T2 = Mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water), T3 = Mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water), T4 = Mechanical control + white sticky trap + spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water, T5 =untreated control. The whole plant was thoroughly covered by spray emulsion.

The percent (%) insect pest population reduction over untreated control was calculated using following formula:

$$\text{\% Insect pest reduction over control} = \frac{\text{Mean value of control - mean value of the treatment}}{\text{Mean value of control}} \times 100$$

The per cent rose flower infestation due to rose thrips infestation was calculated by using the following formula.

$$\text{Per cent flower infestation} = \frac{\text{Number of infested flower}}{\text{Total number of flower}} \times 100$$

The per cent reduction of rose flower infestation due to rose thrips infestation was calculated by using the following formula

$$\begin{array}{l}\text{\% reduction of flower infestation}\\ \text{reduction over control}\end{array} = \frac{\text{\% untreated control - \% flower infestation}}{\text{\% untreated control}} \times 100$$

Yield under different treatments were recorded at each harvest and yield (t/ha) was calculated. Benefit cost ratio of different treatments were also determined following Ali et al. (1996).

Name of district with selected geographic position

Jashore is the first district of undivided Bengal. It was established in 1786 as a part of the oldest Samotat. Geographically, it is at the south-western zone of Bangladesh. Jessore district is located at 88 O -40' to

89 O -50' E and 22 O - 47' to 23 O - 47' N. (Latitude: 23.163401 N, Longitude: 89.218166 E).

Statistical analysis

Data recoded on different parameters were processed for statistical analysis. Data were analyzed by using statistics 10 software for analysis of variance following randomized completely block design (RCBD) and treatment means were separated by applying LSD at 1% level of significance

RESULTS AND DISCUSSION

The effect of different treatment packages on rose against thrips are presented in Table 1. The lowest number of thrips observed in rose was found in treatment with mechanical control + white sticky trap + spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water) after first day spray application (11.52) which was followed by treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water) (13.99), treatment mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water) (14.00), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water) (16.59) and the highest in untreated control (68.22) whereas the highest per cent reduction over untreated control recorded in mechanical control + white sticky trap + spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water (83.11), and it was significantly similar result found in mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water (79.49), mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water (79.48), mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water (75.68%). Similar results were also obtained by Munmun et al., 2020.

Table 1. Effect of different treatment packages on reduction of thrips in flowers during 2020-21 and 2021-22

Treatments	Thrips/flowers/plant		
	Before spray	24 hours after 1st spray	% Reduction over control
Mechanical control + white sticky trap + Matrine 0.5% @ 1.5 ml/L of water	58.92a	16.59b	75.68
Mechanical control + white sticky trap + Bioclean @ 1 ml/liter of water	55.07ab	14.00b	79.48
Mechanical control + white sticky trap + Spinosad 2.5SC @ 1.2 ml/L of water	53.28ab	13.99b	79.49
Mechanical control + white sticky trap + Chlorphenapyr 10 SC@ 1.2 ml/L of water	50.30b	11.52b	83.11
Untreated control	64.77b	68.22a	-
CV (%)	12.67	16.90	-

Means having same letter(s) in a column are not significantly different at P>0.01 followed by LSD.

The effect of different treatment packages on rose against thrips are presented in Table 2. The lowest number of thrips observed in rose was found in treatment mechanical control + white sticky trap + spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water) after second day spry application (8.11) which was followed by treatment mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water) (8.52), treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water) (8.92), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water) (8.97) and and the highest in treatment T5 untreated control (68.37) whereas the highest per cent reduction over untreated control recorded in treatment mechanical control + white sticky trap + spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water) (88.14%), and it was significantly similar result found in treatment mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water) (87.54%), treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water) (86.95%), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water) (86.88%). Similar trends were also obtained by Munmun et al., 2020.

Table 2. Effect of different treatment packages on reduction of thrips in flowers during 2020-21 and 2021-22

Treatments	Thrips/flowers/plant		
	Before spray	24 hours after 2nd spray	% Reduction over control
Mechanical control + white sticky trap + Matrine 0.5% @ 1.5 ml/L of water	13.77b	8.97b	86.88
Mechanical control + white sticky trap + Bioclean @ 1 ml/liter of water	10.01b	8.52b	87.54
Mechanical control + white sticky trap + Spinosad 2.5SC @ 1.2 ml/L of water	10.02b	8.92b	86.95
Mechanical control + white sticky trap + Chlorphenapyr 10 SC@ 1.2 ml/L of water	9.47b	8.11b	88.14
Untreated control	64.77a	68.37a	-
CV (%)	12.67	9.33	-

Means having same letter(s) in a column are not significantly different at P>0.01 followed by LSD.

The effect of different treatment packages on rose against thrips are presented in Table 3. The lowest number of thrips observed in rose was found in treatment mechanical control + white sticky trap + spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water) after third day spry application (1.80) which was followed by treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water) (4.71), treatment mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water) (4.74), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water) (5.05) and highest in untreated control T5 (66.99) whereas the highest per cent reduction over untreated control recorded in treatment mechanical control + white sticky trap + spraying of Chlorphenapyr

(Intrepid 10 SC) @ 1 ml/L of water) (97.13%), which was significantly similar observed in treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water) (92.97%), treatment mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water) (92.92%), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water) (92.46%). Similar trends were also noted by Munmun sssset al., 2020.

Table 3. Effect of different treatment packages on reduction of thrips in flowers during 2020-21 and 2021-22

Treatments	Thrips/flowers/plant		
	Before spray	24 hours after 3rd spray	% Reduction over control
Mechanical control + white sticky trap + Matrine 0.5% @ 1.5 ml/L of water	8.79b	5.05b	92.46
Mechanical control + white sticky trap + Bioclean @ 1 ml/liter of water	7.97b	4.74b	92.92
Mechanical control + white sticky trap + Spinosad 2.5SC @ 1.2 ml/L of water	7.87b	4.71b	92.97
Mechanical control + white sticky trap + Chlorphenapyr 10 SC@ 1.2 ml/L of water	5.42b	1.80b	92.13
Untreated control	64.77a	66.99a	-
CV (%)	12.67	9.06	-

Means having same letter(s) in a column are not significantly different at P>0.05 followed by LSD.

The effect of different treatment packages on rose against thrips are presented in Table 4. The lowest percent flower infestation of rose was recorded in treatment mechanical control + white sticky trap + Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water (2.33%) while the flower infestation reduction over control (84.88%) and it was significantly different result found in treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water) which was followed by treatment mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water) and the highest percent flower infestation in treatment T5 untreated control (15.41%). The highest yield (406306 flowers./ha) was recorded from treatment mechanical control + white sticky trap + Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water which was followed by treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC) @ 1.2 ml/L of water (325363), treatment mechanical control + white sticky trap + Bioclean (D-limonene) @ 1 ml/liter of water (284239), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5%) @ 1.5 ml/L of water (253146) and the lowest in untreated control T5 (210683 flowers/ha). Similar results were also obtained by Munmun et al., 2020.

Table 4. Effect of different treatment package on rose against thrips during 2020-21 and 2021-22

Treatments	Thrips/flowers/plant		
	% Flower infestation	% Flower infestation reduction over control	Yield (number of flower /ha)
Mechanical control + white sticky trap + Matrine 0.5% @ 1.5 ml/L of water	6.75b	56.20	253146d
Mechanical control + white sticky trap + Bioclean @ 1 ml/liter of water	6.00b	61.06	284239c
Mechanical control + white sticky trap + Spinosad 2.5SC @ 1.2 ml/L of water	5.43b	64.76	325363b
Mechanical control + white sticky trap + Chlorphenapyr 10 SC@ 1.2 ml/L of water	2.33c	84.88	406306a
Untreated control	15.41a	-	210683e
CV (%)	5.92	16.34	-

Means having same letter(s) in a column are not significantly different at P>0.01 followed by LSD.

Effect of different management options on the yield of roses flower: Significantly the highest marketable flower yield (406306 flowers/ha) was recorded in treatment mechanical control + white sticky trap + Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water which was followed by spraying with treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC) @ 1.2 ml/L of water (325363 flowers/ha), treatment mechanical control + white sticky trap + Bioclean (D-limonene) @ 1 ml/liter of water (284239 flowers/ha), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5%) @ 1.5 ml/L of water (253146 flowers/ha). However the lowest yield was obtained from untreated control plot T5 (210683 flowers/ha) (Table 5). Similarly, the highest yield increase over control was calculated from also mechanical control + white sticky trap + Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water treated plots (92.85%) followed by spraying with mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water (54.43%), mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water treated plot received 34.91% and the lowest percent yield increase over control obtained from treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5%) @ 1.5 ml/L of water (20.15%). The highest number of thrips captured/sticky trap/ week observed in treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water (41.22) which was followed by treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water 39.22), treatment mechanical control + sticky trap + Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water (35.22) and treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water (35.11). Similar trends were also noted by Munmun et al., 2020.

Table 5. Effect of different treatment package on rose yield against thrips during 2020-21 and 2021-22

Treatments	Thrips/flowers/plant		
	Yield (number of flower /ha)	% Yield increase	Number of thrips captured/sticky trap/week
Mechanical control + white sticky trap + Matrine 0.5% @ 1.5 ml/L of water	253146d	20.15	39.22
Mechanical control + white sticky trap + Bioclean @ 1 ml/liter of water	284239c	34.91	41.22
Mechanical control + white sticky trap + Spinosad 2.5SC @ 1.2 ml/L of water	325363b	54.43	35.11
Mechanical control + white sticky trap + Chlorphenapyr 10 SC@ 1.2 ml/L of water	406306a	92.85	35.22
Untreated control	210683e	-	-
CV (%)	-		1.89

Means having same letter(s) in a column are not significantly different at P>0.01 followed by LSD.

ECONOMIC ANALYSIS

Economic analysis for the management of thrips in rose was calculated in Table 6. The results revealed the highest MBCR was observed in treatment mechanical control + white sticky trap + spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water.) treated plot (11.27) which was followed by treatment mechanical control + white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water) treated plot (6.87), treatment mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/liter of water) treated plot (4.64). Though the highest yield (406306 flowers /ha) and net return (Tk. 389866) was obtained from treatment mechanical control + white sticky trap + Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water treated plot then treatment T3 white sticky trap+Spinosad (Success 2.5SC @ 1.2 ml/L of water treated plot yield (325363 flower/ha) and net return (Tk. 310013), treatment mechanical control + white sticky trap + Bioclean (D-limonene @ 1 ml/L of water treated plot yield (284239 number/ha) and net return (Tk. 270114), treatment mechanical control + white sticky trap + Matrine (Biotrine 0.5% @ 1.5 ml/L of water treated plot yield (253146 flower/ha) and net return (Tk. 239096). Similar results were also obtained by Munmun et al., 2020.

Table 6. Economic analysis of different management approach against thrips in flowers during 2020-21 and 2021-22

Treatments	Yield (number of flower /ha)	Gross return (Tk/ha)	Cost of treatments (Tk/ha)	Net return (Tk/ha)	Adjusted Net return (Tk/ha)	MBCR
Mechanical control + white sticky trap + Matrine 0.5% @ 1.5 ml/L of water	253146	253146	14050	239096	34513	2.45
Mechanical control + white sticky trap + Bioclean @ 1 ml/liter of water	284239	284239	14125	270114	270114	4.64
Mechanical control + white sticky trap + Spinosad 2.5SC @ 1.2 ml/L of water	325363	325363	15350	310013	105430	6.87
Mechanical control + white sticky trap + Chlorphenapyr 10 SC@ 1.2 ml/L of water	406306	406306	16440	389866	185283	11.27
Untreated control	210683	210683	6100	204583	-	-

Cost of relevant materials or activities

1Farmgate price of rose @ Tk. 1.00/piece

[Cost of Matrine (Biotrine 0.5%)@ 350 Tk/100ml, Bioclean (D-limonene) @ 340Tk/100ml, Spinosad (Success 2.5SC)@ 320 Tk/100ml, Chlorphenapyr (Intrepid 10SC) @ 200Tk/100ml, sticky trap (white) @ 35Tk/trap, Cost of mechanical control: Three labourers/spray/ha @ Tk 550/labour/day; cost of spray: Three labour/spray/ha @ Tk 550/labour/day, spray volume required: 500L/ha].

CONCLUSION

From the above results it may be recommended that the mechanical control + white sticky trap + spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water was more effective against thrips of rose in respect of reducing flower infestation, highest yield and marginal benefit cost ratio but if we consider the alternatives to toxic chemical pesticide and environment friendly methods than treatment mechanical control white sticky trap + Spinosad (Success 2.5SC @ 1.2 ml/L of water).

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Bangladesh J. Jute Fib. Res. 2023, 32(1-2) : (23-29)

Review / Overview Paper

EFFECT OF PLANT GROWTH REGULATORS ON TOSSA JUTE FOR FIBRE PRODUCTION

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ABSTRACT

An experiment was conducted at Jute Agricultural Experimental Station, Manikganj in 2022 using tossa jute variety BJRI Tossa pat 5 with different concentrations of three growth regulators i.e. IAA (2.5, 5.0, 7.5 & 10 ppm), BAP (2.5, 5.0, 7.5 & 10 ppm) and GA3 (25, 50, 75 & 100 ppm) for hormonal effects on fiber yield. The growth regulators were sprayed two times in the vegetative growth stage (45 and 60 days after sowing). The application of plant growth regulators showed significant effects on vegetative growth and yield of tossa jute. Application of 100 ppm GA3 was found most effective for fiber yield (4.8 t/ha), followed by 75 ppm GA3 (4.5 t/ha) and 10 ppm BAP (4.4 t/ha) among all the different treatments. GA3 application at 100 ppm gave 29.7% higher fiber yield than the control (3.7 t/ha).

Keywords: Tossa jute, growth regulators, fiber

INTRODUCTION

Bangladesh is now the second largest producer of jute and produces 42% of the world's jute, at 1.33 million tons. India produces around 2 million tons (about 55% world production). However, Bangladesh ranks at the top in jute exports. It exports 285 types of jute products (MoFA, 2022; FAO, 2023). The national average yield is increased from 1.59 to 1.98 tons per hectare. Jute is still contributing about 4% GDP to the national economy (Islam and Ali, 2017). Low genetic diversity is a limiting factor for improvement of tossa jute (Choudhary, 2018). Chances for availability of new genotypes of tossa jute with diseases resistance are very remote unless new techniques like genetic transformation is launched to create variability (Huda et al., 2007). The application of hormones in low concentration regulates growth, differentiation and development either by promotion or inhibition (Naeem et al., 2004) and allows physiological processes to occur at their normal rate (Gulluoglu, 2004). Major plant growth regulators (PGRs) significantly enhanced fiber yield in cotton (Copur et al., 2010), chemical constituents in Croton (Soad et al., 2010), fruit size in Molina (Vwioko and Longe, 2009), seed germination rate in black gram and horse gram (Chauhan et al., 2009b) and other growth parameters in differ-ent plants. Thus, to overcome the production constraints, chemical manipulation can be done to improve yield and growth parameters (Anu, et al., 2013).

IAA plays a major role on regulation of plant growth, for example, it controls vascular tissue development, cell elongation, and apical dominance (Wang, et al., 2001). Also, IAA stimulates cell elongation by modifying certain conditions like, increase in osmotic contents of the cell, increase in permeability of water in to cell, decrease in wall pressure, an increase in cell wall synthesis, protein synthesis and actively participates in adaptive responses of the plant to different stress factors (Yurekli, et al., 2004).

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Gibberellic acid (GA3) has great effects on plant physiological systems including fruit setting, leaf expansion, germination, breaking dormancy, increasing fruit size, improving fruit quality and in many other aspects of plant growth and thereby on crop production (Rahman, et al., 2015). 6-Benzylaminopurine (BAP) is a type of cytokinin, a broad-spectrum plant growth regulator. It stimulates plant cell growth, inhibits plant chlorophyll degradation, increases the content of amino acids, and delays leaf senescence that is why it can play in vital role of plant biomass production (Lian, et al., 2023).

Keeping the above circumstances, an experiment was conducted to observe the effect of plant growth regulators (IAA, BAP, GA3) on tossa jute. The aim of this experiment was to focus on optimizing tossa jute yield, yield contributing characters, improving fiber quality and potentially enhancing resistance to environmental stresses.

MATERIALS AND METHODS

The investigation was conducted at Jute Agriculture Experimental Station, Manikganj in 2022 on tossa jute variety BJRI Tossa pat 5 with foliar application of plant growth regulators. This was a first-time study; no previous study was done on the application of plant growth regulators of tossa jute. Three growth regulators i.e., IAA (2.5, 5.0, 7.5, & 10 ppm); BAP (2.5, 5.0, 7.5, & 10 ppm) and GA3 (25, 50, 75 & 100 ppm) were used as treatments. The experiment was laid out in RCB design kept a plot size of 1m×1.5m and all the treatments along with control were replicated four times. The seed sowing was done on the last week of March, 2022 maintaining a line-to-line distance of 30 cm. The growth regulators were sprayed separately at two times of vegetative stage at 45 and 60 DAS. Plants were harvested at 120 days after sowing. Different data like plant population per plot, plant height, base diameter, bark thickness, green weight with leaves and without leaves, dry fiber weight and stick weight were recorded from the harvested plants.

RESULTS AND DISCUSSION

Plant population (PP)

Significant differences were found for the plant population (Table 1) and it ranged from 3.1 to 3.7 lakh/ha (Table 2) during harvesting time. Thinning is one of the most important practices in jute cultivation. Many researchers worked on this management operation. The optimum thinning practice could provide an effective number of plants (with optimum plant height and base diameter) in the jute field. Plant population is one of the vital yield contributing factors of jute. An average plant population in a farmer's field in Bangladesh is usually found at 2.0-3.0 lakh/ha in the tossa jute field which deals the national average yield of jute fiber in Bangladesh is 2.01 tha-1 (Islam, 2014). It could be assumed from the agronomic research experiences that fiber yield could focus on the jute field's plant population number, viz. 3 lack per hectare plant population with optimum plant height (3.5-4.0 m or above) and base diameter (16-18 mm or above) could provide good quality fiber yield of 3.0 tha-1 or very close to this (Islam, 2014).

Plant height (PH)

In this experiment, plant height was increased effectively by the application of IAA and GA3 on BJRI Tossa pat 5. Gibberellic acid (GA3) increases stem elongation along with plant height, growth, dry matter accumulation as well as yield in various crops (Harrington et al., 1996, Akter et al., 2007 and Emongor 2007). The mean values for plant height were highly significant for treatments (Table 1) and ranged from 3.50 to 4.54 m (Fig.1) during harvesting after application of growth hormones. Plant height increased considerably in relation to the control plants under field conditions. However, the doses which had the highest enhancement in the particular treatment were considered effective doses, and on this basis, the dose of 2.5 ppm IAA was the most effective for plant height (4.54 m) of BJRI Tossa pat 5 followed by the application of GA3 at 100 ppm (4.27 m) (Fig. 1). Quaderi et al., (2006) reported that IAA increases dry matter by increasing photosynthesis activ¬ity in mungbean. Miceli et al., (2019) found that GA3 application on Lettuce has significant effect on biomass accumulation, leaf expansion, stomatal conductance, water use efficiency (WUE), nitrogen use efficiency (NUE) etc

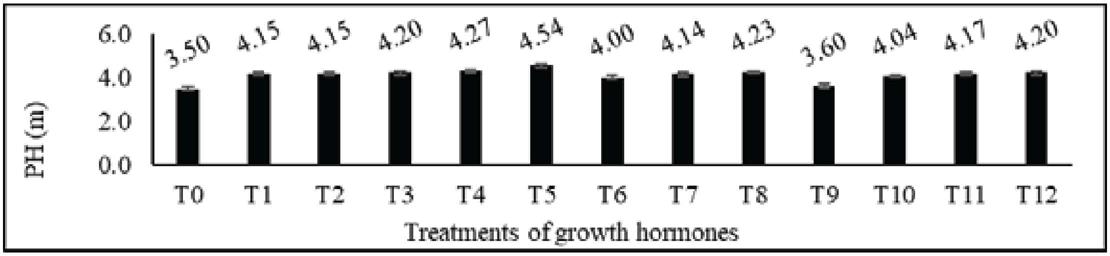

Figure 1: Effect of different growth hormones on plant height of BJRI Tossa pat 5

Table 1: Analysis of variance (MS) for morphological traits of tossa jute treated with different doses of growth hormones.

Sources of var.	df	PP (L/ha)	PH (m)	BD (mm)	BT (mm)	GW1 (t/ha)	GW0 (t/ha)	FY (t/ha)	SY (t/ha)
Rep	3	0.496	0.126	1.703	0.042	42.729	363.25	1.057	3.730
Treatment	12	0.214	0.297	1.521	0.012	0.456	3.4540	0.539	3.540
Error	36	0.104	0.056	2.221	0.030	8.626	33.386	0.305	2.675
‘P’ Value		0.046	0.000	0.755	0.958	1.000	0.999	0.092	0.248
Sig. Level		*	**	ns	ns	ns	ns	*	ns

Note:PP = Plant population; PH = Plant height; BD = Base diameter; BT = Bark thickness; GW1 = Green weight with leaves; GW0 = green weight without leaves; FY = Dry fiber yield and SY = Dry stick yield

Table 2: Mean performance of different morphological traits of tossa jute treated with different doses of growth hormones.

Treatments		PP (L/ha)	BT (mm)	GW_1 (t/ha)	GW_0 (t/ha)
Control	T0	3.10	1.06	68.53	50.05
GA_3 (25 ppm)	T1	3.30	1.09	68.93	50.80
GA_3 (50 ppm)	T2	3.70	1.14	69.28	51.35
GA3 (75 ppm)	T3	3.70	1.17	69.58	52.58
GA_3 (100 ppm)	T4	3.70	1.22	69.78	52.68
IAA (2.5 ppm)	T5	3.20	1.09	68.99	49.90
IAA (5.0 ppm)	T6	3.60	1.10	69.08	50.13
IAA (7.5 ppm)	T7	3.60	1.20	69.43	50.98
IAA (10 ppm)	T8	3.70	1.20	69.48	51.70
BAP (2.5 ppm)	T9	3.20	1.11	68.93	49.95
BAP (5.0 ppm)	T10	3.60	1.16	68.99	50.80
BAP (7.5 ppm)	T11	3.70	1.20	69.18	51.35
BAP (10 ppm)	T12	3.70	1.21	69.43	51.58
Mean		3.52	1.15	69.20	51.06
Range		0.60	0.16	1.25	2.78
S.E.		0.16	0.09	1.469	2.89
CV (%)		9.14	15.19	4.24	11.32
LSD (0.05)		0.41	0.25	4.21	8.29

Base diameter (BD)

Base diameter is also an important character for the fiber yield of jute varieties. In case of the higher base diameter produce the better bark thickness which will ensure higher production of fiber (Akondo et al., 2020). The highest plant base diameter (19.34mm) was recorded at the application of 10 ppm BAP hormone (Fig. 2) and the lowest base diameter (17.36 mm) was recorded in control but the treatments have no significant differences over base diameter (Table 1). Abdullah R. D. et al., (2013) found that vascular bundle numbers in date palm leaves were enhanced by high concentration of GA3 application.

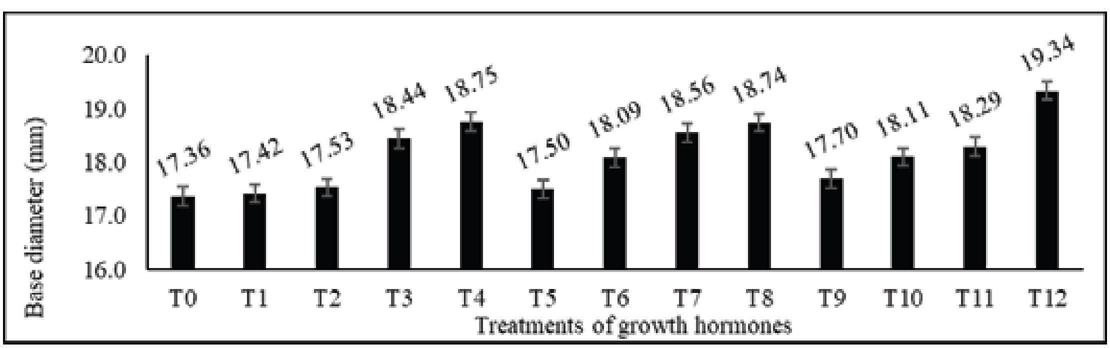

Figure 2: Effect of different growth hormones on base diameter of BJRI Tossa pat 5

Table 3: Pearson correlations among the morphological traits of tossa jute treated with different doses of growth hormones

Characters	PP	PH	BD	BT	GW1	GW0	FY
PH	0.48*						
BD	0.74**	0.35ns					
BT	0.83***	0.45ns	0.88***				
GW1	0.81***	0.60*	0.78**	0.85***			
GW0	0.77**	0.44ns	0.66*	0.78**	0.87***		
FY	0.77**	0.23ns	0.76**	0.82***	0.80***	0.71**	
SY	0.87***	0.59*	0.78**	0.87***	0.91***	0.92***	0.79**

Bark thickness (BT)

The highest Bark thickness (1.22 mm) was recorded at the application of 100 ppm GA3 (Table 2) and the lowest base diameter (1.06 mm) was recorded in control but they are not statistically different. High IAA and low GA concentrations favor xylem formation, whereas low IAA and high GA concentrations favor phloem production (Digby and Wareing, 1966). Fiber cell elongation and quality were enhanced by exogenous application of GA3 on kenaf (Sures K. M. M. et al., 2018).

Green weight with leaves (GW1) and without leaves (GW_0)

The highest green weight with leaves (69.78 t/ha) was observed at the spray of GA3 at 100 ppm and the highest green weight without leaves (52.68 t/ha) was recorded the same concentration of this hormone respectively (Table 2).

Dry fiber yield (FY)

The application of plant growth regulators had significant effect on the fiber yield of jute (Table 1). Application of 100 ppm GA3 was found most effective in fiber yield (4.8 t/ha), followed by 75 ppm gibberellin (4.5 t/ha) (Fig. 3) compare to the control (3.7 t/ha). Application of high concentration of IAA stimulated rapid differentiation of fibers with thick secondary walls, while GA3 resulted in long fibers with thin walls (Roni 1979). Osman et al., (2010), reported that fiber length, fiber fineness, fiber strength and fiber uniformity of cotton were not affected by the hormone treatments. But higher yields were obtained in Maxicrop, Biozyme TF and Biogib treated plots. Therefore, PGRs might be considered a component of cotton growth management to provide higher cotton yields.

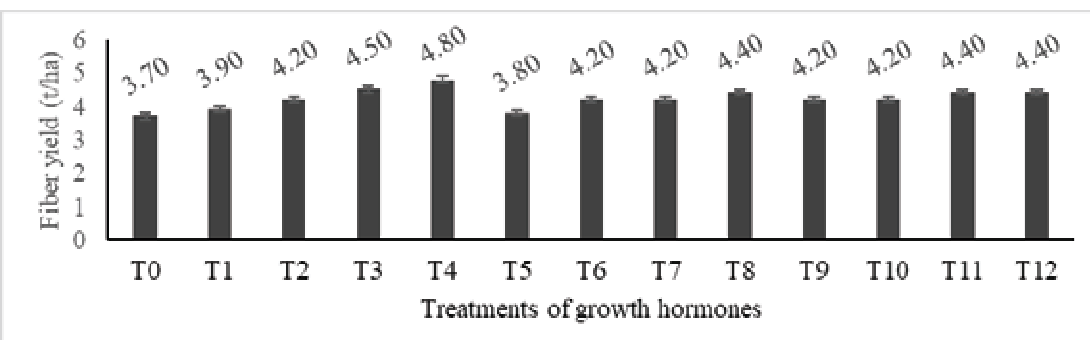

Figure 3: Effect of different growth hormones on dry fiber yield of BJRI Tossa pat 5

Dry stick yield (SY)

The highest stick weight (14.42 t/ha) was observed at the application of GA3 at 100 ppm hormones (Fig. 4) whereas in the control, stick weight was recorded 11.03 t/ha which was 30.73% lower than hormone treated plant.

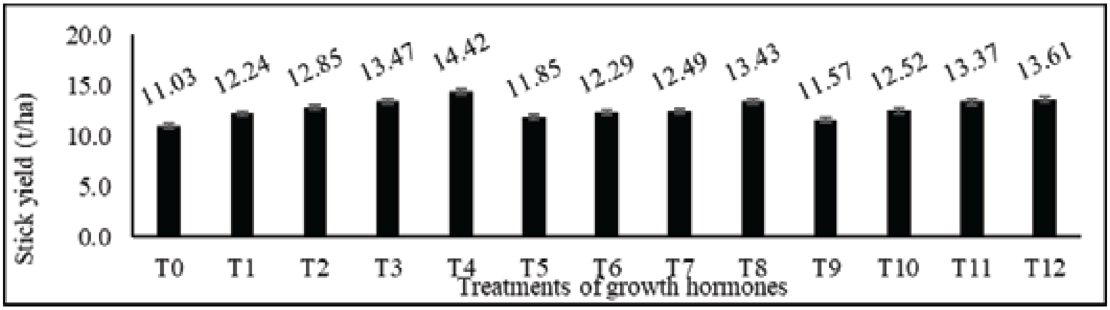

Figure 4: Effect of different growth hormones on dry stick yield of tossa jute (O-795)

CONCLUSION

This experiment gave us a clear assumption that the application of phytohormone may give a positive result in the production of jute fiber depending on the concentration of hormones used. It can be concluded that the application of 100 ppm GA3 was more effective in the fiber yield of BJRI Tossa pat 5 which was 29.7% higher than the control. Further study will be conducted to observe the effect of GA3 on fiber and stick yield production of tossa jute.

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Review / Overview Paper

EFFECT OF SALINITY STRESS ON SEED GERMINATION OF TOSSA JUTE (CORCHORUS OLITORIUS) GENOTYPES

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ABSTRACT

Salinity threatens crop production in every continent. To address the problem of salinity on jute crop an experiment was conducted to evaluate some jute genotypes under different levels of salinity stress at germination stage at the Jute Research sub-station, Monirampur, Jashore during Kharif-2022. The seeds of eight Jute genotypes viz. G_1= O-049-3-1, G_2= O-0512-6-2, G_3= O-043-7-9 (Green), G_4= O-043-7-9 (Red), G_5= O-0412-9-4, G_6= O-0411-10-4, G_7= O-049-1-3 (Red), G_8= O-049-1-3 (Green) were collected from gene bank and breeding division of BJRI. This experiment was conducted following factorial completely randomized design (CRD) with three replications. The experimental factors were i) Jute genotypes (eight) and ii) salt stress (Four levels: 0,3,6,9 and 12 dSm-1). The results showed that jute genotype O-043-7-9 (Red) showed highest value at 0 dSm-1, 3 dSm-1 and 6 dSm-1 in case of germination index (5.84,5.20 and 5.16), germination percentage (100, 94 and 90%), and for mean germination time (1.98,1.94 and 1.92). Both the genotypes O-043-7-9 (Red) and O-0411-10-4 showed the highest value in case of germination stress tolerance index, plant height stress index, root length stress index, shoot fresh weight stress index, root fresh weight stress index, shoot dry weight stress index and root dry weight stress index at 3, 6 and 9 dSm-1. The lowest values in these parameters were found in O-049-3-1 at 3, 6 and 9 dSm-1 salt stress. In 9 and 12 dSm-1 level of salinity, the seedling growth of all the jute genotypes were completely inhibited. Considering various parameters, among the test genotypes, O-043-7-9 (Red) and O-0411-10-4 exhibited better tolerance to salinity than the rest of the genotypes at germination stage.

Key words: Salt, advanced generation, stress, tossa jute

INTRODUCTION

Jute is an important bast fibre producing cash crop which belongs to the family Malvaceae and genus Corchorus. This cash crop is the source of highly versatile environment friendly natural fiber and is the second only to cotton in terms of production and variety of uses (Islam et al. 2013). Salinity stress is a serious threat to crop cultivation in Bangladesh. Increase in salinity problem is expected to have devastating global effects predicting the 30 % lands will be affected by the next 25 years, and up to 50 % by the year 2050 (Wang et al. 2008). The saline affected areas are categorized as moderate to high salinity (8-15 dSm-1) or highly saline (>15 dSm-1) which is increasing rapidly in Bangladesh due to change of global climate (SRDI 1997). Soil salinity is the most alarming problem among abiotic and biotic stresses especially for tossa jute cultivation in Bangladesh (Miah et al., 2020). The global rise in sea water level initiates the salinity problems where 20 % (45million ha) of total globally irrigated area (230 million ha) is affected by salinity (Islam et. al., 2013). More than 1.02 million ha of land is affected by salinity in Bangladesh, and since crop plants are unable to grow in the saline environment due to an

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imbalance of biological and biochemical functions, a significant proportion of agricultural land in this coastal belt of Bangladesh remains fallow throughout the year (Fatema et al., 2021) which has great potentiality for jute cultivation (Miah et al., 2020). As different levels of salinity affect various jute genotypes differently, it is necessary to isolate highly salt-tolerant genotypes for research and cultivation purposes. There are several strategies developed to overcome the adverse effect of salinity. Screening and identification of salt tolerant jute genotypes that maintain productivity under saline conditions are an effective approach for varietal improvement (Ashraf et al, 2006). Physiological parameters such as root length, shoot length, dry matter accumulation (Akram et al., 2010), relative water content (Suriya-Arunroj et al., 2004; Ziaf et al., 2009), etc. are indexes of salt tolerance (Bagci et al., 2007), which can be used to evaluate salt tolerance. For example, Khandker et al. (1992) have reported adverse effects of salinity on root length, shoot length and dry matter accumulation in jute. On the basis of morphological, physiological and biochemical indices different scientific techniques like conventional breeding, selection and transgenic can be used to mitigate the salinity stress in plants. Selection of salt tolerant genotypes in the early stage can be a very reliable strategy as this strategy is less time consuming, less laborious and less expensive (Dasgan et al. 2002). Understanding the physiological or biochemical processes that is more sensitive to salt stress can be used as effective selection criterion too (Ashraf and Harris, 2004). Since jute is a promising crop for the coastal area of Bangladesh a study was conducted to evaluate the influence of salt stress on germination and seedling growth of eight tossa jute genotypes with a view to a better understanding of the mechanisms and capability of salt tolerance of those genotypes.

METHODOLOGY

The experiment was conducted under laboratory conditions having average temperature 25º Celsius. Completely randomized design (CRD) was used keeping eight C. olitorius varieties (O-049-3-1, O-0512-6-2, O-043-7-9 (Green), O-043-7-9 (Red), O-0412-9-4, O-0411-10-4, O-049-1-3 (Red) and O-049-1-3 (Green)) and four salinity levels (0,3,6,9 and 12 dsm-1). Each treatment was replicated thrice. Twenty representative seeds of each variety were sown on a filter paper held in petri dish. The seed germination was observed after every 12 hours. Seed germination was considered when there was radical protrusion through the seed coat. The lengths of root and shoot of the germinated seeds and fresh and dry weight of seedlings were measured and recorded four and eight days after sowing. The final count was done on day nine and germination percentage (GP) was calculated using the following formulae as stated by Almudaris (1998).

$$\text{Germination percentage (GP) (\%)} = \frac{\text{Total no of seed germinated in final day}}{\text{Total no of seed taken}} \times 100$$

The mean germination time (MGT) was calculated using the daily counts, according to the following equation described by Moradi et al. (2008):

$MGT = \Sigma\, nD / \Sigma\, N$

Where, n is the number of newly germinated seeds at day D; D = days from the beginning of the germination test; N = number of all germinated seeds (final germination).

Germination index was calculated as the product of number of days after sowing and number of germinated seeds divided by the total number of seeds sown (Li, 2008).

Germination Index (GI) = $\Sigma\, d_i N_i / S$

where, di = Number of days after sowing seeds under a particular treatment, Ni = the number of germinated seeds and S = the total number of seeds sown for the experiment.

Plumule length (PL) was measured from shoot base to the tip of the longest leaf and radicle length (RL) was measured from root base to the root tip. Seedling fresh weight was recorded immediately after the harvest at day nine. Root length stress tolerance index (RLSI), plant height stress tolerance index (PHSI), shoot fresh weight stress tolerance index (SFSI), root fresh weight stress tolerance index (RFSI), shoot dry weight stress tolerance index (SDSI) and root dry weight stress tolerance index (RDSI) were calculated using the following formula described by Ashraf and Harris (2004):

GSTI = (PI of stressed seeds / PI of control seeds) × 100
PHSI = (Plant height of stressed plants / plant height of control plants) × 100
RLSI = (Radicle length of stressed plants / radicle length of control plants) × 100
SFSI = (Shoot fresh weight of stressed plants / shoot fresh weight of control plants) × 100
RFSI = (Root fresh weight of stressed plants / root fresh weight of control plants) × 100
SDSI = (Shoot dry weight of stressed plants / shoot dry weight of control plants) × 100
RDSI = (Root dry weight of stressed plants / root dry weight of control plants) × 100
Data of different parameters were recorded from five seedlings of each unit petri dish and analyzed statistically by statistical software Statistix-10 and the mean separation was done by least significance difference test at 5% level of probability.

RESULTS AND DISCUSSION

In our experiment, jute seed germination in general reduced with the increasing level of salinity in all the selected eight tossa jute genotypes (Table 1-2). Reduction of jute seeds germination due to salinity was also reported in castor crop (Raghavaiah et al., 2006).

According to Hongyu et al., (2011), salt tolerance of germination stage of jute was consistent with that of seedling stage. At 3 and 6 dSm-1 salt stress, germination is mildly affected or not affected at all, since most varieties will not grow in high concentrations of salt and are some extend inhibited at 12 dSm-1. Germination is a critical stage in the lifecycle of crops and salinity tolerance at this stage is crucially important for the establishment of the plants growing in such environments. Germination percentage and germination index declined sharply with 3, 6 and 9 dSm-1 salt stress. Genotypes O-043-7-9 (Red) and O-0411-10-4 had higher germination percentages 80% than even with the 9 dSm-1 salt stress, while O-049-1-3 (Green) had lower germination percentages with the salt stress (Table 1). Even though salt tolerance during germination differs from that at later stages of plant development (Hongyu et al., 2011), good germination under saline conditions is essential because it is the first stage of plant growth.

Mean germination time (MGT) showed significant variation for genotypes and salt concentrations (Table 1). MGT was increased with the increase of salinity for all the genotypes except O-043-7-9 (Red) and O-0411-10-4. In these two genotypes MGT increased at 9 and 12 dSm-1 salt concentrations (Table 1). Hapsari and Trustinah (2018) also indicated that the increasing of salinity level could reduce the speed of germination. These results were also accordance with Trustinah et al. (2016) and Sehrawat et al. (2014) and Mukul et al., (2021).

Plant height stress index (PHSI) showed significant variations for genotypes and NaCl salt concentrations (Table 2). The results revealed that increase in salt concentration leads to decrease in PHSI. The highest PHSI (73.37) was found by O-043-7-9 (Red) in 6 dSm-1 salt concentrations and the lowest PHSI by O-049-1-3 (Green) in 6, 9, 12 dSm-1 concentrations.

Table 1: Effect of salinity stress on germination percentage (GP), mean germination time (MGT) and germination index (GI) of selected C. olitorius genotypes.

Salt Stress (dSm-1)	Genotype	GP	MGT	GI
0	G_1	100a	1.96e	3.92 b-f
0	G_2	100a	1.94e	4.88a-d
0	G_3	100a	1.98e	2.96ef
0	G_4	100a	1.98e	5.84a

0	G_5	100a	1.92e	5.26a-c
0	G_6	100a	1.90e	5.80a
0	G_7	100a	1.94e	4.88a-d4.88a-d
0	G_8	100a	1.92e	3.92b-f
3	G_1	93ab	1.93e	4.28a-f
3	G_2	92ab	1.94e	4.24a-f
3	G_3	96ab	1.91e	4.16a-f
3	G_4	94ab	1.94e	5.20a-c
3	G_5	93ab	1.95e	4.24a-f
3	G_6	96ab	1.97e	3.36c-f
3	G_7	93ab	1.95e	3.78c-f
3	G_8	93ab	1.92e	4.68a-f
6	G_1	86ab	1.95e	3.64 c-f
6	G_2	84ab	1.94e	4.08a-f
6	G_3	85ab	1.92e	4.58a-e
6	G_4	90ab	1.92de	5.16a-c
6	G_5	88ab	1.98de	3.16d-f
6	G_6	92ab	1.91e	5.68ab
6	G_7	84ab	1.96e	3.12d-f
6	G_8	83ab	1.97e	2.62fg
9	G_1	80b	1.97e	2.56 f-h
9	G_2	88ab	1.95e	3.14a-f
9	G_3	89ab	1.94e	3.18a-f
9	G_4	93ab	1.91e	4.70ab
9	G_5	94ab	1.94e	4.70ab
9	G_6	85ab	1.93e	4.58a-e
9	G_7	89ab	1.95e	2.70c-f
9	G_8	91ab	1.97e	2.26d-f
12	G_1	53c	2.14cd	0.90g-i
12	G_2	43cd	2.16c	0.72hi
12	G_3	53c	2.14c	0.66i
12	G_4	43cd	1.92e	0.92g-I
12	G_5	36cde	2.44a	0.36i
12	G_6	34de	1.91e	0.54i
12	G_7	39cde	2.27bc	0.32i
12	G_8	24e	2.41ab	0.26i
%CV		10.51	3.82	16.47

N.B.: G_1= O-049-3-1, G_2= O-0512-6-2, G_3= O-043-7-9 (Green), G_4= O-043-7-9 (Red), G_5= O-0412-9-4, G_6= O-0411-10-4, G_7= O-049-1-3 (Red), G_8= O-049-1-3 (Green)

Table 2: Salt tolerance stress indices as influenced by genotypes and salt stresses

Salt Sress (dSm^{-1})	Genotype	PHSI	RLSI	SFSI	RFSI	SDSI	RDSI
3	G_1	89.17ab	82.04a-e	74.16abc	83.33	58.12c	21.67c
3	G_2	92.715ab	90.55abc	78.33abc	78.60	79.49abc	25.00c
3	G_3	85.11a-c	84.67a-e	81.09abc	83.44	75.00abc	27.76c
3	G_4	89.66ab	89.30abcd	86.19ab	80.89	79.22abc	81.78a
3	G_5	86.37a-c	79.07a-e	72.81abc	77.85	70.78abc	22.61c
3	G_6	94.54a	70.99ef	87.45a	74.77	82.95abc	62.50ab
3	G_7	79.74a-d	74.92c-f	74.12abc	77.75	72.38abc	23.89c
3	G_8	76.76a-e	94.56a	76.96abc	71.03	79.83abc	26.66c
6	G_1	70.12b-f	71.94ef	70.64abc	84.83	90.21ab	20.00c
6	G_2	53.66ef	77.74b-f	67.37bc	63.49	92.82a	19.20c
6	G_3	57.34d-f	75.90c-f	64.02c	85.93	64.05abc	22.61c
6	G_4	73.37a-e	73.29d-f	89.52a	90.78	80.19abc	46.43a
6	G_5	63.48c-f	92.95ab	81.14abc	86.78	74.12abc	22.03c
6	G_6	71.77a-f	77.410b-f	78.23abc	75.84	89.20ab	37.50ab
6	G_7	69.33b-f	88.96a-d	67.45bc	81.86	62.50bc	18.03c
6	G_8	49.62f	61.05f	66.71bc	72.14	58.00c	15.00c
		14.76	9.83	12.28	NS	18.12	19.32

PHSI= plant height stress index, RLSI= Root length stress index, SFSI=Shoot fresh weight stress index, RFSI=Root fresh weight stress index, SDSI=Shoot dry weight stress index, RDSI=Root dry weight stress index. Plant height stress index, root length stress index, shoot fresh weight stress index, root fresh weight stress index, shoot dry weight stress index and root dry weight stress index were measured for only two levels of salinity (3 dSm-1 and 6 dSm-1) because in higher levels of salinity seedlings growth were completely inhibited. Root length stress index (RLSI) showed significant variations for genotypes and NaCl salt concentrations **(Table 2)**. The results revealed that increase in salt concentration leads to decrease in RLSI. The maximum RLSI was found by O-043-7-9 (Red) and O-0411-10-4 21 in 6 dSm-1 salt concentrations followed by O-049-1-3 (Green) in 9 dSm-1 and the lowest RLSI by O-049-1-3 (Green).

Root dry weight stress index (RDSI) showed significant variations for genotypes and NaCl salt concentrations **(Table 2)**. All the genotypes exhibit minimal RDSI in both the salt concentrations (3, 6 dSm-1) except O-043-7-9 (Red).

Root fresh weight stress index (RFSI) showed non-significant variations for genotypes and NaCl salt concentrations **(Table 2)**. The highest RFSI was found by genotype O-043-7-9 (Red) in 6 dSm-1 concentrations and the lowest RFSI by O-049-1-3 (Green) in both the salt concentrations (3, 6 dSm-1). Root dry weight stress index showed significant variations for genotypes and NaCl salt concentrations **(Table 2)**.

Shoot fresh weight stress index (SFSI) showed significant variations for genotypes and NaCl salt concentrations **(Table 2)**. The results revealed that increase in salt concentration leads to decrease in SFSI for all the genotypes. The highest SFSI was found by O-043-7-9 (Red) in 3 dSm-1 and 6 dSm-1 salt stress and the lowest SFSI by O-049-1-3 (Green).

Salt stresses significantly reduced the seedling shoot and root height and biomass as well. This might have happened for the reduction of the plant ability to uptake water or for inclusion of toxic ions in the transpiration streams by Munns (1993, 2005). Several studies also reported significant reduction in seed germination and seedling growth in different crops and a large genotypic variation in response to salt stresses by Farooq et al. (2015) and Parihar et al. (2015). In case of 6 dSm-1 salt stress, several morphological indices in some genotypes showed their highest positive result in the present study. The genotypic differences in relation to morphological parameters under saline conditions are also reported by Hapsari and Trustinah (2018). They also reported that some tested genotypes showed better normal seedling dry weight compared to control.

CONCLUSION

Germination and seedling stage of tossa jute were sensitive to salinity, and with the increasing NaCl concentration all the growth characters were decreased accordingly. Germination of all genotypes were completely inhibited at higher salt concentrations (9 dSm-1 and 12 dSm-1) and at lower salt concentration the genotypic variation was conspicuous. O-043-7-9 (Red) performed better under saline conditions in case of germination percentage, root and shoot length but the contrast result was found in genotype O-049-1-3 (Green). This variability of genotypes can be used for breeding program. However further study will be needed for assessing whether these genotypes perform similarly at their later stages of growth under NaCl salt stresses.

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Review / Overview Paper

MANAGEMENT OF SUCKING INSECT PESTS IN YARD LONG BEAN BY DEFERENT BIO-PESTICIDES

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ABSTRACT

A field experiment was undertaken at research field of Entomology Division at RARS, Jashore for four bio-pesticides and a chemical insecticide were evaluated against sucking insect pests viz. aphid, jassid and thrips of yard long bean during two consecutive years kharif-1 March, 2022 and 2023. The Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water performed best considering reduced infestation of the target pests, the higher yield and MBCR. The bio-pesticide, Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water offered second best performance, while the other bio-pesticides offered intermediate level of performance. The management approach T5 treatment spraying Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, appeared best as it provided the lowest number of aphids, jassid and thrips (0.83,1.67, 1.33) and the highest percent reduction over untreated control (91.70, 85.69, 82.66%). The highest percent of flower and pod infestation reduction over untreated control (76.07 and 78.50%) and the highest yield (8.37 t/ha) and marginal benefit cost ration (8.42) was observed in the same treatment followed by treatment T3, Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (7.43 t/ha). Similarly, the highest yield increase over control was calculated from T5, Imitaf (Imidacloprid 200 SL) @ 0.5 ml/litre of water (46.07%) followed by treatment T3, Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water (29.67%). Considering the alternatives of toxic chemical pesticide, bio-pesticide, Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water may be used against aphid, jassid and thrips attacking yard long bean.

Key words: Bio-pesticides, Sucking pest, Aphid, Jassid, Thrips

INTRODUCTION

Yard long bean (Vigna unguiculata sub sp. sesquipedalis) (L.) Walp) is an important leguminous vegetable grown widely in summer season of Bangladesh. It is also known as very profitably asparagus bean, string bean, snake bean or vegetable cowpea all over Bangladesh (Purseglove, 1977). It is mostly grown in Chattogram, Chattogram Hill Tracts (CHTs), Faridpur, Noakhali, Cumilla and Rangpur districts. At present, it is extensively grown in Dhaka, Chattogram, Cumilla, Narsingdi, and Jeshore districts and also other districts of Bangladesh. It is extensively grown in kharif season when there is shortage of vegetables supply in the market. A serving of 100 g of yard long bean contains 50 calories, 9.0 g of total carbohydrates, 3.0 g of proteins, 0.2 g total fat and 0.8 g of minerals (Anon., 2013). Yard long bean is one of the economically important vegetable crops in Bangladesh. The area occupied by this crop was 5857.49 ha and the production were 21348 t during the year 2008-2009 (Anon., 2010). It is one of the vegetables having exporting potential in Bangladesh. But the production of this vegetable in Bangladesh is much lower compared to many Asian countries. The attack of different insect pests has

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been reported as one of the serious problems to yard long bean cultivation in the country. At least 11 insect pests are injurious to yard long bean in Bangladesh (Uddin et al., 2013). The cultivation of this crop faces various problems including the pest management (Rashid, 1993). Yard long bean is especially attractive to aphids (Aphis craccivora, Myzus persicae and Aphis gossypii), jassids (Amrasca devastans), thrips (Megalurothrips usitatus), green stink bug (Nezara viridula) and red spider mite (Tetranychus spp.). Aphid, the most destructive pest, causes damage by sucking sap from flowers, buds, pods and tender branches of the plants and reduces the viability of plant (Thaker et al., 1984). Greasy cutworms (Agrotis ipsilon) often cause damage just after emergence (Grubben, 1993). The insect pests have been reported as one of the serious problems to yard long bean cultivation in the country (Rashid, 1999). However, their levels of infestation in different growing regions have not been reported so far. The pest complexes including the major ones are also not exactly known from the major growing areas. Farmers spray locally available chemical pesticides to get rid of this problem. Available reports reveal that synthetic insecticides dominate as the means of control against pod borers in pulses, peas and bean (karim, 1995). But some sucking pests such as aphid, jassid, thrips and mites etc. are gaining tremendous importance in the recent years due to their devastating damage. This pest sucks the cell sap and prevent normal crop growth. Current pest management practices of yard lon bean in Bangladesh include extensive use of chemicals known for their ability to cause negative health effects in humans and wildlife and to degrade the natural environment. Chemical pesticide results in destruction of beneficial organism, flora and fauna (Korsak & Sato, 1977). In vegetable growing areas, farmers practice indiscriminate use of pesticides, sometimes they spray 3-4 times in a week. But indiscriminate use of pesticides has not only complicated the management, but has also created several adverse effects such as pest resistance, outbreak of secondary pests (Hagen and Franz, 1973) health hazard (Bhaduri et al., 1989) and environmental pollution (Fishwick, 1988). Taking into consideration the health and environmental effects of chemical pesticides, it is clear that the need for a new concept in agriculture is urgent. This new concept must be based on a drastic reduction in the application of chemical pesticides, and can result in health, environmental, and economic benefits (Pimentel & Burgess, 2014). Aphid infestations were more severe in the no-spray control plots than in either IPM or conventional treatments during both seasons of study. Beauvaria bassiana (Abdou et al., 2017) and orange essential oil (Mossa 2016) have both been found to be able to control aphids. Therefore, a strategic approach is needed for a reduction in the use of agro-chemicals and for the implementation of sustainable practices. Furthermore, current agriculture has to implement environmentally friendlier practices that pose fewer public health risks. Cost effective crop production requires combination of optimum use of chemicals and no-chemical techniques of pest management. With this view in mind, the present study was designed to select suitable bio-pesticides or new chemical insecticide against sucking insect pests attacking yard long bean.

MATERIALS AND METHODS

The experiment was conducted in the research field at Regional Agricultural Research Station, Jashore (88°40'-89°50' E, 22°47'-23°470' N) during kharif-1 March, 2022 and 2023. Yard long bean seeds of BARI Barboti-2 variety were transplanted in a plot of 4m x 3m. The experiment was laid out in RCBD having 5replication. Four bio-pesticides and a chemical insecticide were evaluated in this study, so there were 6 treatments including control. The crop was fertilized with cowdung 15 t ha-1, urea 50 kg ha-1, gypsum 100 kg ha-1, Zn sulphate 12 kg ha-1 and borax 12 kg ha-1 as prescribed by Rashid et al., 2009. Weeding and other intercultural operations were done as and when necessary to raise a good crop. The treatments were assigned as follows: T1= Spraying Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water, T2= Spraying Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water, T3= Spraying Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water, T4= Spraying Bioclean (D-limonene 5%) @ 1 ml/ litre of water, T5= Spraying Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, T6= Control (Water spray only). Three time applications were started as soon as the infestation of sucking insects were noticed and continued at weekly interval upto last harvest of the crop. Non target pests were controlled with spraying Imitaf (Imidacloprid 200 SL) @ 0.5 ml/litre of water. Data were analyzed by using STAT-10 software for analysis of variance following randomized completely block design (RCBD) and treatment means were separated by applying LSD at 1% level of significance.

Percent insect pest population reduction over untreated control =

$$\frac{\text{Mean value of control - mean value of the treatment}}{\text{Mean value of control}} \times 100$$

Yield under different treatments were recorded at each harvest and yield (t/ha) was caculated. Benefit cost ratio of different treatments were also determined following Ali et al. (1996).

The per cent shoot/fruits infestation due to sucking insect pest infestation was calculated as following.

$$\text{Per cent shoot/fruits infestation} = \frac{\text{Number of infested shoot/fruits}}{\text{Total number of shoot/fruits}} \times 100$$

The per cent shoot/fruits infestation reduction due to sucking insect pest infestation was calculated as following.

% Shoot/fruits infestation reduction over control =

$$\frac{\text{\% untreated control - \% shoot/fruits infestation}}{\text{\% untreated control}} \times 100$$

RESULTS AND DISCUSSION

Effectiveness of four bio-pesticides and a chemical insecticide against aphids in yield of yard long bean has been presented in Table 1. It was indicated that the after first spray, treatment T5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water found in the lowest number of aphid populatopn/ inflorescence (4.00) which was followed by treatment T2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water and T3 Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (5.33), T1 spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (5.67), T4 spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (6.00) whereas untreated control plot recorded in (12.00). The highest per cent reduction of aphid population over untreated control (66.67%) was recorded from treatment T5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots followed by treatment T3= Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/L of water treated plots (55.58%) and similar result showing T2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (55.58%), treatment T1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (52.75%), treatment T4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (50%). After second spray, treatment T5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water recorded in the lowest number of aphid populatopn/ inflorescence (2.00) which was followed by treatment T1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (3.00), treatment T2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (3.00), treatment T3 spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (3.00), treatment T4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (3.00) whereas untreated control plot recorded in (11.00). The highest per cent reduction of aphid population over untreated control (81.82%) was recorded from treatment T5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots followed by treatment T1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (72.73%), treatment T2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (72.73%), treatment T3 spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (72.73%), treatment T4= Spraying Bioclean (D- limonene 5%) @ 1 ml/ litre of water (72.73%). After third spray, treatment T5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5

ml/ litre of water also recorded in the lowest number of aphid populatopn/ inflorescence (0.83) which was followed by treatment T3 spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (1.83), treatment T2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (2.00), treatment T4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (2.00) and treatment T1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (2.17). Similarly, the highest per cent reduction of aphid population over control (91.70%) was recorded from treatment T5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots followed by treatment T3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (81.70%), T2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (80%) and similar result showing treatment T4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (80%), treatment T1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (78%). These results are in agreement with Abdou et al., 2017; Mossa 2016. Beauvaria bassiana (Abdou et al., 2017) and orange essential oil (Mossa 2016) have both been found to be able to control aphids.

Table 1: Effectiveness of different treatments in reducing aphid population in yard long bean at RARS, Jashore, during 2022 and 2023

Treatments	Before spray	After first spray		After second spray		After third spray	
	Aphid population/ inflorescence	Aphid population/ inflorescence	% reduction of aphid population over control	Mean aphid population/ inflorescence	% reduction of aphid population over control	Mean aphid population/ inflorescence	% reduction of aphid population over control
Bio-catch (*Verticillium lecani* 1.15 WP)	12.33ab	5.67b	52.75	3.00b	72.73	2.17b	78.30
Bio-power (*Beauvaria bassiana* 1.15 WP)	13.00ab	5.33bc	55.58	3.00b	72.73	2.00b	80.00
Bio-Magic (*Metarhizium anisopliae* 1.15 WP)	12.00ab	5.33bc	55.58	3.00b	72.73	1.83b	81.70
Bioclean (D- limonene 5%)	13.33a	6.00b	50.00	3.00b	72.73	2.00b	80.00
Imitaf (Imidacloprid 200 SL)	12.33ab	4.00c	66.67	2.00b	81.82	0.83c	91.70
Control (Water spray)	11.67b	12.00a	-	11.00a	-	10.00a	-
CV%	6.83	13.30	-	9.60	-	5.30	-

Mean having same letter(s) in a column are not significantly different at P> 0.01 followed by DMRT.

T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water, T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water, T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water, T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, T6= Control (Water spray only). Effectiveness of different bio-pesticides/chemical insecticides against Jassids in yield of yard long bean has been presented in Table 2. It was indicated that the pooled mean of jassids population after first spray, treatment T5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water found in the lowest number of jassid population (5.67/5 leaves) which was followed by treatment T4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (7.00/ 5 leaves), T2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (7.33/ 5 leaves) and similar result showing treatment T3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (7.33/ 5 leaves), treatment T1= spraying Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (8.00/ 5 leaves) whereas untreated control plot recorded in (13.00). Similarly, the highest per cent reduction of jassid population over control (56.38%) was recorded from treatment T5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots which was followed by treatment T4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (46.15%), T2= Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (43,62%) and similar result showing treatment T3= Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (43,62%), treatment T1= Spraying

Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (38.46%). Seven days interval after second spray, treatment T5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water recorded the lowest number of jassid population (2.67/5 leaves) which was followed by treatment T4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (3.67/ 5 leaves), treatment T3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (3.83/ 5 leaves), treatment T1= spraying Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (4.00/ 5 leaves) and similar result showing treatment T2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (4.00/ 5 leaves) whereas untreated control plot recorded in (12.67). Similarly, the highest per cent reduction of jassid population over control (78.93%) was recorded from T5= treatment spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots which was followed by treatment T4= spraying Bioclean (D- limonene 5%) @ 1 ml/ litre of water (71.03%), T3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (69.77%), treatment T2= Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (68,43%) and similar result showing treatment T1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (68,43%). The pooled mean of jassids population, at 14 days after third spray, treatment T5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water recorded the lowest number of jassid population (1.67/5 leaves) which was statistically similar to treatment T3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (2.33/ 5 leaves) which was followed by treatment T1= spraying Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (2.67) and similar result showing treatment T2= Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (2.67), treatment T4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (2.67) whereas untreated control plot recorded in (11.67). Similarly, the highest per cent reduction of jassid population over control (85.69%) was recorded from T5 treatment spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots which was followed by treatment T3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (80.03%), T2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (77,12%) and similar result showing treatment T4= spraying Bioclean (D- limonene 5%) @ 1 ml/ litre of water (77.12%), treatment T1= spraying Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (77.12%). These results are in agreement with Abdou et al., 2017; Mossa 2016.

Table 2: Effectiveness of different treatments in reducing jassid population in yard long bean at RARS, Jashore, during 2022 and 2023

Treatments	Before spray Jassid population/ 5 leaves	After first spray		After second spray		After third spray	
		Jassid population / 5 leaves	% reduction of Jassid population over control	Jassid population / 5 leaves	% reduction of Jassid population over control	Jassid population / 5 leaves	% reduction of Jassid population over control
Bio-catch (*Veritcillium lecani* 1.15 WP)	16.33a	8.00b	38.46	4.00b	68.43	2.67b	77.12
Bio-power (*Beauvaria bassiana* 1.15 WP)	15.33ab	7.33b	43.62	4.00b	68.43	2.67b	77.12
Bio-Magic (*Metarhizium anisopliae* 1.15 WP)	15.00abc	7.33b	43.62	3.83b	69.77	2.33b	80.03
Bioclean (D- limonene 5%)	14.33bc	7.00b	46.15	3.67b	71.03	2.67b	77.12
Imitaf (Imidacloprid 200 SL)	15.33ab	5.67c	56.38	2.67b	78.93	1.67b	85.69
Control (Water spray)	13.67c	13.00a	-	12.67a	-	11.67a	-
CV%	5.31	8.68	-	2.31	-	2.04	-

Mean having same letter(s) in a column are not significantly different at P> 0.05 followed by LSD.

T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water, T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water, T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water, T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, T6= Control (Water spray only).

Effectiveness of different bio-pesticides/chemical insecticides against thrips in yield of yard long bean has been presented in Table 3. It was indicated that the pooled mean of thrips population at 24 hours after first spray, treatment T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water recorded in the lowest number of thrips populatopn/ inflorescence (3.33) which was followed by treatment T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (4.33) and similar result was found in treatment T_4= Bioclean (D- limonene 5%) @ 1 ml/ litre of water, treated plots (4.33), T_1= spraying Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water treated plots (4.67), T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water treated plots (4.67) whereas untreated control plot recorded in (7.67). Similarly, the highest per cent reduction of thrips population over control (56.58%) was recorded from treatment T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots followed by treatment T3 =Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water (43.55%), T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, treated plots (43.55%), T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (39.11%) and similar result showing treatment T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (39.11%). At seven days interval after second spray, treatment T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water recorded the lowest thrips populatopn/ inflorescence (2.33) which was followed by treatment T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (3.00), treatment T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, treated plots (3.33) and similar result showing treatment T_1= spraying Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water treated plots (3.33), treatment T_2= Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water treated plots (3.33) whereas untreated control plot recorded in (7.00). Similarly, the highest per cent reduction of thrips population over control (66.71%) was recorded from treatment T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots which was followed by the treatment T_3 = spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water (57.14%), treatment T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, treated plots (52.43%) and similar result showing treatment T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (52.43%), treatment T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (52.43%). The pooled mean of jassids population, at 14 days after third spray, treatment T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water recorded the lowest thrips populatopn/ inflorescence (1.33) which was followed by treatment T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (2.33) and similar result showing treatment T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, treated plots (2.33), T_1= spraying Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water treated plots (2.33), T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water treated plots (2.33) whereas untreated control plot recorded in (7.67). Similarly, the highest per cent reduction of thrips population over control (82.66%) was recorded from treatment T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots followed by treatment T_3 = spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water (69.62%) and similar result showing treatment T_4= spraying of Bioclean (D-limonene 5%) @ 1 ml/ litre of water, treated plots 69.62%), treatment T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (69.62%), treatment T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (69.62%). These results are in agreement with Abdou et al., 2017; Mossa 2016.

Table 3: Effectiveness of different treatments in reducing thrips population in yard long bean at RARS, Jashore, during 2022 and 2023

Treatments	Before spray thrips population/ inflorescence	After first spray		After second spray		After third spray	
		thrips population/ inflorescence	% reduction of thrips population over control	thrips population/ inflorescence	% reduction of thrips population over control	thrips population/ inflorescence	% reduction of thrips population over control
Bio-catch (*Verticillium lecani* 1.15 WP)	8.00a	4.67b	39.11	3.33b	52.43	2.33b	69.62
Bio-power (*Beauvaria bassiana* 1.15 WP)	7.33a	4.67b	39.11	3.33b	52.43	2.33b	69.62
Bio-Magic (*Metarhizium anisopliae* 1.15 WP)	7.33a	4.33b	43.55	3.00b	57.14	2.33b	69.62
Bioclean (D- limonene 5%)	7.00ab	4.33b	43.55	3.33b	52.43	2.33b	69.62
Imitaf (Imidacloprid 200 SL)	5.67b	3.33b	56.58	2.33b	66.71	1.33b	82.66
Control (Water spray)	7.00ab	7.67a	-	7.00a	-	7.67a	-
CV%	11.18	2.37	-	9.41	-	3.75	-

Means having same letter(s) in a column are not significantly different at P>0.05 followed by LSD. T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water, T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water, T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water, T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, T_6= Control (Water spray only).

Effectiveness of different treatments in sucking insect pest infestation and réduction of infestation of yard long bean

Sucking insect pests' infestation and réduction of infestation of yard long bean have been presented in Table 4. Result was indicated that the treatment T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water showed significantly the lowest flower infestation (2.99%) which was followed by T_3 spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/L of water treated plots (3.62%) and T_2 Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/ L of water (4.10%), T_4 Bioclean (D- limonene 5%) @ 1 ml/ L of water (4.42), T_1 Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/L of water (4.72) whereas the water treated control plot showed significantly the highest flower infestation (15.13%). It is also observed that the treatment T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water showed significantly the lowest pod infestation (2.53%) which was followed by treatment T_3 spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/L of water treated plots (3.39%) and T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/ L of water (3.65%) treatment T_4 Spraying Bioclean (D- limonene 5%) @ 1 ml L of water (4.04), T_1 spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/ L of water (4.08) whereas the water treated control plot showed significantly the highest flower infestation (15.77%). Similarly, the T_5 Spraying Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water showed significantly the highest flower infestation reduction over untreated control was found in (80.24%) which was followed by treatment T_3 spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g L of water treated plots (76.07%) and T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/L of water (72.90%), T_4 spraying of Bioclean (D- limonene 5%) @ 1 ml/ L of water (70.79), treatment T_1 spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/ L of water (68.80) by aphid. It is also observed that the T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ L of water showed significantly the highest pod infestation reduction over water treated control plot (83.96%) which was followed by T_3 spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ L of water treated plots (78.50%) and treatmnt T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/ L of water (76.85%) treatment T_4 spraying of Bioclean (D- limonene 5%) @ 1 ml/ L of water (74.38), T_1 spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/ L of water (74.18). These results are in agreement with Abdou et al., 2017; Mossa 2016

Table 4: Treatment wise flower and pod infestation of yard long bean by sucking insect pest during 2022 and 2023.

Treatments	(%) flower infestation	(%) reduction flower infestation over control	(%) pod infestation	(%) reduction pod infestation over control
Bio-catch (*Verticillium lecani* 1.15 WP)	4.72b	68.80	4.08b	74.18
Bio-power (*Beauvaria bassiana* 1.15 WP)	4.10bc	72.90	3.65b	76.85
Bio-Magic (*Metarhizium anisopliae* 1.15 WP)	3.62cd	76.07	3.39bc	78.50
Bioclean (D- limonene 5%)	4.42b	70.79	4.04b	74.38
Imitaf (Imidacloprid 200 SL)	2.99d	80.24	2.53c	83.96
Control (Water spray)	15.13a	-	15.77a	-
CV%	7.08		8.02	

Means having same letter(s) in a column are not significantly different at P>0.05 followed by LSD. T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water, T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water, T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water, T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, T6= Control (Water spray only). These results are in agreement with Abdou et al., 2017; Mossa 2016.

Effectiveness of different bio-pesticides and chemical insecticides against natural enemy of yard long bean:

Results of the study have been presented in Table 5. It was find that the after first spray, treatment T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml L of water found in the lowest number of natural enemy/plant (0.33) which was followed by T_1 spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/L of water (0.67), T2 Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/L of water (0.67) and T_3 Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/L of water treated plots (0.67), T_4 Bioclean (D-limonene 5%) @ 1 ml/ litre of water (1.00) whereas water treated control plot recorded in (2.33). The highest per cent reduction of natural enemy/plant over untreated control (85.84%) was recorded from T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/L of water treated plots followed by T_1 Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/L of water (71.24%) and similar result showing T_2 Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/L of water (71.24%), T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/L of water treated plots (71.24%), T4 spraying of Bioclean (D- limonene 5%) @ 1 ml/L of water (57.08%). After second spray, T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/L of water recorded in the lowest number of natural enemy/plant (00) which was followed by T_1 spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/L of water (0.33), T_3 spraying of Bio-Magic (Metar-hizium anisopliae 1.15 WP) @ 6 g/L of water treated plots (0.33), T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/L of water (0.67), T_4 Spraying Bioclean (D- limonene 5%) @ 1 ml/L of water (0.67 whereas water treated control plot recorded in (2.00). Recorded the fully reduced of natural enemy-/plant over water treated control plot (00) was found in T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/L of water treated plots which was followed by T_1 Bio-catch (Vertcillium lecani 1.15 WP) @ 6 g/L of water (84%) and T_3 Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/L of water treated plots (84%), T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/L of water (67%), T_4 Bioclean (D- limonene 5%) @ 1 ml/L of water (67%). After third spray, T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water was not found in the natural enemy/plant (00) which was followed by treatment T_3 Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/L of water treated plots (00), T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/L of water (0.67) and T_1 spraying of

Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/L of water (0.67) T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/L of water (1.00). Similarly, T_3 spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/L of water and T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/L of water recorded the fully reduced of natural enemy/plant (00) treated plots and the highest per cent reduction of natural enemy over control was recorded from T_1 spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/L of water and T_2 spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/L of water treated plots (60%) and followed by T_4 spraying of Bioclean (D- limonene 5%) @ 1 ml/L of water (40%). These results are in agreement with Abdou et al., 2017; Mossa 2016

Table 5: Effectiveness of different treatments in reducing natural enemy (LBB) in yard long bean at RARS, Jashore, during 2022 and 2023.

Treatments	Before spray natural enemy / plant	After first spray		After second spray		After third spray	
		Natural enemy / plant	(%)reduction of natural enemy over control	Natural enemy / plant	(%) reduction of natural enemy over control	Natural enemy / plant	(%) reduction of natural enemy over control
Bio-catch (*Verticillium lecani* 1.15 WP)	2.00a	0.67b	71.24	0.33b	84	0.67b	60.00
Bio-power (*Beauvaria bassiana* 1.15 WP)	1.33a	0.67b	71.24	0.67b	67	0.67b	60.00
Bio-Magic (*Metarhizium anisopliae* 1.15 WP)	2.00a	0.67b	71.24	0.33b	84	0.00b	00
Bioclean (D- limonene 5%)	1.67a	1.00b	57.08	0.67b	67	1.00b	40.00
Imitaf (Imidacloprid 200 SL)	1.33a	0.33b	85.84	0.00b	00	0.00b	00
Control (Water spray)	2.00a	2.33a		2.00a		1.67a	-
CV%	3.96	4.76		2.46		6.24	-

Mean having same letter(s) in a column are not significantly different at P> 0.05 followed by LSD.

T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water, T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water, T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water, T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, T_6= Control (Water spray only).

Effect of different treatments on the yield of yard long bean

Effect of different treatments on the yield of yard long bean have been presented in Table 6. It was indicated that the result showing significantly highest pod yield (8.37t/ha) was recorded in T_5 = spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots which was followed by treatment T_3 = spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water treated plots (7.43 t/ha), T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (7.18 t/ ha), T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (7.17 t/ha), T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (7.03 t/ha) whereas the lowest pod yield was found in water treated control plot (5.73 t/ha). Similarly the highest yield increase over control was calculated from treatment T_5 spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water (46.07%) followed by treatment T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water (29.67%), T_1= spraying of Bio-catch (Verticillium lecani 1.15 WP) @ 6 g/litre of water (25,31%), T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (25.13%) and the lowest yield increase over control was obtained in treatment T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (22.69%). These results are in agreement with Abdou et al., 2017; Mossa 2016.

Table 6: Effect of different treatments on the yield of yard long bean at RARS, Jashore, during 2022 and 2023.

Treatments	Yield (t/ha)	Yield increase over control (%)
Bio-catch (*Vertcillium lecani* 1.15 WP)	7.18b	25.31
Bio-power (*Beauvaria bassiana* 1.15 WP)	7.17b	25.13
Bio-Magic (*Metarhizium anisopliae* 1.15 WP)	7.43b	29.67
Bioclean (D- limonene 5%)	7.03b	22.69
Imitaf (Imidacloprid 200 SL)	8.37a	46.07
Control (Water spray)	5.73c	-
CV%	6.42	-

Mean having same letter(s) in a column are not significantly different at P> 0.05 followed by LSD.
T_1= spraying of Bio-catch (Vertcillium lecani 1.15 WP) @ 6 g/litre of water, T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water, T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water, T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, T_6= Control (Water spray only).

Benefit/ cost analysis

The benefit-cost ratio (BCR) as worked out based on the expenses incurred and value of crops obtained from the treated plots for the control of aphids of yard long bean is given in Table 7. It is to be noted here that expenses incurred reffered to those only on pest control. It is revealed that the highest (8.42) marginal benefit-cost ratio (MBCR) was calculated from treatment T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water treated plots which was followed by treatment T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water (5.34), T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water (4.41), T_1= spraying of Bio-catch (Vertcillium lecani 1.15 WP) @ 6 g/litre of water (4.22), T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water (3.90). So, the considering MBCR, treatment T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water may be recommended for effective management of sucking insect pest attacking yard long bean. These results are in agreement with Abdou et al., 2017; Mossa 2016.

Table 7: Benefit cost analysis of different treatments of the yard long bean sucking insect pest at RARS, Jashore, during 2022 and 2023.

Treatments	Marketable yield (t/ha)	[1]Gross return (Tk/ha)	[2]Cost of treatment (Tk/ha)	Net return (Tk/ha)	Adjusted return (Tk/ha)	M BCR
Bio-catch (*Vertcillium lecani* 1.15 WP)	7.18b	287200	11110	276090	46890	4.22
Bio-power (*Beauvaria bassiana* 1.15 WP)	7.17b	286800	10650	276150	46950	4.41
Bio-Magic (*Metarhizium anisopliae* 1.15 WP)	7.43b	297200	10730	286470	57270	5.34
Bioclean (D- limonene 5%)	7.03b	281200	10620	270580	41380	3.90
Imitaf (Imidacloprid 200 SL)	8.37a	334800	11210	323590	94390	8.42
Control (Water spray)	5.73c	229200	-	229200	-	-
CV%	6.42	-	-	-	-	-

T_1= spraying of Bio-catch (Vertcillium lecani 1.15 WP) @ 6 g/litre of water, T_2= spraying of Bio-power (Beauvaria bassiana 1.15 WP) @ 6 g/litre of water, T_3= spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water, T_4= spraying of Bioclean (D- limonene 5%) @ 1 ml/ litre of water, T_5= spraying of Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water, T_6= Control (Water spray only).

[1]Farmgate price of yard long bean @ Tk. 40.00 per kg
[2][Cost of Bio-catch: @Tk. 380/100 ml; Cost of Bio-power (Beauvaria bassiana 1.15 WP): @ Tk. 3000/kg; Cost of Bio-Magic (Metarhizium anisopliae 1.15 WP): @ Tk.2500/Kg; Cost of Bioclean (D-limonene 5%): @ Tk. 230/100ml; Cost of Imitaf (Imidacloprid 200 SL): @ Tk. 450/100 ml; Cost of spray: Three laborers/spray/ha @ Tk 550.00/labour/day; Cost of hand picking: Three laborers/ha @ Tk 550.00/labour/day; Spray volume required: 500L /ha].

CONCLUSION

From the above results of the presented study clearly indicated that the chemical, insecticide Imitaf (Imidacloprid 200 SL) @ 0.5 ml/ litre of water performed best considering reduced infestation of the target pests, the higher yield and the highest MBCR. The biopesticide spraying of Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/litre of water offered second best performance, while the other bio-pesticides offered intermediate level of performance. But if we consider the alternatives to toxic chemical pesticide and environment friendly methods than the biopesticide, Bio-Magic (Metarhizium anisopliae 1.15 WP) @ 6 g/ litre of water may be used in a well-designed IPM program against sucking insect pest attacking yard long bean.

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Review / Overview Paper

OILSEED PRODUCTIVITY INCREASED WITH THE INCLUSION OF BARI SARISHA-18 IN T. AMAN- FALLOW-JUTE CROPPING PATTERN AT PAZBARIA, JASHORE

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ABSTRACT

The field experiment was conducted at Pazbaria Jashore under Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Jashore two consecutive years 2020-21 and 2021-22 to introduce BARI Sarisha-18 in the fallow period and to study the comparative agronomic performance and economic return of two cropping sequences (viz. improved cropping pattern, Transplant Aman rice –Mustard - Jute and existing cropping pattern - Transplant Aman rice – Fallow - Jute for increasing cropping intensity, productivity and land use efficiency. The experiment was laid out in a randomized complete block design (RCBD) with ten dispersed replications. Three crops pattern (T. Aman rice –Mustard - Jute) and farmers' existing pattern (T.Aman- fallow- Jute) as control were tested. Two years mean data showed that the improved management practices for the pattern provided significantly higher yield in improved pattern. Higher rice equivalent yield (REY) of cropping system (mean value 20.82 t ha-1) was recorded with the improved pattern over existing pattern. REY increased 10.42 t ha-1 by inclusion of mustard with improved production technologies for the component crops. The results also revealed that the improved cropping pattern had a higher production efficiency (63.72 kg ha-1 day-1) and an 89.50% mean land utilization index (LUI) in both years, with a gross return of BDT. 729225 ha-1, which was more than 99.95% higher than the farmer's pattern of BDT. 364700 ha-1.

The gross margin was higher in the revised cropping pattern in both years than existing pattern due to addition of mustard BARI Sarisha-18.

Key words: Oilseed, productivity, land use efficiency, cropping intensity, mustard and variety

INTRODUCTION

Bangladesh is an agriculture dependent country. Agriculture plays a vital role in Bangladesh economy. More than 70% people in the rural areas directly or indirectly are involved with agriculture (BBS, 2015). Bangladesh is one of the most densely populated (1008 per sq. km.) countries of the world with an area of 147570 sq. km with population growth rate 1.89 percent (BBS 2015). The population will increase to about 200 million (Planning Commission). On the other hand, the cultivable land is decreasing by 1% every year. The total land area of Bangladesh is about 14.84 million hectares of which 3.74 million hectares (25% of the total) is not available for agriculture due to use for urban areas, industrial buildings, rural homesteads, roads and other infrastructure. The net area of Bangladesh for crop cultivation declined to 7.84 million hectares in 2011 from 8.85 million hectares in 1985 (BBS, 2015). Bangladesh also suffers regularly from several natural calamities (Haq et al., 2012; Islam et al., 2017; Rahman et al., 2018), which may worsen in the future due to climate change (Hossain et al., 2016; Rokonuzzaman et

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al., 2018; Rahman et al., 2019). Thus, Bangladesh needs to produce more food on less land to assure future food security for millions of people every year. Horizontal expansion is very limited, but increase in crop production could be possible with vertical expansion through increasing cropping intensity and by increasing Land Use Efficiency. To achieve this, the two techniques that need to be adopted more frequently are an increase in the cropping intensity by producing two or more crops on the same land all-year round, and an increase in the productivity of individual crops, particularly their ability to utilize basic or limiting resources such as water and nutrients (FAOSTAT, 2013; Dobermann et al., 2013; Ladha et al., 2016). The present cropping intensity of the requirement is estimated to be doubled in the next 25 years. Under such situation; it is very important improving the existing cropping pattern. There are some scopes of increasing cropping intensity from existing level of 192 to 300% or more by improving the existing cropping patterns by incorporating short duration crops crops like; mustard, potato, mungbean and transplant aus rice in the rice based cropping systems following the modern variety and technologies. Sustainable crop production in Bangladesh through improvement of cropping patterns in rice based cropping system is regarded as an important in national issues such as food security, poverty alleviation and creation of job opportunity. The main challenge of the new millennium is to increase yield of per unit area by at least 50 % through manipulating the limited land resource. In order to produce more food within a limited area, two most important options to be adopted are i) to increase the cropping intensity by producing three or more crops from the same piece of land in a year and ii) to increase the production efficiency of the individual crop by using optimum management practices.

The cropping pattern and the changes therein dependon a large number of factors like climate, soil type, rainfall, agricultural technology, availability of irrigation facilities and other inputs, marketing and transport facilities and growth of agro-industries (Neena, 1998; Gadge, 2003). The cropping pattern in an area depends largely on agro-climatic, technical and institutional factors (Vaidyanathan, 1987). Bangladesh is predominantly a rice growing country and rice is the staple food and the economy mainly depends on rice production. Rice occupies about 80 % of the total cropped area and is cultivated in three seasons a year. The major cropping pattern of agriculture in Bangladesh mostly consists of rice based cereal crops (Haque, 1998). More than 60% of the total cropped areas covered by Boro-Fallow-T. aman rice cropping pattern in Bangladesh. As a result, the vast area remains fallow for 75 days after T.Aman harvest. So, there is a great scope of increasing cropping intensity as well as crop productivity. The areas of oilseed and pulse in rabi season are decreasing because of increasing cultivation of Boro rice. Rice is the staple food and the economy mainly depends on rice production in Bangladesh and now occupies the 4th position in the world. In self sufficiency of rice, the dominant cropping pattern T. Aman (wet season rice)-Fallow-Boro (dry season rice) plays an important role which covers about 1.8 million hectare (about 22% of the total land) of land (Elahi et al., 1999). Bangladesh Rice Research Institute (BRRI) has recommended the T. Aman- Mustard-Boro cropping pattern for the irrigated ecosystem (BARC, 2001; Khan et al., 2004, Anwar et al. 2012) with the inclusion of 70-75 days local mustard variety (Tori 7) in the transition period between T. Aman and Boro rice. But the farmers harvest poor yield from local var. Tori7 that can be increased manifold by introducing high yielding varieties (Alam and Rahman, 2006; Basak et al., 2007). Bangladesh Agricultural Research Institute (BARI) has developed high yielding yellow seeded mustard (Brassica campestris) varieties, BARI Sarisha-14 and BARI Sarisha-15 whose yield potential is higher than Tori-7 and have been recommended for T. Aman-Mustard-Boro cropping sequence (BARI, 2011). Inclusion of these new varieties of mustard with growth duration of 80-85 days in between existing medium duration T. Aman rice (135-140 days) and Boro rice can create opportunity to fit in the T. Aman -Fallow-Boro cropping sequence. Jute may be included after harvest of Boro rice. It is only possible, if jute is cultivated early and short duration T. Aman and Boro rice varieties are included in the pattern. Jute crops can be grown easily under moisture stressed condition in high to medium low land (BJRI, 1990). The crop residue from jute crop contributed to enrich soil fertility and benefit the succeeding rice crop (Singh and Ghosh, 1999). Most areas of Bangladesh at present under two crops based cropping pattern, but there prerequisite to increase crop number to meet up the demand. A number of reports on different cropping pattern are available in Bangladesh and abroad (Khan et al., 2005, Ferdous et al. 2011, Anowar et al. 2012, Nazrul et al., 2013, Khatun et al., 2016 and Anwar et al., 2017, Ahmed et al. 2017) where an additional crop could be introduced without much changes or replacing the existing ones for considerable increase of the overall productivity as well as profitability of the farmers. Keeping these views in mind, the present study was designed to evaluate the feasibility of increasing cropping intensity and productivity by growing three crops in a year in a same piece of land by introduce BARI Sarisha-18 in the fallow period.

MATERIALS AND METHODS

The experiment was laid out in a randomized complete block design with ten dispersed replications. The trial was conducted to increase cropping intensity, productivity and land use efficiency by incorporating BARI Sarisha-18 in the existing cropping pattern T. Aman-fallow-Jute at the farmers' field condition in Pazbaria, Jashore (Latitude: 23.163401 N, Longitude: 89.218166 E) during two consecutive years 2021-22 and 2022-23. Two cropping pattern viz. three crops pattern and farmers' existing pattern were the treatments variables of the experiment. There were two treatments viz., T1 = Existing cropping pattern T. aman rice – Fallow - Jute, T2 = Improved cropping pattern T. aman rice – Mustard - Jute. Small unreplicated trials on farmers' fields, known as "dispersed experiments", were established under local farm conditions (Ferdous et al. 2016; Ferdous et al., 2017). The land was divided into two equal plots. The unit plot size was 620 Sq. m. where one plot was maintained either improved pattern, whereas the other plot was maintained existing pattern. T. Aman rice was the first crop of the sequence. Seedlings of rice were grown in adjacent plot and transplanting was done with 20-25 days old seedlings of T. Aman rice var. BRRI dhan 75 were transplanted with 20 cm × 15 cm during 25-27 July, 2020 and 2021 in both years. Fertilizer management and intercultural operations like weeding, mulching, irrigation and pest management were done according to BRRI (2013). T. Aman rice was harvested during 22 to 24 October, 2020 and 2021 in two consecutive years. T. Aman rice plant was harvested at 15 cm from soil surface and remaining parts of the plants was incorporated in soil. Mustard was grown during rabi season and it was the second crop of the sequence. Fertilizer management and intercultural operations like weeding, mulching, irrigation and pest management were done according to FRG, 2012. Mustard var. BARI sarisha-18 was seeded as broadcast method with seed rate of 7 kg/ ha. The crop was sown during 05 November, 2020 and 2021 and harvested during 15 to 18 February, 2021 and 2022, respectively. Jute was the third crop of the sequence. Jute var. BJRI deshi path-8 was seeded as broadcast method with seed rate of 8 kg/ha. in three cropping pattern. The crop was sown during 08 April, 2021 and 2022. Fertilizer management and intercultural operations like weeding, mulching, irrigation and pest management were done according to BRRI (2013). Jute was harvested during and harvested during 25 to 28 July, 2021 and 2022 in two consecutive years. Jute plant was harvested at 10 cm height from soil surface and remaining parts of the plants was incorporated in soil. Crop nutrient uptake was estimated following the standard value of (FRG, 2012). The area mostly falls under medium-high land and high land areas of the Agro Ecological Zone (AEZ) 11 (High Ganges River Floodplain). Organic matter content is low in higher parts, but moderate in lower parts. The general fertility level is low including N, P, S and B although CEC medium and K- bearing minerals are medium to high but the Zn status is low to medium (FRG, 2012). The area receives an annual rainfall of around 1035 mm with relatively early onset and late cessation and the mean annual high temperature is 32.1ºC (89.78ºF), annual low temperature is 22.95ºC (73.31ºF). The maximum land is under double-cropping followed by triple- and mono-cropping (Anwar et al., 2017). The initial soil status of the experimental sites was presented in Table 1.

Table 1: . Initial status of soils of the experimental plots at Pazbaria, Jashore

Soil depth	pH	OM (%)	Total N (%)	Exchangeable (meq/ 100gm soil)			Available nutrients (μg/g soil)						
				K	Ca	Mg	P	S	Zn	B	Cu	Fe	Mn
0-15cm	7.7	1.71	0.09	0.09	9.69	2.04	14.99	16.05	1.85	0.26	2.45	15.17	2.38
15-30cm	7.8	0.82	0.04	0.04	9.03	2.03	7.62	18.38	0.83	0.14	1.51	1.53	1.11

After physiological maturity, 10 randomly selected plants from each plot were harvested and plant height, yield and yield attributes of Transplant aman rice, Mustard and Jute were measured. Yield for each crop was determined plot-wise and converted into yield on an area basis (kg/ha). Data on yield and yield attributes were statistically analyzed using statistical package IRRISTAT 5.0 (Ferdous et al., 2018) for the data analysis. Benefit-cost analysis was conducted to estimate the economic feasibility of Transplant aman rice, Mustard and Jute crop. The production costs of these crops included the cost of field preparation, seed, planting, irrigation, fertilizers, crop protection measures and harvesting. The details of crop management practices followed for each crop is provided in Table 2, respectively.

Table 2: . Crop management practices in farmer's existing and improved cropping pattern at Pazbaria, Jashore

Observation	Existing cropping pattern			Improved cropping pattern		
Crop	T.aman rice	Fallow	Jute	T.aman rice	Mustard	Jute
Variety	Swarna	-	path 8	BRRI dhan 75	BARI Sarisha-14	BJRI dheshi path 8
Spacing	20 cm × 15 cm		Broadcast	20 cm×15 cm	Broadcast	Broadcast
Unit plot size	1340 m2			1340 m2		
Fertilizer dose (Urea-TSP-MoP-Gyps.-Zn-B Kg ha-1)	102-62-20-08-0-0	-	160-20-40-36-6.5-0	150-90-112.5-90-10-0	262-150-05-160-10+15	160-20-40-36-6.5-0
Date of sowing	1July	-	08 April	1 July	05 November	08 April
Date of transplanting	29 July-15 Aug	-	-	25-27 July	-	-
Seedling age (days)	25-30	-	-	20-25	-	-
Harvesting date	15-30 Nov	-	26 April	22 to 24 October	15 to 17 January	25-27 July

Agronomic performance like field duration, rice equivalent yield (REY), production efficiency and land utilization index of cropping patterns were calculated.

Rice equivalent yield (REY): For comparison between crop sequences, the yield of all crops was converted into rice equivalent on the basis of prevailing market prices of individual crop (Lal et al., 2017) (Verma and Modgal, 1983). Rice equivalent yield (REY) was computed as yield of individual crop multiplied by market price of that crop divided by market price of rice.

$$\text{Rice equivalent yield (t/ha./yr.)} = \frac{\text{Yield of individual crop} \times \text{market price of that crop}}{\text{Market price of rice}}$$

Production efficiency

Production efficiency value in terms of kg/ha/day was calculated by total main production in a cropping sequence divided by total duration of crops in that pattern ((Lal et al., 2017; Tomar and Tiwari, 1990).

$$\text{Production Efficiency (Kg/ha./day} = \frac{\Sigma\ Y i}{\Sigma\ d i}$$

Where, Yi= Yield (kg) of ith crop, di= Duration (day) of ith crop of the pattern and i= 1,2, 3, 4**Land utilization index (LUI)**

It was worked-out by taking total duration of crops in an individual cropping pattern divided by 365 days (Rahman et al., 1989, Tomer and Tiwari, 1990). It was calculated by the following formula:

$$\text{Land Utilization Index (\%)} = \frac{d1+ d2+ d3}{365} \times 100$$

Where, d1, d2 and d3 the duration of 1st, 2nd and 3rd crop of the pattern.

The gross income was estimated using the prevailing average market prices for the yield of these crops in Bangladesh. Net income was calculated by subtracting total expenditure from the gross income which was computed by dividing the gross income with total expenditure (Mahmood et al., 2016). Economic analysis was done on the basis of prevailing market price of the commodities. The inputs used included seed, fertilizer, labour and insecticides. The MBCR of the farmer's prevalent pattern and any replacement for it can be computed as the marginal value product ((MVP) over the marginal value cost (MVC). The Marginal of prevalent pattern (F) and any potential replacement (E) which was computed as (CIMMYT, 1988).

$$\text{Marginal Benefit Cost Ratio (MBCR} = \frac{\text{Gross return (E) - Gross return (F)}}{\text{TVC (E)-TVC(F)}} = \frac{\text{MVC}}{\text{MVP}}$$

RESULTS AND DISCUSSION

Yield of the cropping patterns: Results of the study have been presented in Table 3. It was revealed that the entire component crops of T. Aman rice – Mustard - Jute cropping pattern under improved practices (IP) gave higher yield as well as by-product yield in two consecutive years at the locations Pazbaria, Jashore. The yield of improved pattern was higher due to inclusion of mustard with improved production technologies for the component crops. Similar results were also obtained by Anwar et al., 2017, Khatun et al., (2016), Kamrozzaman et al., (2015) and Nazrul et al. (2013). BARI Sarisha 18 is a medium duration high yielding mustard variety which can easily be grown during the fallow period (Mondal et al., 2015). Inclusion of mustard with improved variety in T. Aman rice - Mustard- Jute cropping pattern practice increased the total yield over the farmers existing cropping pattern practice.

Grain yields of T. aman rice in case of improved cropping pattern were 5.98 t/ha and straw yields 7.86±0.18 t/ha. and 5.95 t/ha and straw yields 7.65±0.12 t/ha. In 1st and 2nd year and mean grain and straw yields of T. Aman rice were 5.97 t/ha and 7.91±0.15t/ha two consecutive years respectively. Seed yield of mustard were 2.68 and 2.78 t ha-1 in two consecutive years respectively. and strover yields were 3.84±0.18 and 3.95±0.19t/ha in two consecutive years respectively. Mean seed yield of mustard was 2.73 ± 0.23 t/ha. Mustard seed yield increased 3.60% by 2nd year and it might be due to longer duration (2 days) than 1st year. It was revealed that all the 3-crops under T. Aman-Mustard - Jute cropping pattern gave higher grain and by-product yield. Fiber yield of Jute were 2.95 and 2.91 t ha-1 in two consecutive years, respectively and strover yields were 3.89±0.12 and 3.85±0.27 t/ha in two consecutive years respectively. Mean fiber and strover yields of Jute were 2.93±0.17 t/ha and 3.875±0.28 t/ha two consecutive years, respectively. T. Aman rice in three crops pattern produced 48.02% higher grain yield over farmers' practice due to change of variety with improved production technologies. Similar results were also obtained by (Nazrul et al., 2013). Farmers' pattern gave lower yield due to imbalance use of fertilizers Urea, TSP, MoP, Gypsum and poor management practices. Three crops pattern produced higher by-product yield (15.52 t/ha) over farmers' practice (9.45 t/ha). Mean by-product yield of three crops pattern was 64.29% higher over farmer's pattern due to change of variety with improved technologies and inclusion of one crop in the existing pattern

Table 3: Productivity of farmer's existing and improved cropping pattern at Pazbaria, Jashore

Year	Cropping pattern	Crop	Variety	Field duration	Total field duration (days	Grain or seed yield (t ha-1)	Straw or strover yield (t ha-1)
2020-21	Existing cropping pattern	T.aman	Swarna	112	225	4.03±0.17	7.05±0.21
		Fallow	-	-		-	-
		Jute	BJRI Deshi path 8	113		2.75±0.12	2.95±0.12
	Improved cropping pattern	T.aman	BRRI dhan 75	113	325	5.98±0.51	7.86±0.18
		Mustard	BARI Sarisha-18	101		2.68±0.13	3.84±0.18
		Jute	BJRI Deshi path 8	111		2.95±0.22	3.89±0.12
2021-22	Existing cropping pattern	T.aman	Swarna	113	227	4.054±0.21	6.03±0.21
		Fallow	-	-		-	-
		Jute	BJRI Deshi path 8	114		2.85±0.15	2.86±0.18
	Improved cropping pattern	T.aman	BRRI dhan 75	110	325	5.95±0.16	7.65±0.12
		Mustard	BARI Sarisha-18	103		2.78±0.24	3.95±0.19
		Jute	BJRI Deshi path 8	112		2.91±0.23	3.85±0.27

Price: Mustard=BDT. 95 kg-1, Rice=BDT. 35 kg-1, Rice straw= BDT. 6 kg-1, Mustard Stover = BDT. 5 kg-1, Jute fiber = BDT. 60 kg-1 and Jute Stick = BDT. 5 kg-1 Price (Tk. kg-1): Urea-22, TSP-22, MP-15, Gypsum-30, Zinc Sulphate-200, Boric acid-160, REY: rice equivalent yield, GM: gross margin.

Rice equivalent yield: Total productivity of a cropping system was evaluated in terms of rice equivalent yield (REY) and it was calculated from yield of component crops. Higher rice equivalent yield (REY) of cropping system (mean value 20.84 t ha-1) was recorded with the improved pattern Transplant aman-Mustard-Jute over farmer's existing cropping pattern (mean value 10.42 t/ha.), Transplant aman-Fallow -Jute at Pazbaria, Jashore (Table 4). REY increased 10.42 t ha-1 by inclusion of mustard with improved production technologies for the component crops. Inclusion of mustard in rabi season in existing cropping pattern increased total productivity by 100% compared to farmers' practice. These results are in agreement with Mondal et al. (2015). They reported that total productivity increased by 67 % over farmers' practice. It is noted that inclusion of additional crop during the fallow period produced higher rice equivalent yield than farmer's practice. Similar results were also obtained by Khatun et al.,2016; Kamrozzaman et al., 2015; Ferdous et al. 2011, Anowar et al. 2012, Nazrul et al., 2013.

Field duration: Field duration of a cropping pattern comprises on the individual crop duration. Farmers' cropping pattern T. Aman -fallow- Jute has needed 225 and 227 days field duration in 1st and 2nd year. The newly introduced one crop in the farmer's existing pattern was mustard var. BARI Sarisha-18. A medium duration T.Aman rice var. BRRI dhan 75 was also introduced to minimize the field duration of the crop. Total field duration of three crops pattern T.Aman-Mustard - Jute has needed 325 and 325 days including seedling age of rice to complete the cycle in 1st and 2nd year (Table 3). Thus, long turn around period of 139 days in the farmer's existing pattern was utilized. Result indicated that mustard could be easily fitted in T. aman rice- Mustard – Jute cropping pattern with an average of 40 days turnaround time in a year. Similar trend was also observed by Mondal et al. (2015) who reported that all the tested four crops pattern can be grown successfully one after another in sequence.

Table 4: REY, PE and LUI of farmer's existing and improved cropping pattern at Pazbaria, Jashore during 2020-21 and 2021-22.

Items	farmers' existing cropping pattern			Improved cropping pattern		
	2020-21	2021-22	Average	2020-21	2021-22	Average
REY (t ha-1)	10.46	10.38	10.42	20.76	20.91	20.84
PE (kg ha-1 day-1)	46.49	45.73	46.11	63.49	63.94	63.72
LUI (%)	61.64	62.19	61.92	89.59	89.59	89.59

REY= Rice Equivalent Yield, PE= Production Efficiency and LUI= Land Utilization Index

Production efficiency: Mean maximum production efficiency (63.72) in terms of kg/ha/day was obtained from Improved cropping pattern T. aman- Mustard -Jute and minimum (46.11 kg/ha/day) in farmers' practice, Transplant aman-Fallow -Jute (Table 4). The higher production efficiency in Improved cropping pattern (three) T. aman- Mustard -Jute might be due to inclusion of high yielding mustard varieties and improved management practices. Similar trend were noted by Nazrul et al. (2013) and Khan et al. (2006).

Land utilization index: Land utilization index is the effective use of land in a cropping year, which mostly depends on crop duration. Results of the study have been presented in Table 4. Mean land utilization index (LUI) indicated that improved cropping pattern used the land for 89.50% period of the year, whereas existing cropping pattern used the land for 61.92% period of the year. The improved cropping pattern leads to higher land use efficiency due to longer period field occupied by the crops (327 days), whereas the farmers practice occupied the field for 226 days of the year. Similar results were also obtained by Khatun et al., 2016.

Table 5: Cost and return analysis of farmer's existing and improved cropping pattern at Pazbaria, Jashore during 2020-21 and 2021-22

Parameters	Gross return (Tk. ha-1)			Total variable cost (Tk. ha-1)			Gross margin (Tk. ha-1)			MBCR		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
farmers' existing cropping pattern	366100	363300	364700	194136	192360	193248	171964	170940	171452	0.89	0.89	0.89
Improved cropping pattern	726600	731850	729225	222108	228712	225410	504492	503138	503815	2.27	2.20	2.24

Price: Mustard=BDT. 95 kg-1, Rice=BDT. 35 kg-1, Rice straw= BDT. 6 kg-1, Mustard Stover = BDT. 5 kg-1, Jute fibre = BDT. 60 kg-1 and Jute Stick = BDT. 5 kg-1 Price (Tk. kg-1): Urea-22, TSP-22, MP-15, Gypsum-30, Zinc Sulphate-200, Boric acid-160, REY: rice equivalent yield, GM: gross margin.

Cost and return analysis

Economic analysis done based on prevailing market price during the crop season. Improved cropping pattern showed its superiority over farmers' pattern during two consecutive years at the locations. Results of the study have been presented in Table 5. From the economic point of view, improved cropping pattern (T.Aman- Mustard- Jute) showed its superiority over farmers' existing cropping pattern (T.Aman- Fellow - Jute). Mean gross return of improved cropping pattern (T.Aman- Mustard- Jute) was found Tk. 729225 ha-1 and farmers' pattern was Tk. 364700 ha-1 which was more than 99.95 % higher over farmers' existing pattern. Two rice crop patterns (Farmer's existing pattern) gave the lower gross return Tk. 364700 ha-1. Mean variable cost was higher in improved cropping pattern (Tk. 225410 ha-1) might be due to inclusion of new component crops (mustard) in the pattern. The mean gross margin was significantly higher in improved cropping pattern (Tk. 503815 ha-1) than farmer's existing cropping pattern (Tk. 171452 ha-1). Three crops pattern achieved higher gross margin mainly due to higher yield advantages of the new component crops. The mean marginal benefit cost ratio (MBCR) was found (2.24) which indicated the superiority of the improved cropping pattern over the farmer's existing cropping pattern (0.89). The marginal benefit cost ratio (MBCR) also showed that inclusion of mustard in the existing pattern might be profitable and acceptable to the farmers. Inclusion of new crop (mustard) as well as improvement of management practices in the improved cropping pattern increased the economic return. These results are supported by Mondal et al. (2015) and Khatun et al., 2016. They reported that inclusion of T. Aus, potato, mustard and mungbean in the existing pattern were profitable and acceptable to the farmers and grown successfully one after another in sequence of one year cycle.

CONCLUSION

From the above results showed that improved cropping pattern was more profitable compared to existing pattern. Considering higher rice-equivalent yield, net monetary return and more sustainability of the improved cropping pattern (T. Aman rice – Mustard - Jute) with additional crop and improved technologies could be suggested for medium-high land and high land areas of the High Ganges River Floodplain Agro Ecological Zone (AEZ) 11 of Bangladesh.

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Review / Overview Paper

GENETIC DIVERSITY IN SALT TOLERANT WHITE JUTE (*CORCHORUS CAPSULARIS* L.)

M. A. Hossain[1], A. K. Chowdhury[2] & U. K. Nath[3]

ABSTRACT

Hierarchical cluster analysis of 50 white jute genotypes carried out taking nine morphological characters during growing season April to September 2009 in the field of Bangladesh Jute Research Institute, Pakhimara, Kolapara, Patuakhali. The wards method of clustering was adopted using Euclidean distances, genotypes were grouped into 5 clusters. The largest clusters II and IV with 17 and 12 genotypes respectively, followed by cluster III (9). The smallest cluster I and cluster V included 6 genotypes per cluster. It was observed that inter group distances were always higher than those of intra group distances. The highest intra clustered distance was found in cluster I and lowest was in cluster V. On the other hand, highest inter cluster distance was measured in between cluster I and cluster V. Indicated maximum genetic diversity between those two clusters. From the cluster mean values, the cluster-I had the highest mean value for dry fibre weight/plant, plant height, base diameter, fresh stem weight with and without leaves/plant and dry stick weight/plant but high mean value of mortality rate. On the other hand, lowest mean value of mortality rate was found among the genotypes in cluster II. This indicates the presence of high yielding genotypes in cluster I and salinity stress tolerant genotypes in the cluster II. The result of PCA revealed that all the characters did not contribute equally to the total diversity, in vector-I the important characters responsible for genetic divergence in the major axis of differentiation were dry fibre weight/plant, dry stick weight/plant, fresh stem weight with and without leaves/plant, plant height, base diameter and plant population density and in vector II mortality rate played significant role.

Key words: Jute genotypes, fibre yield, genetic diversity

INTRODUCTION

Salt stress tolerance is generally considered as a complex character which regulated by multi genes. Screening for salt tolerance needs reliable indicators or selection marker. Plant mortality rate as well as fibre yield depending upon the salinity levels and genotypic characters. The high salinity during seed germination and growing periods resulted in very high mortality which reduces the yield of per unit areas this necessitated considering only the plant population at harvesting time as the criteria for selecting comparatively tolerant genotypes.

The parents identified on the basis of divergence analysis would be more promising. In both cross- and self-pollinated crops genetic diversity is one of the most important tools to quantify genetic variability. Evaluation of genetic diversity is important to know the source of gene for a particular trait within the available germplasm (Tomooka, 1991). The clustering pattern of the genotypes was often not related to their geographical origin. It is suggested that genetic drift and selection in different environmental causes greater diversity (Pandit et al, 1997). The pattern of distribution of genotypes within various clusters was independent for geographical distribution. Based on the mean performance genetic distance and

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clustering pattern, 13 genotypes were selected as better parents for future hybridization program (Yahiya, 2007).

In crop improvement program, genetic divergence is very helpful to select the parents for future breeding program. More diverse the parents, greater are the changes of obtaining high heterotic F1 and broad-spectrum variability in segregating generation (Arunachalam, 1991). So, that choice of parent is a very important task in a breeding program. For any meaningful plant breeding program, accurate estimates of genetic diversity and partitioning within and between gene pools are important consideration.

MATERIALS AND METHODS

A total of 50 jute genotypes including 44 accessions and 6 varieties were used in this experiment (table 1). All of these plant materials were collected from the gene bank and breeding division of Bangladesh Jute Research Institute, Dhaka. This experiment was carried out at the sub-station of Bangladesh Jute Research Institute, Pakhimara, Kolapara, Patuakhali during April to September, 2009 following RCBD design with 3 replications. The seeds of each genotype were sown in two rows of 3.0 m long with 30.0 cm and 10.0 cm spacing in rows and in plants respectively. The replications were interspaced with 1.0 meter. The genotypes were assigned randomly within each replication. Necessary inter cultural operations (weeding, thinning, plant protection measure etc.) were performed for proper growth and development of the plants. Ten sample plants of each genotype were harvested for fibre yield at 120 days from the date of sowing. Data were recorded for 10 quantitative characters (plant population density at harvesting time, plant height, base diameter, node number/plant, internodal length/plant, fresh stem weight with leaves/plant, fresh stem weight without leaves/plant, dry stick weight/plant and dry fibre weight/plant) on per plant basis. Multivariate analysis namely principal component analysis (PCA), principal coordinate analysis (PCO), cluster analysis and canonical Variate analysis (CVA) ware done using SPSS and Stat graphics software

Table 1: List of the jute genotypes used in this research.

SL. NO.	Genotypes	Sources of collection	Characteristics
1.	CVL 1	Bangladesh (variety)	Full green
2.	C-2737	Barisal, Bangladesh	Full green
3.	C-2753	Borguna, Bangladesh	Stem pigmented, long lamina, pigmented band between petiole and lamina.
4.	C-2759	Barisal, Bangladesh	Full green
5.	C-2734	Barisal, Bangladesh	Full green
6.	C-2750	Borguna, Bangladesh	Full green
7.	C-2752	Borguna, Bangladesh	Stem green, petiole light pigmented
8.	C-2763	Barisal, Bangladesh	Stem green, petiole light pigmented
9.	C-2757	Borguna, Bangladesh	Stem green, petiole pigmented.
10.	C-2761	Barisal, Bangladesh	Stem green, petiole pigmented, pigmented band between petiole and lamina.
11.	C-2765	Barisal, Bangladesh	Full green
12.	C-2760	Barisal, Bangladesh	Full green
13.	C-2762	Barisal, Bangladesh	Stem green, petiole light pigmented
14.	C-2726	Barisal, Bangladesh	Full green
15.	C-2738	Barisal, Bangladesh	Full green
16.	C-2596	Barisal, Bangladesh	Stem green, petiole pigmented, pigmented band between petiole and lamina.
17.	C-2597	Barisal, Bangladesh	Stem pigmented, long and pigmented petiole, red band between petiole and lamina.

SL. NO.	Genotypes	Sources of collection	Characteristics
18.	C-2197	Nawgoan, Bangladesh	Stem green, deep pigmented petiole, and long lamina.
19.	C-2589	Barisal, Bangladesh	Full green
20.	C-2594	Barisal, Bangladesh	Full green
21.	C-2598	Barisal, Bangladesh	Stem green, petiole light pigmented.
22.	C-2611	Borguna, Bangladesh	Full green
23.	C-2610	Borguna, Bangladesh	Stem and petiole pigmented.
24.	C-3070	Patuakhali, Bangladesh	Stem green, petiole upper side dull coppery red.
25.	C-3060	Patuakhali, Bangladesh	Stem green, petiole light pigmented.
26.	D-154	Bangladesh (variety)	Stem green, long petiole and light pigmented at mature stage.
27.	BJC -7370	Bangladesh (variety)	Full green
28.	C-83	Bangladesh (variety)	Full green
29.	C-45	Bangladesh (variety)	Stem green, petiole upper side dull coppery red.
30.	C-12033	Breeding Divi. (BJRI)	Stem green, petiole light pigmented.
31.	C-2234	Dinajpur, Bangladesh	Full green
32.	C-2242	Kurigram, Bangladesh	Full green
33.	C-2142	Bangladesh (variety)	Full green
34.	C-2186	Joypurhat, Bangladesh	Full green
35.	C-2295	Bogura, Bangladesh	Stem green, petiole light pigmented.
36.	C-2281	Nawgoan, Bangladesh	Stem green, petiole light pigmented.
37.	C-12221	Breeding Divi. (BJRI)	Full green
38.	C-2593	Barisal, Bangladesh	Stem green, petiole pigmented.
39.	C-2749	Patuakhali, Bangladesh	Stem green, petiole light pigmented and small size lamina.
40.	C-2730	Barisal, Bangladesh	Stem green, petiole pigmented.
41.	C-3468	Tangail, Bangladesh	Full green
42.	C-3464	Tangail, Bangladesh	Stem green, petiole light pigmented.
43.	C-3476	Munshiganj, Bangladesh	Full green
44.	C-3467	Tangail, Bangladesh	Stem green, petiole pigmented.
45.	C-3466	Tangail, Bangladesh	Full green
46.	C-3473	Gazipur, Bangladesh	Full green
47.	C-3472	Gazipur, Bangladesh	Full green
48.	C-3468	Dhaka, Bangladesh	Full green
49.	C-3465	Tangail, Bangladesh	Stem green, petiole pigmented.
50.	C-2591	Barisal, Bangladesh	Full green

RESULT

Analysis of variance for yield and its different yield contributing characters viz., population density at harvesting time (120 DAS), mortality rate, plant height, base diameter, node number/plant, inter-nodal length/plant, fresh stem weight with leaves/plant, fresh stem weight without leaves/plant, dry stick weight/plant and dry fibre weight/plant showed highly significant variation among the genotypes (Table 2).

Table 2: Analysis of variance (mean squares) for ten morph-physiological characters in 50 jute genotypes.

Characters	Source of variations		
	Replication	**Genotypes**	**Error**
	d f=2	**d f =49**	**d f = 98**
Plant population at harvesting time	23.847	121.847**	6.520
Mortality (%)	54.320	289.703**	15.422
Plant height (m)	0.040	0.186**	0.019
Base diameter (mm)	2.345	4.731**	0.694
Node number/plant	9.947	173.337**	7.770
Inter nodal length/plant (cm)	0.219	4.838**	0.042
Fresh stem wt. with leaves/plant(g)	1392.167	3175.497**	242.507
Fresh stem wt. without leaves/plant(g)	871.167	2858.711**	225.588
Dry stick wt./plant (g)	14.056	62.062**	4.362
Dry fibre wt./plant (g)	3.357	7.800**	0.492

Hierarchical cluster analysis of 50 jute genotypes carried out taking ten morpho-physiological characters. Genotypes were grouped into 5 clusters (Table 3), the largest cluster II with 17 genotypes and followed by cluster IV (12) and cluster III (09). Cluster I and cluster V were smallest, included 06 genotypes.

Table 3: Distribution of 50 jute genotypes in five clusters

Cluster	No. of genotypes	Sl. no. of genotypes	Name of genotypes
I	06	1, 16, 26, 27, 28, and 49.	CVL-1, C-2596, D-154, C-7370, C-83 and C-3465
II	17	2, 3, 10, 12, 15, 19, 24, 25, 29, 30, 31, 37, 38, 41, 44, 45 and 46	C-2737, C2753, C-2761, C-2760, C-2738, C-2589, C-3070, C-3069, C-45,C-12033, C-2234, C-12221, C-2593, C-3468, C3467, C-3466 and C-3473,
III	09	4, 5, 6, 7, 14, 21, 22, 32 and 36.	C-2759, C-2734, C-2750, C-2752, C-2726, C-2598, C-2611, C-2242 and C-2281.
IV	12	8, 9, 13, 17, 18, 20, 23, 33, 39, 42, 47 and 48.	C-2763, C-2757, C-2762, C-2597, C-2197, C-2594, C-2610, C-2142, C-2749, C-3464, C-3472 and C-3478.
V	06	11, 34, 35, 40, 43 and 50.	C-2765, C-2186, C-2295, C-2730, C-3476 and C-2591.

Canonical Variate Analysis:

The averages of intra and inter cluster distance were shown in table 4. It was observed that inter group distances were always higher than those of intra group distances. The intra cluster ranged from 3.11 to 6.62. Highest intra cluster distance was estimated for cluster I (6.62) which consisted of 06 genotypes and this was followed by cluster IV (4.56), cluster III (4.53) and cluster II (4.15). The lowest intra cluster distance was observed in cluster V (3.11). From the table 4, it is evident that inter cluster distances ranged from 4.58 to 12.78. The highest inter cluster distance was measured in between cluster I and cluster V (12.78). This indicated maximum genetic diversity between those two clusters. The minimum inter cluster distance was observed in between cluster III and cluster IV (4.58). Suggesting that the genotypes included in these clusters had relatively closer ancestry. The second highest inter cluster distance was observed in between cluster I and cluster III (12.20) followed by cluster II and cluster V (10.91), cluster II and cluster III (10.57), cluster I and cluster IV (9.66).

Table 4: Average intra (bold) and inter cluster distance (D2) for the 50 genotypes of jute.

Cluster	I	II	III	IV	V
I	**(6.62)**	7.37	12.20	9.66	12.78
II		**(4.15)**	10.57	9.53	10.91
III			**(4.53)**	4.58	4.82
IV				**(4.56)**	5.49
V					**(3.11)**

Characterization of individual characters:

The cluster mean values of 10 characters are presented in table 5. Difference in cluster means excited for almost all the characters.

Table 5: Cluster means value for yield and yield contributing characters in jute genotypes.

Characters	Cluster				
	I	II	III	IV	V
Plant Population density	47.67	51.0	41.78	41.58	43.33
Mortality rate	26.17	21.5	35.67	36.08	33.5
Plant height	2.85	2.69	2.29	2.47	2.17
Base diameter	18.0	16.8	15.0	16.0	14.7
Node number/plant	70.0	70.0	61.0	63.0	54.0
Internodal length/plant	10.3	9.7	9.9	9.1	9.2
Fresh stem wt. with leaves/plant	235.56	200.10	148.89	169.16	133.89
Fresh stem wt. without leaves/plant	210.00	176.55	111.85	148.33	113.89
Dry stick wt./plant	33.7	29.7	23.5	25.8	20.7
Dry fibre wt/plant.	12.1	10.0	07.9	08.7	07.5

Contributing of the characters towards divergence of the genotypes:

The result of PCA (table 6) revealed that in vector I (Z1) the important characters responsible for genetic divergence in the major axis of differentiation were dry fibre weight/plant (0.944), dry stick weight/plant (0.931), fresh stem weight with leaves/plant (0.961), fresh stem weight without leaves/plant (0.960), plant height (0.934), base diameter (0.916) and plant population density (0.650) and in vector II, mortality rate (0.702) played significant role.

Table 6: Latent vectors (Egen values) of fibre yield and yield contributing characters in 1st and 2nd principal components for contributing of different characters toward genetic diversity.

Characters	Vector-I	Vector-II
Plant population density	0.650	-0.712
Mortality rate (%)	-0.663	0.702
Plant height (m)	**0.934**	0.184
Base diameter (m m)	0.916	0.225
Node number/plant	0.711	-0.283
Intermodal length/plant (cm)	0.168	0.376
Fresh stem weight with leaves/plant (g)	0.961	0.163
Fresh stem weight without leaves/plant (g)	0.960	0.177
Dry stick weight/plant (g)	0.931	0.187
Dry fibre weight/plant (g)	0.944	0.199

DISCUSSION

The clustering pattern of the genotypes indicated that developing from the same location or common eco-geographic origin did not form a single cluster. The genotypes belonging to different locations were included in the same cluster. This result indicated that there was no relationship between genotypic distribution and genetic divergence. This might be due to continuous exchange of genetic materials through introduction. Varieties developed at the same place have different genetic makeup.

Here interestingly, the genotypes with high dry fibre weight per plant but low plant population and high mortality rate clustered together. On the other hand, genotypes with low dry fibre weight per plant but high plant population and low mortality rate were remained together

Fifty genotypes of *Corchorus Capsularis* L. were grouped into five clusters with low intra but higher inter cluster distance, which indicated the presence of possible genetic divergence in the population. The clustering pattern revealed that the nature of selection force operating under one eco-geographical region was similar to that of other regions, since genotypes from distinct centers were grouped together. Genotypes from one eco-geographical region and also belonging to different pigmentation grade were grouped into different clusters. It indicated the presence of substantial variability within them. It was evident that there was no parallelism between genetic diversity and geographical distribution of genotype. Information on genetic divergence among the parental materials is vital to plant breeder for an efficient choice of parent for hybridization. It is an established fact that genetically diverse parents are likely to contribute to desirable segregates and or to produce high heterotic crosses. More diverse the parents the greater are the chances of obtaining high heterotic F1s and broad spectrum of variability in segregating generation (Murty and Arunachalam, 1966). Devi et al., (2004) reported that the pattern of clustering had no general association between ecological distribution of genotypes and its genetic divergence. This might be due to differential adaptation, selection criteria, selection pressure and environment. The grouping of materials of same origin into different clusters was an indication of broad genetic base of the genotypes belonging to the origin or vice-versa.

Endang et al., (1971) stated that the clustering patterns could be utilized in choosing parents for cross combinations which likely to generate the highest possible variability for effective selection of various economic traits. Chaudhary et al., (1975) suggested that selection for one type from each cluster and testing them by a series of diallel analysis may prove to be highly fruitful. The result of this study was in conformity with the above suggestions and also the findings of Islam, (1996) and Chawla and Shingh, (1984).

From the Canonical Variate Analysis, it can be said that maximum amount of heterosis will be obtained in hybrids involving genotypes belonging to the more divergent cluster. However, in practice, plant breeder's objective in general is to achieve high level of production by improving the yield contributing traits so that it could be adjusted in various types of purposes rather than getting only high heterosis.

From the cluster mean values it was found that the cluster I had the highest mean value for plant height, base diameter, node number/plant, internodal length/plant, fresh stem weight with leaves/plant, fresh stem weight without leaves/plant, dry stick weight/plant and dry fibre weight/plant associated with medium mean value for the characters of plant population density and mortality rate, these indicates the presence of high yielding genotypes in the cluster I. On the other hand cluster II had the lowest mean value for the character mortality rate; it indicates the presence of salinity stress tolerant genotypes in the cluster II. Though the genetic distances between cluster-I and cluster II was not highest but they have shown high diversity, which would probably bring about desirable results in salt stress tolerant variety development programme.

The result of PCA revealed that in vector I (Z1) the important characters responsible for genetic divergence in the major axis of differentiation and in vector II, mortality rate (0.702) played significant role.

CONCLUSION

From the above result, it can be concluded that, the geographic divergence of the jute genotypes was not strict parallel with the genetic divergence. Dry fibre weight/plant, dry stick weight/plant, and fresh stem weight with and without leaves/plant, plant height, base diameter and plant population density were major characters that contribute to genetic divergence.

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Review / Overview Paper

SALINITY MANAGEMENT IN LATE JUTE SEED PRODUCTION OF BJRI TOSSA PAT 5

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ABSTRACT

Salinity management in late jute seed production is crucial for ensuring a healthy crop and maximizing seed yield. The research study was aimed to generate information together salinity management using mulch materials and maximize jute seed production of BJRI Tossa pat 5. The experiment was laid out in RCBD with 5 treatments having three replications at experimental stations of kalapara, Patuakhali. The results indicated significant effect on yield and yield contributing characters over control with different treatments. The highest plant height (83 cm), maximum number of branches per plant (2.9), number of pods per plant (24.00) and number of seeds per pod (196.67) and seed yield (0.78 tha-1) found highest with the same treatment (T5). Therefore, white polythene using as a mulch materials gave best output for salinity management and high yield potential for BJRI Tossa pat 5 for seed production in Bangladesh.

Key words: Salinity management, maximize yield, Jute seed and BJRI Tossa pat 5

INTRODUCTION

Jute is known as the "golden fiber of Bangladesh," and it was one of the country's most important exports following independence. Bangladesh is the world's second-largest producer of jute. In the fiscal year 2022–2023, farmers produced 84 lakh bales of jute, an increase of 0.3% year over year (BBS,2022). One of the most serious issues for jute production in Bangladesh is the scarcity of quality seed at the optimal period of sowing. Only about 15% - 20% of quality jute seeds are given by institutional sources such as the Bangladesh Agricultural Development Corporation (BADC), with the remainder generated and maintained by farmers. In 2022-23, Bangladesh imports approximately 5,200 tons of jute seeds from India. (NSB, 2023). Chowdhuri and Ali (1963) hypothesized that controlling vegetative development through late seeding was one strategy for enhancing jute seed output. They also suggested that jute crops should be planted in June or later to keep plants stunted, induce early flowering, and create a better seed production. Evidence also suggested that jute seeds could be sowed even in December to produce seeds for the next agricultural season (Chang, 1960).

Bangladesh's coastline region is under constant threat of soil and water salinization. (MoA and FAO, 2013). Salinity refers to the accumulation of soluble salts in the soil, which can be detrimental to plant growth and agricultural productivity. Mulching is the technique of covering the soil surface around plants to produce favorable circumstances for crop growth. This may include moisture and soil conservation, temperature moderation, salinity and weed control etc. Soil moisture is an important factor that influences seed yield. Upper soil areas must be kept moist to stimulate root growth and provide adequate water for the plant.

Mulching with Synthetic (polyethylene film) or natural (edit buildup) materials has been widely practiced for generation of commercial broadly dispersed crops and vegetables counting tomato, lettuce and others (Albert et al., 2010). Mulching has a major impact on soil moisture conservation because of its capacity. (Vavrina and Roka, 2000).

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Organic mulches, such as straw or compost, can enhance microbial activity in the soil. Certain microbes are capable of breaking down organic matter and releasing organic acids that can aid in leaching away accumulated salts from the root zone. (Forge et al., 2003; Yang et al.,2003) Black and white polythene mulch or organic mulch are a reasonable expense and conserve soil moisture (Mukherjee et al., 2004). Polyethylene mulch has been shown to be an effective method to stimulate crop germination by regulating soil microclimate in winter by increasing soil temperature. (Bu et al., 2013; Dong et al., 2009; He et al., 2010). Polythene mulch also increases soil temperature and moisture especially in early spring. These synthetic mulches suppress weeds and certain insect pests while also stimulating higher crop yields by more efficient soil nutrient utilization (Kashi et al., 2004).

Soil Mulching is an effective solution for salinity control, evaporation control, crop growth speed-up, erosion control and weed control (Zhang et al., 2008). Soil amelioration and mulching is an alternative to alleviate negative effect of salinity. This study was taken to generate information together salinity management using mulch materials and maximize jute seed production of BJRI Tossa pat 5.

MATERIALS AND METHODS

The southern belt of Bangladesh is affected by salinity. e.g. Satkhira, Khulna, and Patuakhali Districts. The experiment was carried out at experimental stations of Kalapara, Patuakhali District (21°56'59.8"N 90°10'37.3"E) of Bangladesh Jute Research Institutes during 2021-2022. The experiment was laid out in RCBD with 5 treatments having three replications. BJRI Tossa pat 5 was used as a planting material because it shows relatively more salt tolerance, lower mortality or higher survivability rate, and good fiber yield under salinity stress (Mukul, 2022) The following treatments combinations were used in the experiments:

Treatments:
T1= No Mulch
T2= Rice Straw
T3= Water Hyacinth
T4= Black Polythene
T5= White Polythene

The experimental plot size was 3.0 m × 3.0m. Space between plots, blocks and around the field is 1.0 m. There will be 20 cm deep drain around each plot, block and the whole plot to drain out excess rain water. It should be maintained up to harvest the crop. Recommended dose of fertilizer e.g. nitrogen (N), phosphorus (P), potassium (K), sulphur (S), zinc (Zn) and boron (B) was used at the rate of 100-10-30-20-3-3 kg/ha. (BJKB, 2007) Total amount of PKSZn and B from TSP, MoP, Gypsum, Zinc Sulphate and Boric acid respectively and 5 ton/ha cow dung were applied in the field at the final land preparation. Total amount of N from urea as per treatment was applied in three equal splits-one at sowing- one at 30-35 and rest at 50-55 days after sowing. Weeding, Thinning, Gap filling, Irrigation, insect pest and disease control were completed on time. Each plot was measured in terms of plant population, plant height, number of branches per plant, number of pods per plant, seeds per pod, thousands seed weight, percentage of germination and total seed production. Initial soil sample was collected, processed and analyzed for P, K and S (Hunter, 1984). Nitrogen was determined by kjeldahl method and described by Jackson 1973. Soil pH was determined in 1:2.5 (soil: water) suspend by pH meter, EC 11.87 dsm-1. All acquired data were statistically analyzed using the ANOVA approach, and the means were determined using the DMRT (Gomez and Gomez 1984)

RESULTS AND DISCUSSIONS

Plant population

In saline areas, maintaining proper soil moisture levels is essential for plant growth. White polythene mulch helps conserve soil moisture by reducing evaporation and preventing salt accumulation at the soil surface. This can create a more suitable environment for plant roots and improve overall plant health. In treatment T5 (white polythene) plant population was 59.33 per meter square and 52.33 per meter square in control conditions (Table 2).

Plant height

The plant growth and yield were affected by the different treatments over the control. The highest plant height (83 cm) was observed by treatment T5 (white polythene) and the lowest height was (66 cm) by the treatment of T1 whereas no mulch material was used. The results indicated that plant height was increased 25.8% by using white polythene from control conditions. (Table 2) By using rice straw (T2), water hyacinth (T3) and black polythene (T4) as a mulch material we got 75 cm, 77 cm and 73 cm of plant height that was 13.6%, 16.6% and 10.6% also increased from control treatment. White polythene mulch is used to increase soil temperature and reflect sunlight. White polythene mulch helps to increased plant height. (Sikdar et al. 2016).

Number of Branches/Plant

There was no significant effect of salinity on number of branches per plant. In control condition the number of branch per plant was 2.67 and that of 2.90 in T5 treatment, respectively. So, organic or synthetic (Polythene) mulch material had no significant effect on number of branches per plant. (Table 2)

Pods per plant

Effects of both organic and synthetic mulch materials had a substantial impact on the number of pod per plant in saline soil. The maximum number of pods (24.00) per plant was recorded by T5 (White polythene) treatment whereas the minimum number of pods (13.13) per plant observed by the T1 treatment. As a result, utilizing white polythene as a mulch material increased the number of pods per plant by 82.8% above the control condition. (Table 2). Synthetic mulch materials performed better but there were no appreciable changes in grain yield between the white and black plastic mulches. (Sedaghati et al., 2016)

Seeds per pod

The association between the quantity of seeds per pod and its positive and significant value suggests that employing white polythene mulch applied treatment produced more seeds per pod (196.67) than other treatments or the control (158.33). (Fig 1) The combined application of plastic mulch and organic mulch resulted in the maximum seed and biomass output for sunflower production. (Zhao, Li, Wang, Pang, & Yan, 2016).

Thousands seed weight (g)

When synthetic mulch was utilized instead of no mulch, thousands seed weight were much higher. In treatment T5 (white polythene) highest thousands seed weight (1.90 g) was obtained and lowest weight (1.78 g) was in control conditions. (Fig. 2)

Yield (t/ha)

The use of different mulch materials for seed production of BJRI Tossa pat 5 had a substantial effect on seed yield. In T5 (white polythene) treatment produced the highest seed yield of 0.78 t/ha, while the T1 treatment produced the lowest seed yield of 0.62 tha-1. In treatment T2 seed yield was 0.64 tha-1 that was statistically identical to treatment T3 (0.67) and T4 (0.66 tha-1). (Fig 3). The use of white polythene as a mulch material enhanced seed output by 25.8% above the control condition. Xu et al. (2015) found that plastic film mulching increased maize yield by 15-26% than control.

Percentage of germination

White polythene mulch reflects sunlight and helps to maintain a more stable and cooler soil temperature. This can be specially helpful for germinating seed that prefer cooler soil conditions. By reducing temperature fluctuations, it creates a more favorable environment for germination. The Percentage of germination was 92.33% in T5 treatment and 89% in control condition.

Table 1: Initial Soils fertility status of the experimental plot at Kalapara, Patuakhali

p^H	EC (ds/m)	OM (%)	Total N (%)	Phosphorus (µg/g)	Potassium (meq/100g)	Sulpher (µg/g soil)
5.3	11.87	1.71	0.076	4.3	0.31	11.8

Table 2: Yield and yield contributing characters of BJRI Tossa pat 5 at Kalapara, Patuakhali.

Treatment	Plant Population/m^2	Plant height (cm)	No. of Branch per plant	No. of pod per plant
T_1 (No mulch)	52.33	66 c	2.67	13.13c
T_2 (Rice Straw)	53.67	75 b	2.56	14.97 bc
T_3 (Water Hyacinth)	50.00	77ab	2.86	16.77 b
T_4 (Black Polythene)	53.67	73b	2.26	15.30 bc
T_5 (White Polythene)	59.33	83a	2.90	24.00 a
CV(%)	10.83	5.08	17.83	7.93
$LSD_{(0.05)}$	NS	0.72	NS	2.5

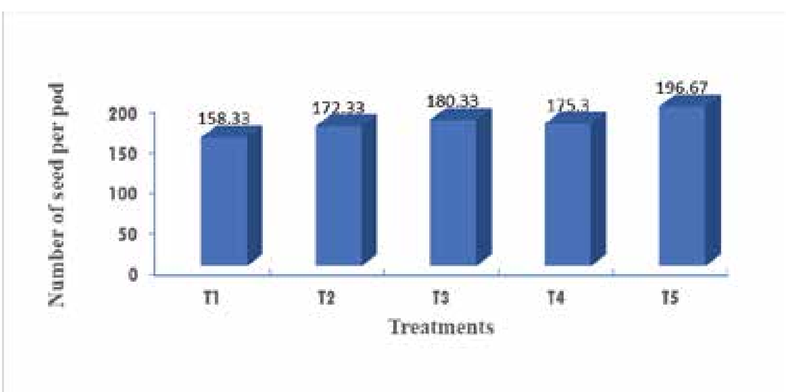

Figure 1. Number of seed per pod of BJRI Tossa pat 5 with different treatments. (T1: No mulch, T2: Rice Straw, T3: Water Hyacinth,T4:Black Polythene,T5:White Polythene)

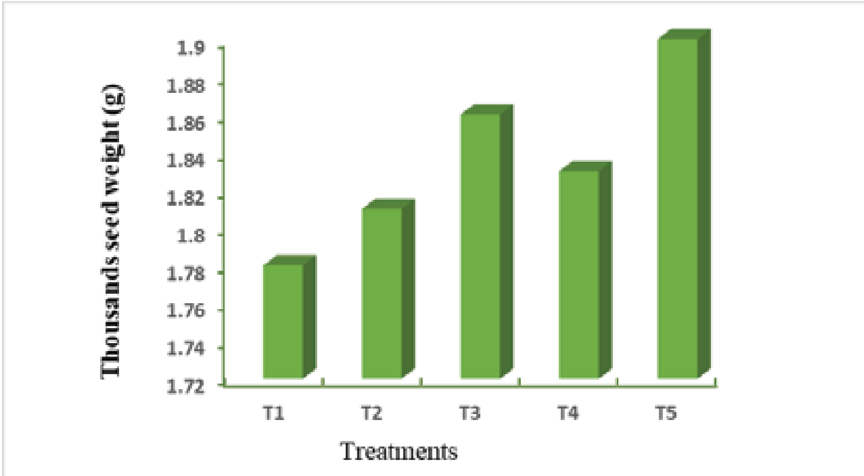

Figure 2. Thousands seed weight of BJRI Tossa pat 5 with different treatments. (T1: No mulch, T2: Rice Straw, T3: Water Hyacinth,T4:Black Polythene,T5:White Polythene)

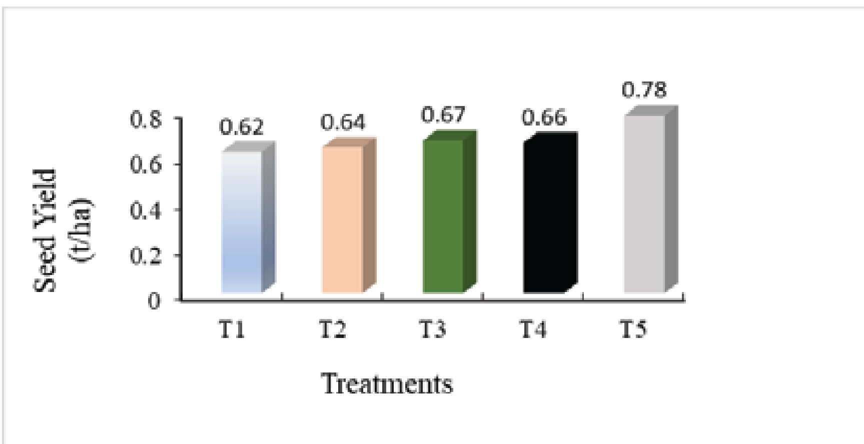

Figure 3. Seed yield of BJRI Tossa pat 5 with different treatments. (T1: No mulch, T2: Rice Straw, T3: Water Hyacinth,T4:Black Polythene,T5:White Polythene)

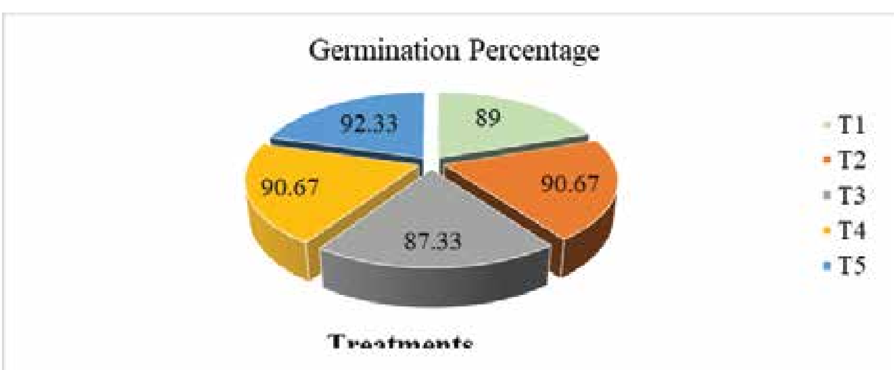

Figure 4. Germination percentage of BJRI Tossa pat 5 with different treatments. (T1: No mulch, T2: Rice Straw, T3: Water Hyacinth,T4:Black Polythene,T5:White Polythene)

CONCLUSION

Yield and yield contributing characteristics e.g. number of pod per plant, number of seed per pod, thousands seed weight and percentage of germination were found higher in T5 (white polythene) treatments over the control. In saline soils, white polythene helps in reducing the accumulation of salts at the soil surface due to reduce evaporation.To mitigate salinity and produce maximum seed production using synthetic mulch material white polythene is the best mulch material for BJRI Tossa pat 5 in saline soil.

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Review / Overview Paper

EFFECT OF SOWING DATE ON FIBRE YIELD AND YIELD ATTRIBUTES OF HIGHLY SALT TOLERANT CORCHORUS CAPSULARIS VARIETY BJRI DESHI PAT 10

Jannatul Ferdous[1], M. T. Sultan[1], M. A. Alim[2], Abida Sultana[3], I. J. Noor[1], Nazia Shirin[4] & Israt Jahan[5]

ABSTRACT

The experiment was carried out at Jute Research Sub-station, Kalapara, Patuakhali at 2020 during the jute growing season to determine optimum sowing time of salt tolerant BJRI Deshi Pat 10. The experiment was laid out in RCBD design with three replications and variety BJRI Deshi Pat 8 was used as control. Crops seeds were sown on four different dates like 20 March, 30 March, 10 April and 20 April were regarded as treatments. Plants were harvested at 120 days after sowing. All crops were attained recommended cultural practices. Results revealed that salt tolerant BJRI DeshiPat10gave significantly highest fibre yield and stick yield (3.15 tha-1and 6.65 tha-1respectively) sown on 20 March to 10 April.

INTRODUCTION

The agricultural climate of Bangladesh is very much suitable for quality fibre production. Jute is a versatile and environmentally friendly biodegradable natural fibre which is grown widely grown in Asia, particularly in Bangladesh, India, and China [16]. Soil salinity is a major factor limiting plant productivity, affecting about 95 millions hectare world wide. In Bangladesh saline soils occur mainly along the coastal areas of the southern part of the country. The total saline area of the country is about 0.88 millions hectare of which more than 0.36 million hectares is in Khulna, 0.22 million hectares in Patuakhali, 0.11 million hectares in Chittagong region and 0.17 million hectares in Barishal and Noakhali region [8]. Salinity incidence in these regions varies in different month of the year. Maximum salinity occurs in the month of the March –April and minimum in the months of July-August after the onset of monsoon rain. Agricultural productivity is severely affected by soil salinity and the damaging effect of salt accumulation in agricultural soils has become an important environmental concern all over the world [8]. Salinity severely affects different physiological processes in plant like water relation traits, chlorophyll content; accumulation of organic solutes and other activities includes photosynthesis which may reduce yield [7]. Excess Na and Cl accumulation in plant body causes ionic imbalances that may damage the selectivity of root membranes and induce potassium deficiency [8].

Bangladesh the second largest producer of jute; produces the best quality jute in the worlds and leads the export market [16]. Jute is a common term used both for plant and the fibre obtained from the bark of the plants, Corchorus capsularis L. and Corchorus olitorius L [5]. Bangladesh is not only the largest producer of jute but also produces the best quality jute fibre and leads the export market. The crop is a versatile and environmental friendly biodegradable natural fibre widely grown in Asia, particularly in Bangladesh, India, and China [14]. The jute crop also greatly improves the soil fertility status by incorporating organic matter to the soil through decomposition of shaded leaves and plant residues and helps in breaking plough-pans through its long taproots [6]. In 1970-80 decades about 15-16 lakh hectare

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of the total cultivable land was occupied by jute whereas in (2021-22) it has now reduced to about 7.00 to 8.00 lakh hectare which produced bout 84-85 lakh bale of fibre. However, national average yield is increased from 11.324 to 11.593 bale per hectare [3]. It is happened due to use of high yielding jute varieties and improved production technologies, which together contributed toward higher yield. One highly salt tolerant variety BJRI Deshi Pat-10 was developed that can be grown in saline area of Bangladesh. Recently, jute variety which have the slightly salt tolerance capacity can be grown in saline soils. Considering its tolerance especially to the chlorine salinity, jute has been recently suggested as a promising candidate for planting in wet lands and saline soils [7]. There are so many attributes responsible for yield of jute fibre i.e sowing time, plant population, plant height, base diameter etc. In traditional jute cultivation at farm level, farmers are usually sow seeds in different times, but optimum sowing time plays very important role for higher yield and quality fibre. At present due to population density and increasing land salinization problem, breeding for salinity tolerance in many crops needs to be paid more attention. So, cultivation of jute is regularly being pressed to the marginal land with higher grade of soil salinity year-round. However, in many cases they do not follow appropriate date of sowing for jute cultivation. As a result, they do not get satisfactory yield. About 12% of yield increment obtained when timely planting and proper weeding is being practiced [6]. The appropriate time of sowing is an important agronomic practice which deals with increment of yield. Therefore, one highly salt tolerant will be tested in relation to ascertain optimum time of sowing for higher fibre yield under saline condition.

MATERIALS AND METHODS

The experiment was conducted at Jute Research Sub-Station, Kalapara, Patuakhali during the jute growing season at 2020. The experiment was laid out in Randomized Complete Block Design with three replications. Unit plot size was 4.0m × 2.5 m. Space between plot to plot and the field was 1.0m. Salt tolerant C. Capsularis variety BJRI Deshi Pat 10 was tested with BJRI Deshi Pat 8 were treatment factor-A. Crops were sown on assign dates i.e. 20 March, 30 March, 10 April and 20 April regarded as treatment factor- B. Seeds were sown in line of 30 cm apart. Crops were harvested at 120 days after sowing. All the intercultural operation like weeding, thinning, irrigation, insect pest and disease management were done in time and fertilizer were attended as per BJRI recommendation. Plant population, plant height, base diameter, fibre yield and stick yield were recorded from 10 plant of each plot. All the collected data were analyzed statistically with the help of computer statistical package (Statistix 10). The mean differences among the treatments mean were adjudged as per Least Significant Difference (LSD) and T-test at 0.05 level [10].

RESULTS AND DISCUSSION

Effect of variety:

Variety was not affecting significantly on yield and yield contributing parameters like plant population, plant height, base diameter, fibre yield and stick yield, (Table.1). BJRI Deshi Pat10 gave numerically higher fibre yield (2.66 tha-1) and stick yield (5.71tha-1) compare to BJRI Deshi Pat 8 used as control. Other authors [11,13] were observed the similar findings regarding different varietal effect of jute

Table 1: Effect of variety irrespective of date of sowing on fibre yield and yield components of deshi jute under saline condition

Treatment	PP(m^{-2})	PH(m)	BD(mm)	FY(tha^{-1})	SY(tha^{-1})
BJRI Deshi Pat 10	31.93a	2.38a	19.24a	2.62a	5.48a
BJRI Deshi pat 8	32.68a	2.42a	19.43a	2.66a	5.71a
LSD (0.05)	NS	NS	NS	NS	NS
CV (%)	11.99	10.00	9.18	14.56	17.45

Legend: PP=Plant Population, PH=Plant height, BD=Base diameter, FY=Fibre yield, SY=Stick yield, NS =Non-significant

Effect of date of sowing:

Sowing at different dates significantly affected on yield and yield contributing characters like base diameter, fibre yield and stick yield whereas others parameters like plant population were was not affected significantly (Fig. 1). Crop sown on 30 March gave the highest plant population (33.5). The Crop sown on 20 April recorded the lowest plant population (30.43). Similar observations were reported by several authors [11, 12,13].

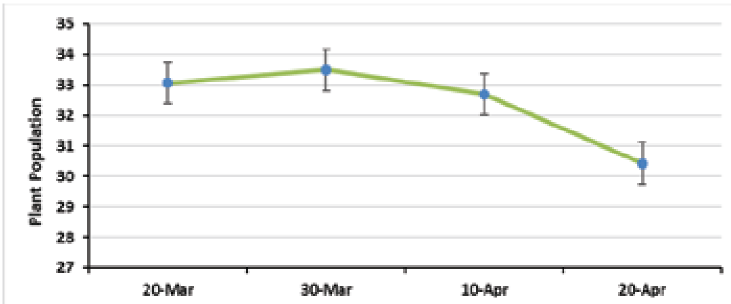


Fig. 1: Effect of date of sowing irrespective of variety on plant population of deshi jute

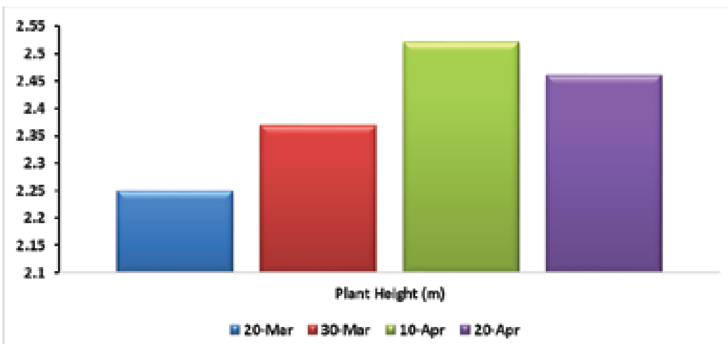


Fig. 2: Effect of date of sowing irrespective of variety on plant height of deshi jute

Plant height was not affected significantly due to sowing date (Fig. 2). Crop sown on 10 April gave the highest plant height (2.52 m) whereas sowing on 20 March recorded the lowest plant height (2.25 m). Several authors [9,11] reported the same findings.

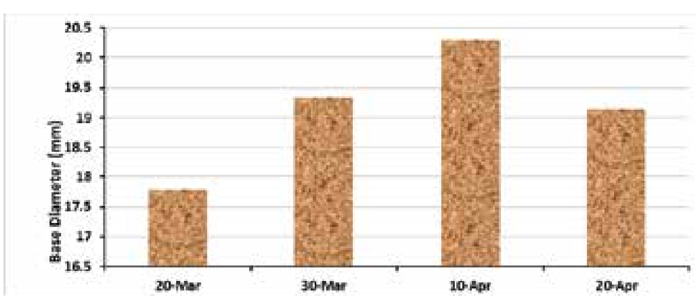
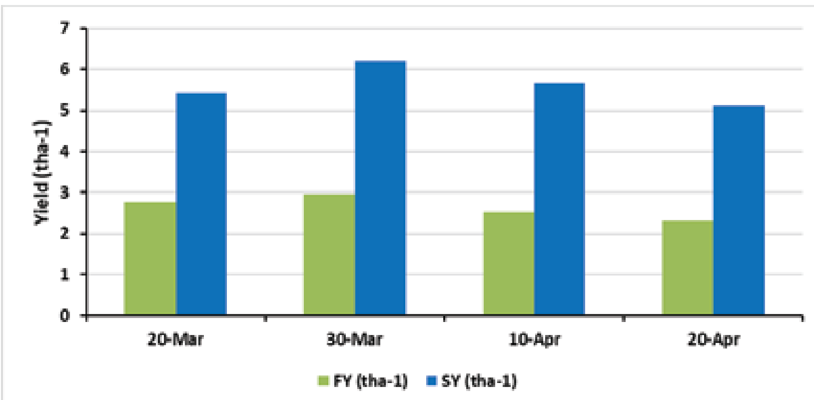


Fig. 3: Effect of sowing date irrespective of variety on base diameter of deshi jute

Plant base diameter was significantly affected by sowing at different dates (Fig. 3). Crop sowing on 10 April gave the highest base diameter (20.30 mm) whereas sown on 20 March recorded the lowest base diameter (17.78 mm). Other scientist [11,9] also found the similar observations.

Sowing at different date also significantly affected on fibre yield where stick yield was not affected significantly (Fig. 4). Crop sown on 30 March gave the highest fibre and stick yield (2.96 tha-1 and 6.2 0tha-1 respectively). The Crop sown on 20 April recorded the lowest fibre and stick yield (2.30 tha-1 and 5.11 tha-1 respectively). Similar findings were strongly supported by different researcher [2,4,11 and 13]

Interaction effect:
It was observed that yield and yield contributing characters like base diameter was affected significantly but plant population and plant height were not affected significantly due to interaction of variety and sowing date



(Table. 2). Numerically the highest plant population (34.97) was recorded from V1 × S2 treatment (BJRI Deshi Pat-10 with 20 April sowing).The BJRI Deshi Pat 10 gave the highest plant height (2.58 m) when it was sown on 10 April. Significantly highest base diameter (21.06 mm) was recorded from BJRI Deshi Pat-10 with 20 March date of sowing. Similar observations were reported by other scientists [1,4,9,15].

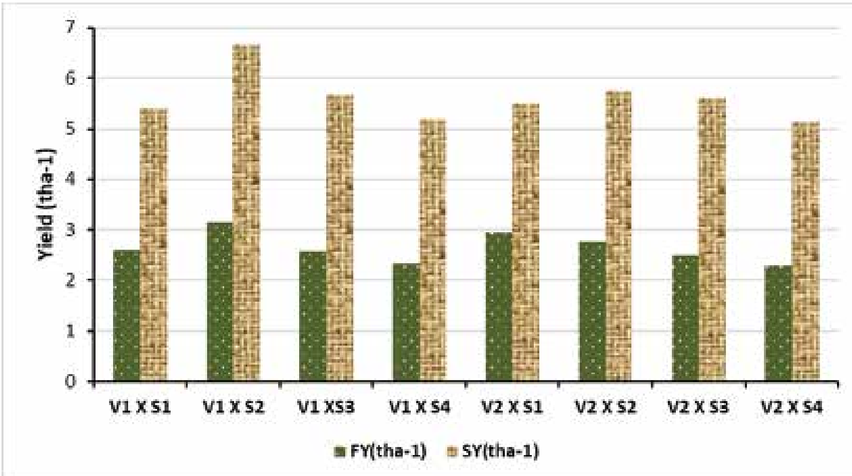
Table 2: Interaction effect of variety and date of sowing on yield components of deshi jute

Treatment	PP(m^{-2})	PH(m)	BD(mm)
V1 × S1	32.90 a	2.19 a	18.33 bc
V1 × S2	34.97 a	2.47 a	20.00 ab
V1 × S3	32.10 a	2.56 a	21.06 a
V1 × S4	30.77 a	2.58 a	18.32 bc
V2 × S1	32.23 a	2.32 a	17.33 c
V2 × S2	31.07 a	2.29 a	20.33 ab
V2 × S3	28.77 a	2.48 a	20.6 ab
V2 × S4	28.64 a	2.46 a	18.8 abc
LSD (0.05)	NS	NS	2.33
CV (%)	12.07	10.20	6.97

Legend: V1=BJRI Deshi Pat-10, V2=BJRI Deshi Pat-8, S1=20 March, S2=30 March, S3=10 April, S4=20 April; PP=Plant Population, PH=Plant height, BD=Base diameter and NS =Non-significant.

Result also showed that fibre yield was affected significantly where as stick yield was insignificantly due to interaction of variety and sowing date. The BJRI Deshi Pat 10 gave the highest fibre and stick yield (3.15 tha-1 and 6.65 tha-1 respectively) when it was sown at 30 March (Fig. 5). The lowest fibre yield and stick yield (2.32 tha-1 and 5.18 tha-1 respectively) were recorded from V2 × S4 treatment combination i.e. BJRI Deshi Pat 10 sown on 20 April followed by BJRI Deshi Pat 8. Similar findings were strongly supported by different researchers [4,9,11,13].

Fig. 4: Effect of date of sowing irrespective of variety on fibre yield and stick yield of deshi jute



Legend: V1=BJRI Deshi Pat-10, V2=BJRI Deshi Pat-8, S1=20 March, S2=30 March, S3=10 April, S4=20 April; FY=Fibre yield, SY=Stick yield

Fig. 5: Interaction effect of variety and date of sowing on fibre yield and stick yield of deshi jute

CONCLUSION

Yield and yield contributing characters like plant population and plant height, base diameter, fibre yield and stick yield were affected significantly due to sowing at different time. From the study, it can be concluded that salt tolerant variety BJRI Deshi Pat-10 gave highest yield when sown on 30 March to 10 April.

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Review / Overview Paper

FUNCTIONAL SIGNIFICANCE OF WETTING IN BIOMOLECULAR

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ABSTRACT

Wetting refers to the ability of a liquid to spread over a solid surface while maintaining contact with it. This process involves the liquid and gas moving across the surface of particles, resulting in the disappearance of the solid-vapor interface and the formation of a solid-liquid interface. These properties have found widespread application in the field of biomolecular condensates. Biomolecular condensates are membrane less organelles formed through the liquid-liquid phase separation of biological macromolecules within cells, serving diverse purposes. Recently, the wetting phenomenon in biomolecular condensates has emerged as a significant regulator of various cellular events. This review aims to comprehensively understand the physical, chemical, and biological principles, properties, and functional significance of wetting in biomolecular condensates. Specifically, it explores wetting in biomolecular condensates such as Lewy bodies, stress granules, P-bodies, nucleoli, Cajal bodies, and colloid nodules of the thyroid gland, as well as serum albumin and globulins. Additionally, the role of wetting in cytoskeletal condensate filaments, bimolecular cytoplasmic condensates, plasma membrane-associated condensate bindings, and determining end-points in wet granulation properties for biomolecule concentration will be described.

Key words: Wetting, liquid-liquid phase separation, bimolecular condensates, membrane less organelles, colloidal emulsions

INTRODUCTION

Wetting phenomena are observed globally in various ways, representing the ability of a liquid to maintain contact with a solid surface through intermolecular interactions. The degree of wetting depends on the balance between adhesive and cohesive forces, playing a crucial role in bonding and adherence. It encompasses the three phases of matter: gas, liquid, and solid.

The wetting properties of a solid surface reflect its ability to establish and maintain contact with a liquid, leading to the formation of intermolecular interactions between the two. Surfactants, known as wetting agents, are chemical substances that lower the surface tension of a liquid, thereby enhancing its spreading and penetrating properties. Good wetting results in a larger contact area, enabling effective bond formation between different materials.

The wetting ability of water and biological liquids has been evaluated on various biocompatible surfaces, with and without the presence of different colloidal metals. The introduction of insoluble nanoparticles into biological tissues enhances several properties, including interface adhesion between surfaces, X-ray contrast in medical imaging, and the absorbed dose during radiotherapy treatments (Zhao and Zhang, 2020; Yuan et al., 2021). Nanoparticles generally improve wetting ability and alter other solution

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properties due to the distinct distribution of adhesion forces. They also enhance the wetting ability for oil recovery, playing a significant role in determining the interactions between solids and liquids in resource exploitation. The wetting ability of a biomaterial surface is an essential concept that determines its subsequent interaction with water, leading to either hydrophilic (water-loving) or hydrophobic (water-repelling) surface characteristics.

Biological condensates refer to membrane-less organelles that organize various materials within biological cells.

These micron-scale compartments, found in eukaryotic cells, concentrate proteins and nucleic acids without surrounding membranes (Zhang and Rabouille, 2019). They are involved in numerous processes, including RNA metabolism, ribosome biogenesis, DNA damage response, and signal transduction. The formation of these condensates often occurs through the physical process of liquid-liquid phase separation. However, the mechanisms by which cells regulate this process are still under research.

Bimolecular condensates are found throughout eukaryotic cells, including in the nucleus, in the cytoplasm and on membranes, sometimes referred to as membrane less organelles, can sequester specific proteins from the rest of the cytoplasm, preventing unwanted biochemical reactions and greatly increasing the efficiency of useful ones (Banani et al. 2017; Riback et al. 2020).These discoveries are changing our fundamental understanding of how cells work. They are also implicated in a wide range of cellular functions, organizing molecules that act in processes ranging from RNA metabolism to signaling to gene regulation.

The formation of bimolecular condensates is phase-separated domains in the nucleoplasm or cytoplasm by weak and highly multi-valent interactions between their protein and RNA components. They allow cells to create compartments strongly enriched or depleted in specific proteins or RNAs, without the need for membranes. Condensates can form and maintain organization through a wide range of different processes, the most known of which is phase separation of proteins, RNA and other biopolymers into either colloidal emulsions, liquid crystals, solid crystals or aggregates within cells.

Bimolecular condensates form through liquid-liquid phase separation (LLPS) to form colloidal emulsions or liquid crystals in living organisms (Bergeron-Sandoval and Michnick, 2018). Phase separation is a process by which a well-mixed solution of macromolecules such as proteins or nucleic acids spontaneously separates into two phases: a dense and a dilute phase with different solute concentrations. Phase separation allows the components to become rapidly concentrated in one place in the cell (Alberti et al. 2019; Buchan et al. 2013). Liquid phase separation (LLPS) generates a subtype of colloid known as an emulsion that can link up to from large droplets within a liquid. Ordering of molecules during liquid-liquid phase separation can generate liquid crystals rather than emulsions. The products of phase separation in cells, which are known as bimolecular condensates.

There are various organelles concerned to form bimolecular condensates. Lewy bodies, Stress granule, P-body, Starch granules, Glycogen granules are formed cytoplasmic condensates. Nucleolus or nucleoli, Cajol body are focused on forming nuclear condensates. Secreted thyroglobulin colloid, colloid nodules of Thyroid gland, serum albumins and globulins are emphasizing on forming secreted extra cellular condensates.

Bio-molecular condensates, also known as membrane-less organelles, are present throughout eukaryotic cells, including the nucleus, cytoplasm, and membranes. They have the ability to sequester specific proteins from the rest of the cytoplasm, preventing unwanted biochemical reactions and significantly enhancing the efficiency of useful ones (Banani et al., 2017; Riback et al., 2020). These ground breaking discoveries are reshaping our fundamental understanding of cellular processes and have implications in various cellular functions, organizing molecules involved in RNA metabolism, signaling, and gene regulation.

The formation of bio-molecular condensates occurs through phase separation, creating distinct domains in the nucleoplasm or cytoplasm through weak and highly multi-valent interactions between their protein and RNA components. This enables cells to establish compartments that are highly enriched or depleted in specific proteins or RNAs, without the need for membranes. Condensates can establish and maintain organization through diverse processes, with the most well-known being the phase separation of proteins, RNA, and other biopolymers into colloidal emulsions, liquid crystals, solid crystals, or aggregates within cells.

Bio-molecular condensates, arising from liquid-liquid phase separation (LLPS) in living organisms, exhibit colloidal emulsions or liquid crystals (Bergeron-Sandoval and Michnick, 2018). This spontaneous process segregates macromolecules like proteins or nucleic acids into dense and dilute phases, concentrating components in specific cellular regions (Alberti et al., 2019; Buchan et al., 2013). Cytoplasmic condensates, including Lewy bodies, stress granules, P-bodies, starch and glycogen granules, form bio-molecular condensates. Nuclear condensates emerge in nucleoli, nucleolus, and Cajal bodies, while extracellular condensates like thyroglobulin colloid, thyroid gland colloid nodules, serum albumin, and globulins contribute to extracellular condensate formation. This dynamic process involving diverse organelles orchestrates the intricate architecture of bio-molecular condensates within cells.

The different types of bio-molecular condensates have distinct biological functions. For instance, Lewy bodies are abnormal assemblies of protein molecules found inside neurons in the brain and contribute to the pathology of Parkinson's disease and other neurodegenerative diseases (Feeney et al., 2018; Yang et al., 2007). The nucleolus is a nuclear organelle that plays a vital role in the transcription and processing of ribosomal RNA. Secreted extracellular condensates, like thyroglobulin (Tg), act as a substrate for the synthesis of thyroid hormones, thyroxine (T4) and tri-iodothyronine (T3), as well as the storage of inactive forms of thyroid hormone and iodine within the follicular lumen of a thyroid follicle.

Phase separation refers to the process where macromolecules condense into a dense liquid-like phase, separating from the surrounding diluted environment. This liquid-liquid phase separation (LLPS) enables the formation of membrane less compartments such as P granules, the nucleolus, facultative heterochromatin, transcriptional complexes, and DNA repair centers within cells. These compartments selectively enrich specific factors and create unique environments that promote or restrict biochemical reactions (Hyman et al., 2014).

LLPS is driven by weak intra- and intermolecular interactions, including hydrophobic and electrostatic contacts, leading to the self-organization of macromolecules such as proteins and nucleic acids into a dynamic network. The wetting effect of LLPS can produce various material states in cells. Liquid assemblies exhibit liquid-like properties and can fuse, coalesce, and drip due to their surface tension. Polymer molecules can move within and between the dense and light phases. LLPS can be reversible, but condensates can also undergo transitions to form hydrogels or amyloid-like fibers (Shin and Brangwynne, 2017).

The driving force behind LLPS is the exchange of interactions between macromolecules and water for interactions between macromolecules themselves, which is energetically favorable. The concentration

and identities of the macromolecules, as well as environmental conditions such as temperature, salt concentration, pH, and the presence of other macromolecules, influence whether LLPS occurs. Macromolecules can undergo stimulus-responsive phase separation, and there is evidence that specific protein sequences have evolved to utilize liquid-to-solid transitions for functional purposes (Fujioka et al., 2020; Roth et al., 2000; Patel et al., 2015).
Wetting, which refers to the ability of a surface to maintain contact with a liquid, plays a role in LLPS and the formation of cytoskeletal structures. Cytoskeletal systems, composed of actin filaments, microtubules, and intermediate filaments, provide shape, support, and movement to cells. Wetting agents known as surfactants. Wetting phenomena have been observed in cytoskeletal condensates like lewy bodies, stress granules, and P-granules, where attractive interactions between condensates and cytoskeletal filaments resemble wetting processes (Fletcher and Mullins, 2010).

Interactions between the cytoskeleton and condensates are numerous. Cytoskeletal proteins themselves can form condensates and influence the assembly, deformation, and degradation of other condensates. The concentration of cytoskeletal monomers and regulators can regulate the assembly of cytoskeletal filaments, complementing biochemical pathways (Knorr et al., 2017; Hotulainen and Lappalainen, 2006).

In summary, LLPS enables the formation of membrane less compartments in cells, and the wetting effect plays a role in this process and in the formation of cytoskeletal structures. The interactions between the cytoskeleton and condensates are important for cellular functions and require further investigation.

Intracellular wetting mediates contacts between Liquid compartments and membrane-less Organelles
Protein-rich droplets, known as biomolecular condensates or membrane-less compartments, are formed through phase separation and serve various specialized cellular functions. They include stress granules, nucleoli, and P-bodies, which play roles in sequestering ribonucleoproteins, ribosome biogenesis, and RNA processing, respectively. Droplets form in the cytosol and nucleoplasm through liquid-liquid phase separation, creating distinct liquid-like compartments. These droplets lack enclosing membranes and exhibit unique features that have significant implications for understanding cellular organization. Wetting plays a role in the intracellular relocation of droplets, which can occur through controlled phase dissolution, cytoplasmic flow, or motor protein-mediated transport. Wetting also influences the behavior of membrane-bound droplets, including their role in the assembly of adhesion complexes, storage space formation, vesicle clustering, and autophagy. The interactions between molecules within droplets, those bound to intracellular membranes, and the surrounding solution are critically influenced by wetting. Membrane-wetted droplets exhibit restricted diffusive exchange of molecules across their surfaces. The interfacial tensions, determined by electrostatic and protein-protein interactions, play a key role in membrane wetting. Altering the composition of droplets, membranes, and the cytosol can cause changes in interfacial tensions, highlighting the importance of the physiological state and physicochemical properties of these components in understanding droplet dynamics and intracellular wetting.

Effects of wetting in plasma membrane-associated condensate bindings
Membrane proteins are essential components that interact with biological membranes and play crucial roles in various cellular functions. Approximately one-third of all human proteins are membrane proteins, making them medically important and common drug targets. They can be classified into integral membrane proteins, which are permanently embedded in the membrane, and peripheral membrane proteins, which transiently associate with the membrane. Membrane receptor proteins facilitate signal transmission between the cell's internal and external environments, while transport proteins facilitate the movement of molecules and ions across the membrane. Integral membrane proteins can only be separated from the membrane using detergents, nonpolar solvents, or denaturing

agents.

In the context of intracellular assemblies, pre-wetting refers to the process of spraying salt with a liquid de-icing agent (salt brine) before spreading it on roadways. Pre-wetted salt improves performance by providing sufficient moisture to melt snow or ice, resulting in faster melting at lower temperatures and reduced waste. The effects of wetting and prewetting in the field of plasma membrane-associated condensate bindings were introduced as suitable terms to describe non-schematic assemblies of biomolecules.

The membrane can undergo a surface phase transition independent of the bulk, characterized by a positive interaction parameter among membrane-bound molecules. Wetting and prewetting without phase separation in the membrane can affect binding. Membrane proteins have diverse functions, including cell communication, maintenance of cell shape, response to chemical messengers, and material transport. Surface densities, resembling pre-wetting, involve the formation of a thin three-dimensional liquid layer on a typically solid membrane surface with an independent propensity for phase separation. Membrane wetting allows electrolyte solutes to penetrate membrane pores, increasing permeate electrical conductivity. This conductivity change is often measured using permeate conductivity readings. Wetting the membrane is an important initial step in preparing filters, as it eliminates dry pathways that could allow the passage of contaminants, such as particles, gels, or bubbles, resulting in higher defect levels in biological processes.

CONCLUSION

This article presents a comprehensive review focusing on the functional importance of wetting in various biomolecular condensates, specifically highlighting cytoplasmic condensates such as stress granules, P-bodies, starch granules, and glycogen granules, as well as nuclear condensates including the nucleolus, Cajal bodies, and secreted extracellular condensates. The review explores the role of wetting in liquid-liquid phase separation (LLPS) of condensates and its impact on facilitating interactions between liquid compartments and membrane-less organelles. It also discusses the effects of plasma membrane-associated condensate bindings, considering both wetting and pre wetting scenarios with or without phase separation in the membrane. A comprehensive understanding of wetting processes, along with their advantages and disadvantages, is crucial during the development of biomolecular condensates. Overall, this review article provides valuable insights into the wetting phenomenon in biomolecular condensates, serving as a valuable resource for researchers and scientists in the field.

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Review / Overview Paper

A REVIEW ON OXIDATIVE STRESS; AGING, AGE RELATED DISEASES, CURE AND PREVENTION

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ABSTRACT

Oxidative stress is a phenomenon caused by an imbalance between production and accumulation of oxygen reactive species (ROS) in cells and tissues and the ability of a biological system to detoxify these reactive products. ROS can play, and in fact they do it, several physiological roles (i.e., cell signaling), and they are normally generated as by-products of oxygen metabolism; despite this, environmental stressors (i.e., UV, ionizing radiations, pollutants, and heavy metals) and xenobiotics (i.e., antiblastic drugs) contribute to greatly increase ROS production, therefore causing the imbalance that leads to cell and tissue damage (oxidative stress).Result from it produce aging or age related disease. Several antioxidants have been exploited in recent years for their actual or supposed beneficial effect against oxidative stress, such as vitamin E, flavonoids, and polyphenols. While we tend to describe oxidative stress just as harmful for human body, it is true as well that it is exploited as a therapeutic approach to treat clinical conditions such as cancer, with a certain degree of clinical success. In this review, the most recent findings in the oxidative stress field, highlighting both its bad and good sides for human health has been described.

INTRODUCTION

Reactive oxygen species (ROS) are produced as by-products of biological systems and are necessary for certain cellular processes, but can also cause harm to important cellular structures when their production increases. Oxidative stress caused by ROS has been linked to the onset and/or progression of age-related diseases such as cancer, diabetes, metabolic disorders, atherosclerosis, and cardiovascular diseases. (Agorogiannis et al., 2004; Aisen et al., 2000; Albrecht et al., 1997; Aloni-Grinstein et al., 1993). Aging leads to age-related diseases and a burden on society due to the accumulation of cellular senescence, which affects tissue regeneration and produces negative effects on the surrounding environment. Blocking cellular senescence may cause other complications, making it a double-edged sword in maintaining cellular balance. (Campisi et al. 2019; López-Otín et al. 2013; Baker et al. 2016; Bael et al. 2018; Silva-Álvarez et al. 2020).The objective of this review is to comprehensively examine the role of oxidative stress in aging, age-related diseases, and potential strategies for both treatment and prevention

LITERATURE REVIEW

Oxidative Stress

Oxidative stress is caused by an imbalance between reactive oxygen species and the body's ability to detoxify them, leading to damage to cells and disruption of cellular signaling. Factors contributing to oxidative stress include diet, lifestyle, environmental factors, and certain conditions, and uncontrolled oxidative stress can accelerate aging and contribute to various diseases.

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Free Radicals

Mitochondria produce free radicals as byproducts of energy generation through combining oxygen and glucose, which include reactive oxygen species such as superoxide, hydroxyl radical, and nitric oxide radical.

Antioxidants

Antioxidants are substances that neutralize or remove free radicals by donating an electron. The neutralizing effect of antioxidants helps protect the body from oxidative stress. Examples of antioxidants include vitamins A, C and E.

Like free radicals, antioxidants come from several different sources. Cells naturally produce antioxidants such as glutathione (Bacsi,et al., 2006).

Effects of Oxidative Stress on the body

Oxidative stress from physical activity can have beneficial effects on the body, such as regulating tissue growth and stimulating antioxidant production, but long-term oxidative stress can damage cells and contribute to aging and diseases (Dharajiya et al. 2005; Staton et al. 2005).
We discuss some of these conditions below:

Chronic Inflammation

Oxidative stress can cause chronic inflammation. Infections and injuries trigger the body's immuneresponse. Immune cells called macrophages produce free radicals while fighting off invading germs. These free radicals can damage healthy cells, leading to inflammation. Chronic inflammation due to oxidative stress may lead to several conditions, including diabetes, cardiovascular disease, and arthritis.

Neurodegenerative Diseases

The brain is vulnerable to oxidative stress due to its high oxygen consumption, which can lead to damage and cell death, increasing the risk of Parkinson's disease. Oxidative stress can also modify essential proteins, contributing to the accumulation of amyloid plaques in the brain, a key marker of Alzheimer's disease.

Conditions linked to oxidative stress

exposure to oxidative stress may play a role in the development of a range of conditions,including :
Cancer
Alzheimer's disease,
Parkinson's disease,
Diabetes,
Cardiovascular conditions such as high blood pressure, atherosclerosis, and stroke,
Inflammatory disorders,
Chronic fatigue syndrome,
Asthma and
Male infertility.

Risk factors for oxidative stress

pollution can increase the risk of long-term oxidative stress. Factors that may increase a person's risk of long-term oxidative stress include :

Obesity,
Diets high in fat, sugar, and processed foods,
Exposure to radiation,
Smoking cigarettes or other tobacco products,
Alcohol consumption,
Certain medications,
Pollution pesticides or industrial chemicals

AGING

Ageing is the process of becoming older and is associated with dynamic changes in biological, psychological, physiological, environmental, behavioral, and social processes. It results from the accumulation of molecular and cellular damage over time, leading to a gradual decline in physical and mental capacity, a growing risk of diseases, and ultimately, death. (Aloni-Grinstein et al., 1993; Aisen et al., 2000).

THE SEVEN SIGNS OF AGING

Fine Lines And Wrinkles: Fine lines, crow's feet and wrinkles are the most evident and often most concern-causing signs of ageing for men and women.
Wrinkles are a result of the elastin and collagen fibers, which keep our skin firm and taut, weakening. This leads to skin looseness and laxity and the subsequent wrinkles.

Dullness Of Skin: The glowing, dewy skin of youth slowly fades with age. The result is a dulledcomplexion due to the depleted moisture levels in the top layer of the skin, which naturally occurswith age. While young skin renews itself at every three to four weeks, older skin is slower to renewitself at every four to six weeks.
Uneven Skin Tone: Ageing causes the complexion to become uneven in certain places. This maybe due to parts of the skin harbouring more melanin than others, or the function in the hormonal levels in females. This unevenness can lead to skin looker older than its years.
Dry Skin: Young, healthy skin has a high moisture content, leading to a fresh, dewy and radiant appearance, Over the ageing process this depletes as the skin loses its ability to retain the moisture.Older skin is often characterized by dryness and dehydration.

Blotchiness And Age Spots: Thinning skin associated with ageing leads to the increased visibilityof tony bloods vessels that appear. Age spots or liver spots, which are reddish or brown in colour,are caused mostly by over-exposure to UV rays and become more evident in ageing skin. They produce a blotchy look that contributes to an aged appearance.

Rough Skin Texture: As the skin matures, changes in texture become noticeable. Skin that was once baby-soft and smooth becomes uneven and bumpy on the surface due to the layers of dead cells and the cell turnover slowing.
Visible Pores: Pores become enlarged or more visible with age due to loss of skin elasticity and skin being drawn down by gravity.

BIOLOGICAL THEORIES OF AGING:

Genetic Theory:

The theory of aging assumes that an organism's life span is genetically determined, supported by the fact that people with long-lived parents tend to live long themselves and identical twins have similar life

spans. Genetic factors affecting telomeres, such as mutations in the terc gene, can alter an organism's rate of aging.
mutations in the terc gene disrupt the normal function of the telomerase enzyme, which normally prevents the over shortening of telomeres, lending support to the theory that cell death is the result of errors introduced in the formation of key proteins.

Non-Genetic Theories:

Theories of aging focus on cellular and molecular changes, but age changes are more marked in overall performance than in measurable cellular processes, possibly due to breakdown in control mechanisms or accumulation of damaging molecules.

AGE RELATED DISEASES:

Changes can be described in every organ system, this review will address changes with public health and clinical decision-making implications.
Sensory Changes

Hearing Loss

Hearing loss increases with age and has a high association with reduced quality of life, but only 14.6% of individuals with hearing loss use hearing aids, which could reverse adverse effects on quality of life and cognitive function (Benowitz et al. 2007; Berndit et al. 2007).

Visual Acuity

Visual acuity decreases with age, leading to problems with glare and increased risk during night driving. A longitudinal survey in the UK found that severe visual impairment prevalence increases with age, reaching 23% at ages 85-89 and 37% at age over 90. Cataract surgery is a safe option that can improve function (Bilikiewinz, et al. 2004).

Vestibular Function

Dizziness is a common multifactorial geriatric syndrome contributing to falls. Vestibular functiondeclines subtly with age. Vestibular rehabilitation can be an effective treatment (Boldogh,et al.2007).

Muscle Strength and Fat Changes

Muscle mass and strength decline with age, leading to sarcopenia, which is caused by chronic inflammation, declining hormone levels, impaired muscle mitochondrial function, and impaired muscle stem cell function. This decline in muscle mass and increase in fat mass affects pharmacokinetics and may require lower medication doses for older adults. Muscle weakness and rapid rate of strength decline predict future mortality. (B.K. Choudhury, et al. 2005).

Urologic Changes

The urinary bladder is often not sterile in older adults but rather is colonized with bacteria not causing infection. Asymptomatic bacteriuria is more common in women than men and is most frequent among hospitalized patients and residents of long term care facilities (up to 50% of womenin these high risk groups) (Bacsi,et al., 2006).
Somatic Disease and Multiple Chronic Conditions

Cardiovascular Disease

Cardiovascular disease remains the most common cause of death of older adults, although death rates have dropped in the last 20 years. This category includes chronic ischemic heart disease, congestive heart failure, and arrhythmia. Ischemic heart disease may be underdiagnosed in the oldest-old (Aisen,et al., 2000). Normal aging includes vascular remodeling and vascular stiffness (Dharajiya, et al., 2005).

Hypertension

Aggressive treatment for hypertension in people over 75 should be offered and continued as long as it is well-tolerated and consistent with the patient's goals, despite controversy surrounding its value.

Cancer

Cancer is the second leading cause of death in older adults, but the death rate from cancer begins to fall after age 85, and slow-growing tumors are common in this population. Age should not be the sole factor in denying aggressive cancer treatment to individuals in their ninth or tenth decade, and breast and colon cancer screening after age 75 should be based on predicted life expectancy and capacity to tolerate treatment. (Bilikiewicz et al. 2004, Bolodagh et al. 2007, Albrecht et al. 1997)

Osteoarthritis

Osteoarthritis is a common chronic condition among American older adults, with higher prevalence in women and obesity as a risk factor, leading to costly joint replacement surgery and vexing pain management.

Diabetes Mellitus

Diabetes rates are increasing, with a projected 400% increase in prevalence among American older adults by 2050. It remains a strong risk factor for cardiovascular disease and can lead to diabetic foot ulcers and amputations. Management should be individualized, with careful consideration of the risks associated with sulfonylureas and insulin. Regular foot examinations and walking can help prevent complications.

Osteoporosis

Osteoporosis is associated with increased bone fractures, while osteopenia is not; bone density screening is recommended for women over 65, but the value of screening for men is unclear; calcium and vitamin D supplementation for fracture prevention is controversial.

Multiple Chronic Conditions

62% of Americans over 65 have multiple chronic conditions, which is increasing due to aging and diabetes rates, and targeting this population for research and quality improvement can improve care and reduce costs.

Physical Function

Normal age-related changes and accumulated pathology contribute to functional changes seen withaging.

Mobility Disability

Seventy-three percent of Americans over age 85 have some difficulty with walking according to aUS Census study. Mobility disability is associated with social isolation, falls, and depression. One-third of people over age 85 with a disability live alone).

Disability in Activities Of Daily Living

Disability rates are high among adults over 85, with 75% having difficulty with bathing and 25% with using the toilet, and rates of disability in daily activities increasing with age over 80.

Falls

Falls are a major cause of morbidity and disability among older adults, with 30-40% of adults over age 70 falling each year and rates being particularly high for those in long-term care facilities. Multifactorial fall prevention programs including physical activity, vitamin D supplementation, balance exercise, and home safety assessment have been shown to reduce the incidence of falls (Beal, et al. 2005).

Frailty

Frailty is characterized by weakness, slowness, exhaustion, and weight loss, and can be easily assessed; it predicts future disability, falls, hospitalizations, and poor surgical outcomes.
Targeted interventions for frail populations should include physical activity, nutritional components, and medication reviews. (Berndit, et al. 2007).

Prevention of Age Related

Lifestyle changes can prevent half of all cancers. Avoid smoking and second-hand smoke, limit alcohol intake, eat a healthy diet, maintain a healthy weight, exercise regularly, and protect skin from the sun. These lifestyle changes can reduce the risk of several types of cancer, according to Cancer Research UK.

Drugs for Anti-Aging:

The authors focus on three anti-aging drugs candidates: metformin, rapamycin and resveratrol andone anti-aging component NAD+ precursors whose randomized control trials on animals have appeared to provide some efficacy in this respect and they seem to be promising in the aging process of human beings.

Anti-Aging Vitamins and Supplements:

Curcumin, EGCG, Collagen, CoQ10, Nicotinamide Riboside, Nicotinamide Mononucleotide, Crocin, and Vitamin C are compounds that offer cellular protection, reduce signs of aging, and improve skin health. These compounds have been shown to possess potent antioxidant effects, reduce the risk of certain diseases, and stimulate collagen production (Woodbery et al., 2006; Routtenberg et al., 2004; Lilig et al., 2007; Graus et al., 2004). Vitamin C may also safeguard against premature aging due to sun exposure. Other supplements such as Vitamin E, Rhodiola, and Fisetin may support healthy aging, but more human research is needed on each of them. (Hazra et al. 2005, Liebenthal et al. 2003, Bourhim et al. 2007)

Gene Therapy Proposed for Anti-Aging:

CRISPR/Cas9 Therapy

Researchers have identified new human senescence-promoting genes using a genome-wide CRISPR/Cas9 screening system, providing a new therapeutic approach for treating aging and aging-related pathologies. (Das, et al. 2005). Researchers identified KAT7 as a top target in alleviating cellular senescence and inactivating it decreased histone H3 lysine 14 acetylation, repressed p15INK4b transcription, and rejuvenated senescent human stem cells. (Pauli, et al. 1994; Bourhim, et al. 2007). Age-associated accumulation of senescent cells and proinflammatory cells contribute to aging-related disorders, but intravenous injection of a lentiviral vector encoding Cas9/sg-KAT7 reduced the proportions of these cells in the liver, diminished circulatory senescence-associated secretory phenotype factors in the serum, and extended health span and lifespan of aged mice. (Hazra, et al. 2005)

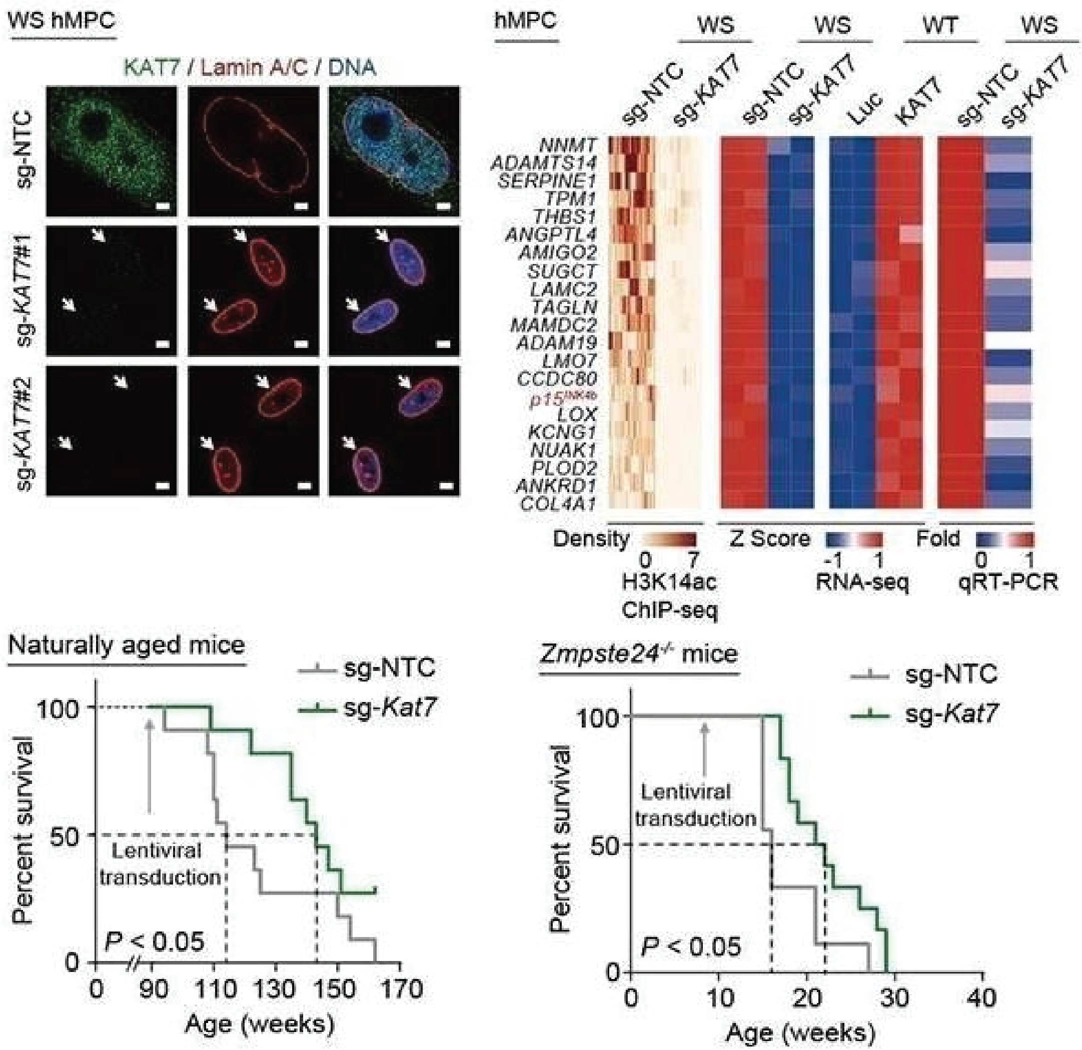

Figure 1.. Gene therapy targeting Kat7 extends lifespan in naturally

These results suggest that gene therapy targeting single-factor inactivation, such as KAT7, can extend mouse lifespan and alleviate human hepatocyte senescence, providing potential targets for aging interventions in clinical settings. (IOZ)

CONCLUSION

Oxidative stress and free radicals are generally known to be detrimental to human health. A largeamount of studies demonstrates that in fact free radicals contribute to initiation and progression ofseveral pathologies, ranging from CVD to cancer.

Antioxidants, as class of compounds able to counteract oxidative stress and mitigate its effects onindividuals' health, gained enormous attention from the biomedical research community, because these compounds not only showed a good degree of efficacy in terms of disease prevention and/ortreatment but also because of the general perception that they are free from important side effects.If it is true that antioxidants can be very useful in preventing, managing, or treating human pathologies, it is true as well that they are not immune to generating adverse effects. On the otherhand, some prooxidant compounds or agents can be as well useful to human health, particularly regarding cancer treatment. We can reach to the conclusion that oxidative stress, as phenomenon, although being one of the major harms to individuals' wellness and health, it can also be exploited as a treatment tool when and if we will be able to operate a fine tuning of this process inside human organism.

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