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Effect of White Leaf Disease on different Growth Parameters and Yield of Sugarcane

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ABSTRACT

An experiment was conducted to study the effect of white leaf disease (WLD) on different growth and yield parameters of sugarcane varieties Isd 16 and Isd 20. The crop raised from WLD affected seed materials of sugarcane showed 14.91 to 19.57% reduction in germination compared to healthy check. In the diseased plants, number of tillers per clump and side shoot production were found to increase by 136.84 to 156.25% and 625.31 to 704% respectively while the leaf area were found to reduce by 336.36 to 372.19% compared to their healthy ones. Shoot and root dry weight was also found to reduce drastically in the diseased plants compared to healthy ones. Number of millable stalks, length and girth of millable stalks and yield of cane were found to reduce in the diseased plants respectively by 40.45 to 45.45%, 47.18 to 55.64%, 41.53 to 50.38% and 76.92 to 78.70% compared to their respective healthy checks. All these changes might have due to metabolic change brought about by the etiologic agent in the diseased plant.

Key words : sugarcane white leaf disease, effect on growth parameters.

INTRODUCTION

White leaf is one of the most serious diseases of sugarcane (*Saccharum officinarum* L.) in Bangladesh. The disease is caused by mycoplasma like organism (MLO) (Talukder *et al.* 1989). The disease was first reported in Bangladesh by Rahman *et. al.* (1980) in some sugarcane varieties on the basis of its external apparent symptoms. Since then the disease increased in the subsequent years and covered most of the commercial varieties of sugarcane (Anon., 1988).

The disease is characterized by the production of increased number of lanky tillers with narrow leaves having varying degree of chlorophyll loss ranging from partial white to pure white. Stunted growth of plants and proliferation of side buds have been associated with WLD. Incase of primary infection, canes are not formed and the whole clump appears as a tuft of grass with chlorotic leaves. Whenever a few canes are produced, these are thin and short with side buds proliferating prematurely. The diseased plants exhibit subnormal growth with reduced leaf size i.e. the disease affects different growth and yield parameters of sugarcane qualitatively and quantitatively. It has been reported that yield loss could reach 77 to 78% if diseased cuttings were used for planting and the loss in yield was contributed less by shortening of cane (37.2%) and more by the reduction in weight (51.15) (Leu *et al.* 1963). Talukder *et. al.* (1986) reported 51.8% reduction in millable cane and 60.62% reduction in weight of cane in the white leaf disease infected plants compared to healthy ones. In Bangladesh very little work has been done on the effect of WLD on different growth parameters and yield of sugarcane. As such the present experiment was undertaken to

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determine the effect of white leaf disease on various growth parameters like germination, leaf area, height, girth, shoot and root dry weight, side shoot production, number of millable cane, weight of cane etc. of disease affected sugarcane plants.

MATERIALS AND METHODS

During the cropping season 1991-92 the experiment was conducted at BSRI farm. White leaf disease infected and healthy canes (foundation seed) of the varieties Isd 16 and Isd 20 collected from the field, were cut into single bud setts. Four hundred setts of each category were planted in polythene bags (13 cm lengths and 8 cm diameter) filled with soils mixed with cowdung after dipping in 0.1% aqueous solution of Bavistin (Methyl benzimidazole carbamate) a seed treating fungicide. The polythene bags with setts were placed on nursery beds and watered regularly to provide required moisture in the bags.

Data on germination were recorded up to 45 days in nursery beds. The settlings were transplanted in the field at a distance of 50 cm in the micro plots (5x6m) having 6 rows of sugarcane 90 cm apart. Three replications were maintained for each category and randomized. Attempts were made to maintain identical nursing for each plots throughout the experimental period. Normal cultural practices and fertilizer dose were used for the experiment. Data on tillers were recorded at the age of 2, 4, 6 and 8 months old plant in the field. Total number of tillers per plot was recorded and average number of tillers per clump was determined. Leaf area of healthy and diseased plants were recorded at the age of 8 months when diseased symptoms expressed fully. Twenty five leaves were collected from 25 randomly selected clumps of each plot. Third leaf from the top was selected for this purpose. The leaf area was measured by using leaf area meter. Data on dry matter (shoot and root dry weight) production of plants were recorded at 2, 4, 6 and 8 months of age. For recording shoot and root dry weight, three clumps from each plot were carefully dug out and the root system of each clump was thoroughly washed with a jet of water to remove the adhering soil particles. The shoot and root portions were separated out and after spitting stalks, both shoot and root were dried in an oven at 8^0C for 48-72 hours to constant dry weight. Data on side shoot production, number of millable cane, girth of cane and yield of cane were recorded at harvest at the age of 12 months. Twenty cane stalks were collected from 20 randomly selected clumps (five from each row) of each plot. Total number of buds and number of sprouted buds of each cane were recorded. Length and girth of those canes were recorded. Girth of third inter node from the bottom were recorded with the help of slide calipers. Four randomly selected rows (containing 40 clumps) from each plot cut down, detrashed and detopped. Total number of millable canes per clumps were determined.

RESULTS AND DISCUSSION

White leaf disease caused a significant ($P<0.05$) reduction in germination of seed materials of varieties Isd 16 and Isd 20 as compared to their respective healthy check (Table 1). The results corresponds to the findings of Dhumal and Nimbalkar (1983) who reported that sugarcane varieties affected with grassy shoot disease (GSD) reduced germination by 11.42 to 19.11% compared with their respective healthy ones. The plausible reasons for the law germination in diseased setts might be as a results of (i) death of sprout due to improper or reduced number of root produced from root primordia of setts which draw nutrient and water from soil for emerging plant. (ii) due to planting of sprouted buds which could be damaged during planting as most of the buds of the white leaf diseased plants sprout or proliferate in the standing cane (Figure 5) (Ling, 1962; Ling and Chuang Yang, 1962).

Table 1. Effect of white leaf disease on different growth parameters of sugarcane in the varieties Isd 16 and Isd 20.

Growth parameters [1]	Isd 16			Isd 20		
	Healthy	Diseased	% increase (+) or decrease (-) over check	Healthy	Diseased	% increase (+) or decrease (-) over check
Germination (%)	65.14	55.43	-14.91	62.28	50.093	-19.57
Leaf area (cm^2)	366.36	99.70	-72.76	372.19	110.19	-70.39
Side shoot/cane (after sq. root transformation)	0.746	2.01	+625.31	0.949	2.69	+704.00
Number of millable cane/clump	5.5	3.0	-45.45	7.416	4.416	-40.45
Length of cane (m)	2.253	1.19	-47.18	2.75	1.22	-55.64
Girth of cane (cm)	2.64	1.31	-50.38	2.15	1.257	-41.53
Yield of cane/20 sq. m area [after sq. root transformation (kg)]	12.263	5.661	-78.70	14.141	6.794	-76.92

LSD value at	5%	1%
Germination	8.176	12.386
Leaf area	8.44	12.79
Side shoot	0.166	0.252
Millable cane	0.634	0.9605
Length of cane	0.089	0.135
Girth of cane	0.0633	0.0959
Yield of cane	0.59	0.90

[1] Mean of three replicates.

White leaf diseased plants produced much higher number of tillers compared to healthy plants (Figure 1). At all the stages of growth, number of tillers in diseased plants were higher than healthy ones. At 6 month age, the number of tillers in the diseased plants increased to the extent of 136.84 to 156.25% over the healthy check, respectively in Isd 16 and Isd 20. The Figure 2A and 2B showing lanky stunted tillers in the diseased plants while in healthy plants tillers formed millable stalks. Similar results were also reported by many other workers (Kirtiker and Verma 1961a. Corbet *et al.* 1972. Bachchav *et al.* 1979). Increased number of tillers in diseased plants which is one of the diagnostic character of the disease could be due to imbalance or disturbed mineral nutrition in the plants brought about by the disease organism (Dhumal and Nimnalkar, 1982).

Leaf area in the diseased plants reduced by 70.39 to 72.76% compared with their respective healthy check (Table 1 and Figures 2A & 2B). In the diseased plants, leaf become chlorotic, stunted and reduced in size. Similar results are reported by Dhumal and Nimabalkar (1983) in grassy shoot disease of sugarcane. Mycoplasma like organism (MLO) associated with other plants were also reported to reduce the leaf area. Yang *et al.* (1987) observed that MLOs associated with Witch's broom of wild balsam pear reduces the leaf size as a result, diseased plants showed typical witch's broom of bushy little leaves. Heints (1989) reported about a new MLO type originating from *Cuscuta odorata* causing stunting and reduction of flower and leaf size in *Catharanthus roseus*. 'Ash dieback' associated with MLO in Decline white ash (*Fraxinus americana* L.) showed subnormal leaf size and chlorosis (Matteoni and Sinclair, 1985).

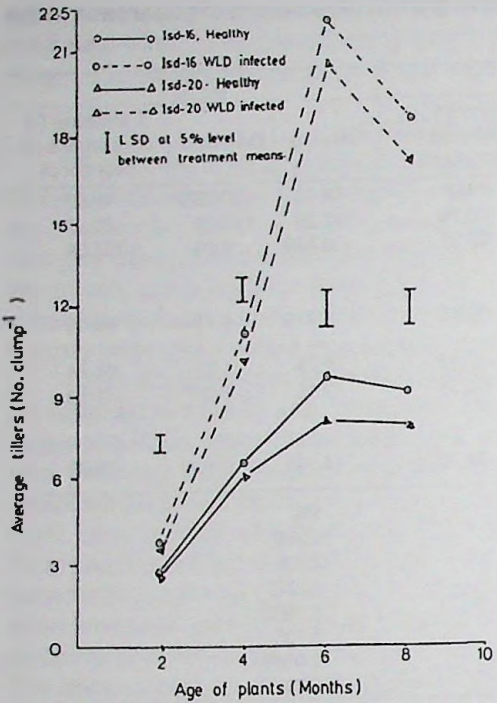

Figure 1. Effect of WLD on tiller production in sugarcane.

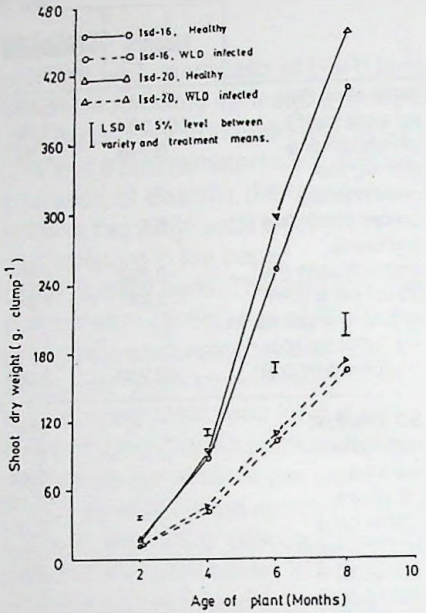

Figure 3. Effect of WLD on shoot production in sugarcane.

Figure 2A. A WLD infected clump (left) and a healthy clump (right) of lsd 16.

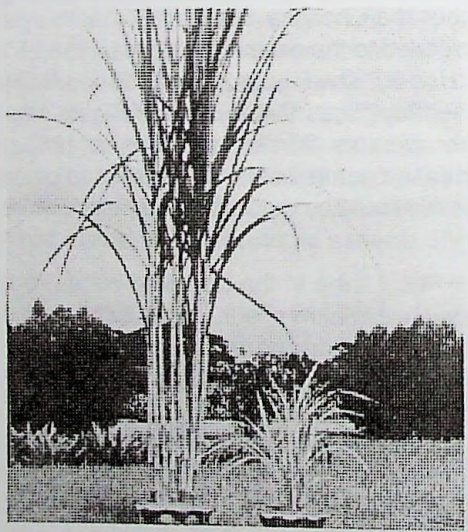

Figure 2B. A WLD infected clump (right) and a healthy clump (left) of lsd 20.

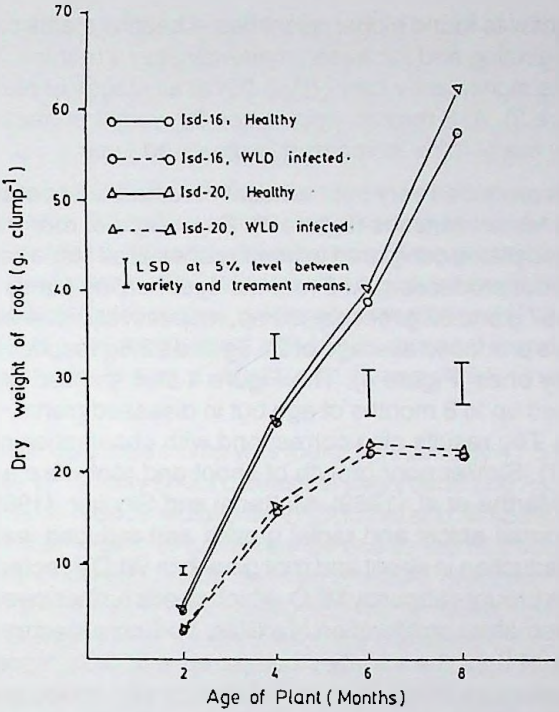

Figure 4. Effect of WLD on root production in sugarcane.

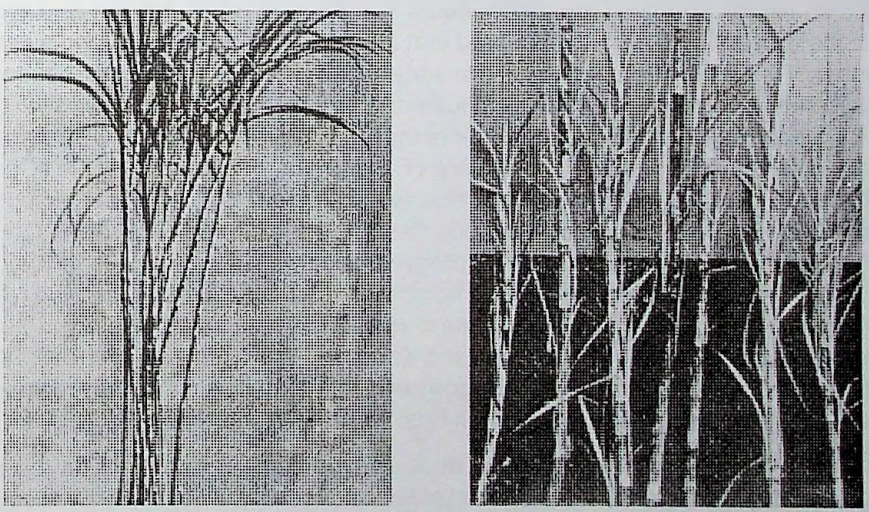

Figure 5. WLD infected stalks whichsprouted prematurely (Right) and healthy stalks (Left) of Isd 20.

Shoot day weight was found higher quantities in healthy plants compared to diseased ones from the very beginning and increased markedly after 4 months. The dry wt. of shoots of diseased plants was significantly lower ($P<0.05$) at all stages of plants growth than that of healthy ones (Figure 3). At 8 months age, shoot dry weight of healthy plants of both the varieties increased by many folds compared to diseased ones.

Diseased plants produced very poor amount of roots like shoot production compared to healthy ones in the tested varieties (Figure 4). Dry weight of root was significantly lower ($P<0.05$) in the diseased plants compared to healthy ones at all stapes of plant growth as that observed incase of shoot production. At 8 months age, healthy plants of Isd 16 and Isd 20 was found to produce 57 g and 62 g root per clump, respectively while at that stage diseased plants of those varieties produced average of 21.5g and 22.5g respectively which was lower than half of the healthy ones (Figure 4). The Figure 4 also showed that the root growth of healthy plants continued up to 8 months of age but in diseased plants, root growth retarded after 6 months of age. The results also correspond with observation made by Leu (1990). Srivastava *et al.* (1987). Similar poor growth of shoot and root were also reported in other MLO infected plants. Martha *et al.* (1989). Matteoni and Sinclair (1985) and Sinclair *et al.* (1987) reported subnormal apical and radial growth and reduced leaf size in "white ash" infected with MLOs. Reduction in shoot and root growth in WLD infected plants could be due to metabolic alterations brought about by MLO, which needs further investigation. Production of the side shoots or premature proliferation of axillary bud increased by many folds ($P<0.01$) in the diseased plants of both the varieties compared with their respective healthy check (Table 1, Figure 5). Premature lateral bud proliferation or side shoot production is one of the diagnostic character of WLD. Similar report on axillary bud proliferation of GSD of sugarcane was made by many workers (Edision *et al.* 1976, Dhumal and Nimbalkar, 1983). Phyllode disease of *Crotalaria saltiana* Andr. associated with MLO exhibited stunted and excessive proliferation of lateral shoots (Witch's broom growth) with small and chlorotic leaves (Dafalla and Cousin, 1988). White ash (*F. americana* L.) affected with 'ash yellow' disease caused by MLO also exhibit abortive sprouts (Matteoni and Sinclair, 1985, Hibben and Wolanski, 1971). In the present study it was observed that the diseased plants produced significantly less number of millable cane compared to healthy check (Table 1). It has been observed that white leaf diseased plants produced large number of thin stunted chlorotic tillers which dried early in the season as a result a few number of thin stalks were produced. The results are in conformity with the reports of other workers (Talukder *et al.* 1986, Rahman *et al.* 1982, Ponniah, 1982). Reduction in number of millable stalks in white leaf diseased clumps was due to mortality of tillers which could be due to some possible reasons (i) high degree of albinism resulting in sharp decline in photosynthesis, which in turn affects the overall metabolism of the foliage, (ii) high degree of nutritional imbalance (Singh *et. al.* 1967, Dhumal and Nimbalkar, 1982 (iii) Significant increase in respiratory rate in all white coloured leaves wherein photosynthesis is too weak (Chen and Kong, 1976, Shukla and Bhansali, 1985) (iv) Production of toxin (s) by the etiologic agent of white leaf disease as mycoplasma like organisms are known to produce toxin(s) in host plant (Maramoresch, 1974).

Generally white leaf diseased plant become stunted poor in growth. In the present investigation, height of cane in the diseased clump reduced by 47.18 to 55.64% compared to the healthy check (Table 1). The results confirmed the report of Liu *et al.* (1963) who found 37.2% reduction in height of white leaf diseased cane compared to healthy check. Dhumal and Nimbalkar (1983) observed that sugarcane plant infected with grassy shoot disease

reduced in height of cane by 52.63 to 52.73% compared healthy ones. Reduction in height of cane in grassy shoot diseased plants were also reported by many other workers (Singh, 1974, Edison. *et al.* 1976. Bachchav *et al.* 1999). Reduced height of cane in the diseased plants compared to healthy ones may be due to low nitrogen, magnesium and manganese content in the diseased plant leaves as opined by Dhumal and Nimbalkar (1982). It is also reported that distrubed mineral nutrition is one of the most common effect of plant disease (Huber, 1978) which was found in the present study. Mycoplasma like organism associated with the disease of other plants also showed reduced apical and radial growth. Ash die back disease of white ash associated with MLO reduced apical and radial growth (Metteoni and Sinclair, 1985). Witch's broom of Lucerne, witches broom disease of jujube, rice yellow dwarf and lethal declines of palm etc. associated with MLOs reported to reduce the apical growth of the plants (Thomas and Peitersen, 1988; La and Chang, 1981; Chen, 1981 and Thomas, 1979).

The girth of cane in diseased clump was found to reduce by 41.53 to 50.38% compared to healthy check (Table 1). Grassy shoot disease of sugarcane and Ash die back of white ash caused by MLO reported to reduce radial growth (Dhumal and Nimbalkar, 1982, Matteoni and Sinclair, 1985). Reduction in girth of cane may be due to the nutritional imbalance brought about by the pathogen. Diseased plants resulted a drastic reduction in cane yield of 76.92 to 78.70 % (Table1). Reduction in cane yield was mainly due to lower number of millable stalks and decreased height and girth of cane in the diseased clump. Similar results were reported by Liu *et al.* (1963). They observed that yield loss in white leaf diseased plants could reach 77 to 78% if diseased cuttings were used. They also mentioned that loss in the yield was contributed less by shortening of cane and more by the reduction in weight. Significant yield reduction in white leaf diseased plants were also reported earlier (Rahman *et al.* 1982, Talukder *et al.* 1986). Grassy shoot disease of sugarcane caused by MLO were reported to reduce cane yield significantly. Singh and Rao (1966) found an yield reduction of 60.3% in GSD infected canes of Co 419. Similarly Singh and Rao (1967) observed the reduction of cane yield in GSD infected canes of variety Co 419 and Co 453 to the extent of 90.5 and 82.2% respectively compared to healthy check.

Mycoplasma associated with the disease of other plant species were also reported to reduce the yield parameter. Witch's broom disease of Paoulownia (*P. taiwaniana* Hu & Chang) caused by MLO become a limiting factor of its cultivation, because 80% of paulownia plantations are affected by this disease (Ying, 1981). Lethal yellowing of palm caused by MLO exhibited fruit drop and rapid death (McCoy and Gwin, 1977). Decline of white ash associated with MLO exhibited similar symptoms like other MLOs disease as suppressed growth, die back and death as a result timber yield of white ash is greatly lost (Martha *et al.* 1989, Castello *et al.* 1984).

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