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Loss Assessment of Sugarcane due to Attack of Stem Borer

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ABSTRACT

An experiment was undertaken to screen 10 recommended sugarcane varieties namely Isd 31, Isd 32, Isd 33, Isd 34, Isd 35, Isd 36, Isd 37, Isd 38, Isd 39 and Isd 40 against stem borer, *Chilo tumidicostalis* Hampson infestation under field conditions during 2009-2010 at Bangladesh Sugarcane Research Institue farm, Ishurdi, Pabna. A negative linear relationship was observed between stem borer infestation with rainfall 71% (R^2=0.711) and temperature 47% (R^2=0.473). Positive correlation was found between stem borer infestations with relative humidity 36% (R^2=0.367) and bright sunshine 6% (R^2=0.060). The highest recovery loss 2.64% was found in Isd 34 and lowest recovery loss 0.10% in Isd 40 when 10 % infestation was considered. The highest weight loss 10% was found in Isd 36 when 9.66% weight loss was found in Isd 34 and lowest weight loss 0.21% in Isd 35 when 10 % infestation was considered. The results revealed that loss in recovery and weight due to stem borer infestation different for different varieties and should that losses was increased with the increase in insect infestation.

Key words: Sugarcane, loss assessment, stem borer

INTRODUCTION

Sugarcane, *Saccharum officinarum* L. production in Bangladesh is affected by different insect pests. Among them, stem borer is the major insect pest responsible for its considerable damage (Rao and Rao, 1965). In Bangladesh, about 70 species of insect pests have so far been identified and reported to feed on sugarcane (Anon., 1973-78; 1992). Alam (1967) reported that insect pests alone caused damage ranging from 20-60% under the field conditions. Among various factors, insect pests inflict considerable losses which are estimated to be around 20% in cane yield and 15% in sugar recovery (Avasthy, 1983). These pests of sugarcane are grouped into borers, sap suckers, leaf feeders and underground feeders according to their feeding or dwelling nature. Among the pests the most damaging insect is stem borer, *Chilo tumidicostalis* Hampson. Due to the primary infestation, top leaves completely dry up and infested plant is visible from a distance. Copious red colour frasses ooze out from the bored holes. Aerial roots come out profusely from the nodes adjacent to the damaged internodes. At late infestation stage, the grown up larvae come out and migrate to the neighboring canes to cause secondary infestation. The secondary infested canes show the entry holes with oozing

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out excreta and saw dust like damaged tissue. Aerial roots are initiated after secondary infestation. Due to their infestation, heavy losses in yield incurred every year which are estimated to be 8.2-12.6% by SB (Khanna *et al.*, 1957). Different pest management tactics viz., cultural, mechanical, biological and chemical methods have been recommended to control stem borer. Among these, farmers of Bangladesh are mostly practiced chemical control (Alam *et al.*, 2005). But recommended chemical pesticides are not always available, expensive and sometimes do not give desirable results. Moreover, these create environmental hazards. Continuous use of pesticides (sub lethal dose) causes resistance to the target pest. Plant resistance is an important management strategy in most sugarcane growing regions around the world against stem boring pyralids (Mathes and Charpentier, 1969). In Louisiana, plant resistance is included as a component of the sugarcane IPM programs against sugarcane borer for successful management strategy of the pests (Bessin *et al.*, 1990). In practical agriculture, resistance represents the ability of a certain variety to produce a crop of good quality than other varieties under the same level of insect infestation and comparable environment. So, effective control of the pest demands some new approaches which do not rely exclusively on chemicals, reduce the use of chemicals and safe guard the environment. The resistant crop plant can provide the basic foundation on which structures of IPM can be built (Panda and Khush, 1995). Use of resistant varieties seems to be the most important method of pest management. As most of the major sugarcane pests are monophagous, there is a good scope for their control by developing resistant sugarcane varieties. Selection of insect resistant variety is the first step towards insect management (Bessin *et al.*, 1990 and Keeping, 2006). Clones having potential of high sugar yield with considerable tolerance to major insect pests attack would be more economic to cultivate by the sugarcane growers in Bangladesh. Therefore, the present study was undertaken to find out the weight and recovery loss caused by stem borer attack at different infestation levels as affected in ten latest released sugarcane varieties.

MATERIALS AND METHODS

Experimental site and duration

The experiment was conducted in the experimental farm of Bangladesh Sugarcane Research Institute (BSRI), Ishurdi, Pabna during the cropping season of 2009-2010 under a Ph. D. work. The location of the site was 24.8^0 North latitude and 89.4^0 East longitudes with an elevation of 15.5 m from sea level (Anon., 2010-11). The experimental site represents the high Ganges Flood Plain Soils under the AEZ 11. The climate of the experimental site is subtropical characterized by heavy rainfall during May to October and scanty during the rest of the year. The air temperature, humidity, rainfall and sunshine during the study were collected from the meteorological station of BSRI, Ishurdi, Pabna.

Design and layout of the experiment

Design of the experiment was RCBD with three replications. The unit plot size was 5 m x 5 m. Each of the unit plots was separated by 1m and block to block distance was 2 m. Every unit plot had 5 rows with 35 setts placed in each row. The total numbers of setts per plot were 175.

Fertilizer application

Recommended doses of manure (Cowdung @ 10 t ha^{-1}) and fertilizers viz., urea, triple super phosphate, muriate of potash, gypsum and $ZnSO_4$ were applied @ 326, 250, 180, 189 and 10 kg ha^{-1}, respectively (BARC, 2012). The urea was applied in three equal splits, the first split at the settling establishment stage, the second at tiller completion stage (90 DAP) and the third at grand growth phase (180 DAP). Full amount of TSP, gypsum and one third of MP were applied in trenches and thoroughly mixed with soil prior to sett placing. The rest amount of potash fertilizer and urea was applied as first and second top dressing at 90 DAP and 180 DAP (days after planting), respectively. Fertilizers as top dressing were applied at root zone in furrows prepared on both sides of cane rows and then covered with soils. Intercultural operations such as irrigation, weeding, mulching, thinning were done throughout the cropping season for proper growth and development of the plants following hand book of Rahman and Pal (2003). Other agronomic practices were done as per Matin *et al.* (1998).

Recording insect pest infestation

Infestation of sugarcane stem borer was recorded monthly during the period from July to October. The total numbers of plants were counted and percent infestation by a particular insect species of stem borer was calculated. The percent effectiveness was calculated by the following formula:

$$\% \text{ Infestation} = \frac{B}{A} \times 100$$

Where, A= Number of total cane, B = Number of borer infested cane
The percent efficacy was calculated by using the following formula:

$$\% \text{ Effectiveness} = \frac{\text{Control—Treated}}{\text{Control}} \times 100$$

Estimation of weight loss

The weight loss of the plants due to the attack of insect pests was recorded at harvested. The data was collected from the 5 m × 5 m plot. Plants were separated into two groups including the healthy and infested. Ten plants were selected randomly. The weights of healthy and infested plants were measured separately. Healthy and infested plants were weighed after cutting elongated plants into small pieces and were placed on the balance. The weight loss was estimated by the following formula:

$$\text{Weight loss (\%)} = \frac{A—B}{A} \times 100$$

Where, A = Weight of healthy cane, B = Weight of borer infested cane
No pest control measures were applied. At harvest, samples of 10 canes were collected containing uniformly infested and healthy canes comprising 0-100% infested cane. The investigation consisted of 11 infestation levels including one standard. The infestation levels were calculated as the mean of three replications. Weight and sugar recovery of cane were taken for statistical analysis for comparison.

The levels of infestation for each of the study pest including stem borer were as follows:
L_0: 0% infested cane (10 healthy canes)- (standard)
L_1: 10% infested cane (9 healthy canes + 1 infested cane)
L_2: 20% infested cane (8 healthy canes + 2 infested canes)
L_3: 30% infested cane (7 healthy canes + 3 infested canes)
L_4: 40% infested cane (6 healthy canes + 4 infested canes)
L_5: 50% infested cane (5 healthy canes + 5 infested canes)
L_6: 60% infested cane (4 healthy canes + 6 infested canes)
L_7: 70% infested cane (3 healthy canes + 7 infested canes)
L_8: 80% infested cane (2 healthy canes + 8 infested canes)
L_9: 90% infested cane (1 healthy cane + 9 infested canes)
L_{10}: 100% infested cane (10 infested canes)

Data collection and statistical analysis

Data on different parameters related to percent stem borer infestation, percent recovery loss, percent weight loss and yield contributing attributes were recorded. Data on the stem borer, *Chilo tumidicostalis* Hampson was taken by counting the total number of sugarcane and the number of stem borer infested sugarcane per plot and percent infestation was recorded during the period from July to October, 2010. At harvest yield data by weight per plot were recorded. The infestation of the insect pest was expressed in percent, based on total number of sugarcane and infested cane (number/number) and yield (w/w) of sugarcane using the following formulae:

$$\text{Percent infestation of stem borer} = \frac{\text{Number of borer infested sugarcane}}{\text{Total number of sugarcane}} \times 100$$

The cumulative yield (kg per plot) of healthy as well as infested sugarcane was computed. The final yield was expressed in t ha^{-1}. All the data collected and computed were analyzed statistically. The collected data were statistically analyzed using the "Analysis of variance" (ANOVA) technique and the means were separated by using the Duncan's Multiple Range Test (DMRT) with the help of computer MSTAT-C programme (Gomez and Gomez, 1984). Data on borer infestation was recorded by counting total and infested canes for individual plot and the borer percent infestation, recovery loss and weight loss percent were computed for interpretation and discussion of the results.

RESULTS AND DISCUSSION

Relationships of percent stem borer infestation with weather factors

A negative linear relationship was observed between sugarcane stem borer infestation and rainfall (Figure 1A). This suggests that stem borer population is dependent on the rainfall and more than 71% (R^2=0.711) of variation in the stem borer population can be explained by the variation of rainfall. So, it indicates that the stem borer population decreased with decreased rainfall.
A negative linear relationship was observed between sugarcane stem borer infestation and temperature (Figure1C). This suggests that stem borer population is dependent on

the temperature and more than 47% (R^2=0.473) of variation in the stem borer population can be explained by the variation of temperature. So, it indicates that the stem borer population decreased with decreased temperature.

A positive linear relationship was observed between % sugarcane stem borer infestation and percent relative humidity (Figure 1B). This suggests that stem borer population is dependent on the relative humidity and more than 36% (R^2=0.367) of variation in the stem borer population can be explained by the variation of relative humidity. So, it indicates that the stem borer population increased with the increase of relative humidity.

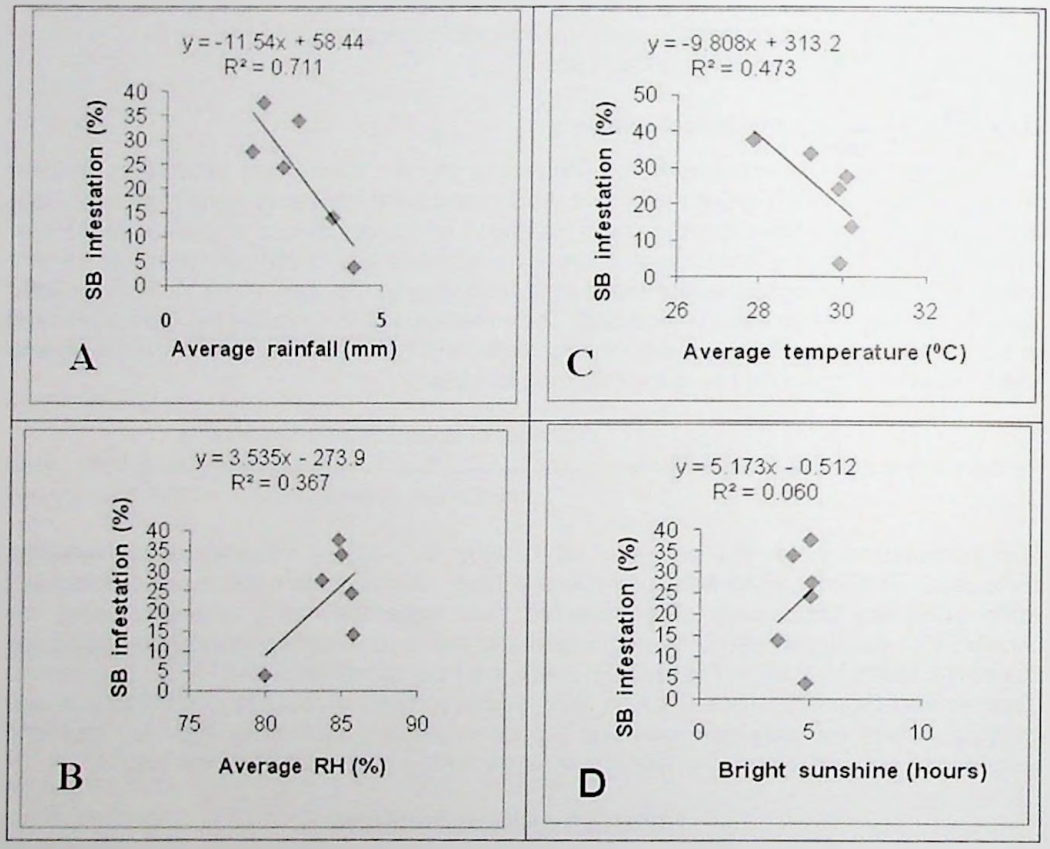

Figure 1. Relationship of sugarcane stem borer infestation with (A) average rainfall, (B) average relative humidity, (C) average temperature (^{0}C) and (D) bright sunshine (hours) at BSRI farm, Ishurdi, Pabna during the cropping season 2009-2010

A positive linear relationship was also observed between sugarcane stem borer infestation and bright sunshine (Figure 1D). This suggests that stem borer population is dependent on the relative humidity and only more than 6% (R^2=0.060) of variation in the stem borer population can be explained by the variation of bright sunshine. So, it indicates that the stem borer population increased slowly with the increase of bright sunshine.

Kalra (1967) also reported the strong relationship of rainfall, relative humidity and temperature the incidence of higher stem borer infestation of sugarcane. Atwal and Sidhu (1967) also observed positive performance of climatic factors on the population buildup of sugarcane stem borers.

Percent recovery loss due to SB infestation

The percent loss of recovery ranged from 0.10 to 2.64%. Loss of recovery at 10% infestation was the highest (2.64%) in lsd 34 which was close to lsd 36 (2.54%). The lowest recovery loss (0.10%) was found in lsd 40. In case of 30% infestation, the highest recovery loss (11.26%) was observed in lsd 34 followed by lsd 32 (11.09%). The lowest recovery loss was found in lsd 38 and lsd 39 (1.29%). The loss of recovery varied from 1.29% to 11.26%. In case of 50% infestation level, the highest recovery loss (14.26%) was obtained from lsd 34 followed by lsd 32 (14.04%). The lowest recovery loss was found in lsd 39 (2.47%). The loss of recovery ranged from 2.47% to 14.26%. In case of 100% infestation level, the highest loss of recovery (41.32%) was observed in lsd 34 followed by lsd 40 (40.85%). The lowest (21.18%) recovery loss was found in lsd 39. The percent loss of recovery varied from 21.18 to 41.32%. From the above discussion, 10% infestation in lsd 31 the loss of recovery was (0.32%). In 50% infestation it was 8.95% and at 100% it was 31.84% (Table 1). With the increasing of percent infestation the percent loss of recovery increased. Same trend was evident in other tested sugarcane varieties. Gupta and Singh (1951) reported that loss in sugar recovery ranged from 1.7 to 3.70 units at 29% infestation of internodes by stalk borer, *Chilo auricilius* Dudgeon in India. Begum *et al.* (2006) reported that sucrose loss of 2.97 units was observed in lsd 16 due to stem borer, *Chilo tumidicostalis* Hampson infestation.

Weight loss due to SB infestation

Loss in weight at 10% infestation was the highest (10.00%) as obtained in lsd 36 followed by lsd 34 (9.66%). The lowest percent loss in weight (0.21%) was found in lsd 35. The loss in weight ranged from 0.21 to 10.00%. At 30% infestation level, the highest percent loss in weight (26.08%) was observed in lsd 34 followed by lsd 38 (26.05%). The lowest percent loss in weight (12.02%) was found in lsd 35. The percent loss in weight ranged from 12.02 to 26.08%. At 50% infestation level, the highest (37.97%) percent loss in weight was recorded in lsd 33 followed by lsd 36 (35.54%). The lowest percent (21.62%) loss in weight was found in lsd 39. The percent loss in weight ranged from 21.62 to 37.97%. At 100% infestation level, the highest percent (72.52%) loss in weight was observed in lsd 36 followed by lsd 35 (69.63%). The lowest percent (48.17%) loss in weight was found in lsd 39. The percent loss in weight ranged from 48.17 to 72.52%. At 10% infestation in lsd 31 weight loss was 5.30%. In 50% infestation it was 23.60% and at 100% it was 62.63% (Table 2). So, when the percent infestation increased the percent loss in weight was also increased. Abdullah and Sardar (1995) reported 18.4% weight

loss in Isd 16 due to borer infestation over healthy cane. These results are to some extent comparable with the results of present study. Alam *et al.* (2006); Begum *et al.* (2006), Abdullah and Sardar (1995), Rao and Krishnamoorthy (1973) and Gupta and singh (1951) evaluated sugarcane varieties like Isd 34, Isd 31 and Isd 33 against major insect pests of sugarcane also studied on different varieties. But none of them found completely resistant against this minacious insect pest like SB. However, varieties moderately tolerant against sugarcane stem borer was found studies continued and still to get such varieties which may be used as a component of IPM. In the present study may be categorized as varieties like Isd 38, Isd 39 and Isd 40 were obtained. Studies are necessary to find out possible reason(s) responsible for this kind of tolerance and exploit for stem borer control.

From the above study it revealed that among the latest ten released sugarcane varieties Isd 40, Isd 39 and Isd 38 showed comparatively higher tolerance and Isd 34 and Isd 31 expressed higher susceptibility to sugarcane stem borer. Recovery loss and weight loss due to stem borer infestation were different at different levels of infestation of those varieties and if decreased with the decreasing rate of insect infestation. Varieties Isd 38, Isd 39 and Isd 40 may be recommended for safer commercial cultivation in Bangladesh especially in stem borer prone areas.

Table 1. Percent loss in sugar recovery due to different levels of stem borer infestation in different latest commercial released sugarcane varieties at BSRI farm, Ishurdi, Pabna, 2009-2010

Different levels of infestation	Percent loss in recovery due to stem borer infestation									
	Isd 31	Isd 32	Isd 33	Isd 34	Isd 35	Isd 36	Isd 37	Isd 38	Isd 39	Isd 40
0% infestation	-	-	-	-	-	-	-	-	-	-
10 % infestation	0.32	0.61	0.97	2.64	0.45	2.54	0.11	0.17	0.54	0.10
20 % infestation	2.02	2.34	5.16	3.25	1.07	5.50	2.84	0.94	1.18	3.02
30 % infestation	5.96	11.09	6.32	11.26	5.82	7.28	7.53	1.29	1.29	6.44
40 % infestation	8.31	12.92	7.75	12.12	6.36	11.42	7.86	1.37	1.94	6.94
50 % infestation	8.95	14.04	8.90	14.26	7.16	12.44	11.68	3.52	2.47	11.87
60 % infestation	9.48	14.95	9.62	15.88	9.13	14.30	11.90	5.23	3.44	25.45
70 % infestation	17.15	22.78	13.27	18.05	14.68	17.85	12.45	10.46	4.52	28.97
80 % infestation	19.91	24.52	14.87	19.58	14.95	18.19	14.41	10.55	4.84	37.32
90 % infestation	22.15	29.70	15.49	21.30	25.51	20.39	15.94	19.30	14.62	38.23
100 % infestation	31.84	34.38	27.60	41.32	26.86	25.89	23.03	21.53	21.18	40.85
LSD (0.05)	1.762	1.730	1.729	1.765	1.800	1.772	1.644	1.768	NS	1.777
CV (%)	12.45	12.20	10.05	11.23	10.54	10.04	11.69	9.55	11.92	12.83

Table 2. Percent loss in weight due to different levels of stem borer infestation in different latest released commercial sugarcane varieties at BSRI farm, Ishurdi, Pabna, 2009-2010

Different levels of infestation	Percent loss in weight due to stem borer infestation									
	Isd 31	Isd 32	Isd 33	Isd 34	Isd 35	Isd 36	Isd 37	Isd 38	Isd 39	Isd 40
0% infestation	-	-	-	-	-	-	-	-	-	-
10 % infestation	5.30	2.00	6.81	9.66	0.21	10.00	6.18	9.16	6.88	9.23
20 % infestation	8.55	5.72	18.21	15.74	10.94	18.15	14.22	19.45	8.50	18.66
30 % infestation	17.40	7.94	18.89	26.08	12.02	19.12	22.04	26.05	13.36	25.87
40 % infestation	17.70	15.59	36.70	26.23	32.40	34.66	23.08	27.16	16.35	31.34
50 % infestation	23.60	22.05	37.97	35.35	32.73	35.54	29.78	29.13	21.62	33.62
60 % infestation	28.22	24.05	44.21	35.84	44.21	44.95	36.93	35.56	23.64	40.70
70 % infestation	38.05	31.92	55.50	40.76	54.93	55.33	44.68	38.30	30.36	47.70
80 % infestation	48.57	38.16	59.10	43.15	63.19	65.33	44.38	42.25	30.93	47.87
90 % infestation	58.70	44.32	63.29	43.68	63.84	65.05	50.11	44.04	30.76	50.39
100 % infestation	62.63	53.97	65.92	66.60	69.63	72.52	60.53	62.55	48.17	64.80
LSD (0.05)	1.411	1.567	1.509	1.555	1.538	1.243	1.378	1.442	1.526	1.644
CV (%)	11.32	8.80	13.69	11.39	14.89	11.52	8.63	10.42	9.18	11.51

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