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ORIGINAL ARTICLE

Investigation on Antixenosis Mechanism of Resistance to Early Shoot Borer, *Chilo Infuscatellus* Snellen in Sugarcane

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ABSTRACT
In vivo experiment was conducted to screen 56 genotypes for resistance to early shoot borer, Chilo infuscatellus Snellen at Zonal Agricultural Research Station, V.C farm, Mandya during 2014-2015. Among the 56 genotypes, 47 genotypes were found less susceptible, while nine genotypes were found moderately susceptible to early shoot borer. Among these 16 genotypes, 009-64(3.44%), 10-65-01(5.59%), 10-65-01(3.83%), 10-17-08(4.97%), 10-57-07(12.65%), 07-10-02(10.57%), 10-28-02(10.03%), 09-61-02(14.85%), 10-17-05(15.39%), 07-06-05(16.48%), 10-33-33(17.75%), 10-38-06(29.86%), 08-15-06(25.88), 06-09-03(27.45) and checks CoVC 99463(4.83%) and Co 86032(22.39%) were selected to find out the antixenosis mechanism associated with them. Correlation studies on the morphological characters of different genotypes on ESB incidence revealed that the ESB incidence was highly influenced by leaf angle, leaf sheath thickness and shoot girth. Among the morphological parameters, leaf angle showed positive correlation (r= 0.819) with ESB incidence. Whereas leaf sheath thickness (r= -0.674) and shoot girth (r= -0.541) had negative correlation with ESB infestation in different genotypes. Correlation studies revealed no relationship between number of leaves, length of leaf, breadth of leaf, plant height and per cent incidence with ESB.
Key words: *Antixenosis, Chilo infuscatellus, Early shoot borer, Leaf angle Morphological parameters*

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INTRODUCTION

In sugarcane based on feeding habit, the insect pests are broadly classified as borers, sucking pests, subterranean pests, defoliators and non-insect pests. The nine species of lepidopteran pests regularly damage sugarcane [3] in India. Among the major species of borers, the early shoot borer (ESB), *Chilo infuscatellus* Snellenis an important pest infesting the crop during early stages prior to internode formation. It also infests millable cane during years of drought or scanty rainfall. It has been computed that the shoot borer destroys 23-65 per cent mother shoots and 6.4, 27.1 and 75 per cent of primary, secondary and tertiary tillers respectively [4; 8]. As reported by [11] the ESB can cause a loss to the extent of 22-33 per cent in yield, 12 per cent in sugar recovery, two per cent in commercial cane sugar and 27 per cent in jaggery.

Several control methods have been evaluated from time to time. Among the different management strategies, the use of resistant genotype is one of the important components of IPM. So different genotypes have been screened under natural conditions to identify the less susceptible genotype for early shoot borer.Among the screened genotypes the morphological parameters that impart resistance to early shoot borer were investigated. Knowledge on resistance mechanism and associated factors involved is essential for effective utilization of source of resistance which is useful in future breeding programme.

MATERIAL AND METHODS

Preliminary study on field screening of different genotypes was done to identify the less susceptible genotyps against ESB, *C. Infuscatellus* during 2014 at Zonal Agricultural Research Station, V.C farm, Mandya. Three budded sets of 56 genotypes were obtained from plant breeding department, AICRP on sugarcane, Mandya. The experiment was laid out in a randomised block design with fiftysix genotypes and was replicated twice. All agronomic practices were carried out as per the package of practices recommended for sugarcane cultivation by UAS, Bangalore [1]. Based on the per cent cumulative incidence of ESB, genotypes were graded according to [13].

Dead heart counts: Number of dead hearts caused by early shoot borer out of the total number of tillers observed in all the entries at 30, 60, 90 and 120 days after planting (DAP) was recorded. After each count, the dead hearts were pulled out to avoid counting them later on. The per cent incidence of ESB, *Chilo infuscatellus* was calculated by using the formula

$$\text{Per cent incidence} = \frac{\text{Number of dead hearts}}{\text{Total number of tillers}} \times 100$$

Cumulative per cent incidence of ESB, *Chilo infuscatellus*: The cumulative per cent incidence was worked out by relating the progressive total of infested tillers (dead hearts) in proportion to the total number of tillers (14) at 120 DAP. Based on the cumulative per cent incidence, the sugarcane varieties were grouped in to three categories (13).

Grade/Category	Cumulative per cent incidence
Less susceptible (LS)	0-15 per cent
Moderately susceptible (MS)	15-30 per cent
Highly susceptible (HS)	>30 per cent

Studies on the mechanism of resistance to ESB, *C.infuscatellus*: Antibiosis components of resistance to the ESB, *C.infuscatellus* was studied in sixteen selected sugarcane genotypes under natural field conditions at the Zonal Agricultural Research Station, V.C farm, Mandya. The test genotypes consisted of eight least susceptible and six moderately susceptible genotypes along with two checks Co 86032 and CoVC 99463.

Morphological parameters: Studies were taken up to identify the biophysical differences between the sixteen selected promising genotypes. For this, five randomly selected plants were used and observations on physical parameters like thickness of leaf sheath, height of the plant, girth of the plant, number of leaves, leaf angle, and length and breadth of leaf were recorded. The data were subjected to ANOVA and was correlated with the cumulative incidence of early shoot borer to calculate 'r' value.

RESULTS AND DISCUSSION

Among the 56 genotypes, 47 genotypes were graded as least susceptible including the standard check CoVC 99463 (4.83%) of which genotype 09-60-06 was found to be highly resistant to ESB throughout the crop growth with 0.00 cumulative per cent incidence of ESB.The nine genotypes were categorized as moderately susceptible including the standard check Co 86032 (22.39%) and none of the genotypes were categorized under highly susceptible category. The highest cumulative incidence of ESB was recorded in genotypes 08-15-06 (25.88%), 06-09-03 (27.45%) and 10-38-06 (29.86%).Among them, sixteen genotypes showing low to moderate susceptibility to ESB were selected for Antixenosis studies (Table 1). Similar results were also reported by the earlier workers (12, 9 and 2).

Morphological parameters

Number of leaves: The number of leaves per plant varied from 6.10 to 7.50 in different genotypes. The maximum numbers of leaves were recorded in genotype, 08-15-06 (7.50 leaves/plant) with the cumulative ESB incidence of 25.88% and the minimum numbers of leaves were recorded in the genotype, 10-17-08 (6.10 leaves/plant) with the cumulative ESB incidence of 4.97%. Whereas the checks CoVC 99463 and Co 86032 recorded 7.30 and 6.80 leaves/plant with the cumulative ESB incidence of 4.83% and 22.39%, respectively (Table 2). However, a non significant correlation (r= 0.17) was observed between number of leaves and cumulative ESB incidence in different genotypes (Table 3).The present findings are in agreement with those reported [10].

Leaf length: The length of the leaf was maximum (99.80 cm) in the LS genotype, 09-61-02 with cumulative ESB incidence of 14.85 per cent. Shortest leaf (72.70 cm) was found in LS genotype 10-28-02 with cumulative ESB incidence of 10.03 per cent (Table 2). A non significant negative correlation was found (r= -0.29) between length of leaf and cumulative incidence of ESB (Table 3). Present findings are in agreement with those reported [10].

Width of leaf: The maximum width of leaf was recorded in genotypes, 10-65-01 (2.50 cm) and 10-17-05 (2.32cm) with the cumulative ESB incidence 5.59% and 15.39%, respectively and minimum leaf width

was found in the genotypes, 10-33-16 (1.66 cm) and 06-09-03 (27.45 cm) with the cumulative ESB incidence 3.83% and 27.45%, respectively (Table 2).However, a non significant negative correlation (r = -0.28) was found between breadth of leaf and cumulative incidence of ESB (Table 3).Present findings are in agreement with those reported [10].

Leaf inclination: The leaf angle ranged from 18° to 25° and 22° to 35° in LS and MS genotypes, respectively. The LS genotype, 009-64 having significantly lower leaf angle (18°) with the cumulative ESB incidence (3.24 per cent) and the MS genotype, 10-38-06 having significantly higher leaf angle (35.50°) with the cumulative ESB incidence of 29.86 per cent. Whereas checks CoVC 99463 and Co 86032 registered 25 and 29 degree of leaf angle with the cumulative ESB incidence of 4.83% and 22.39% , respectively (Table 2). A significant positive correlation was observed between leaf inclination (r= 0.81) and cumulative ESB incidence in different genotypes. (Table 3 and Figure 1).The results obtained with leaf angle are in conformity with the findings (2) who reported that leaf angle was largely accountable for variation in early shoot borer incidence in different genotypes.

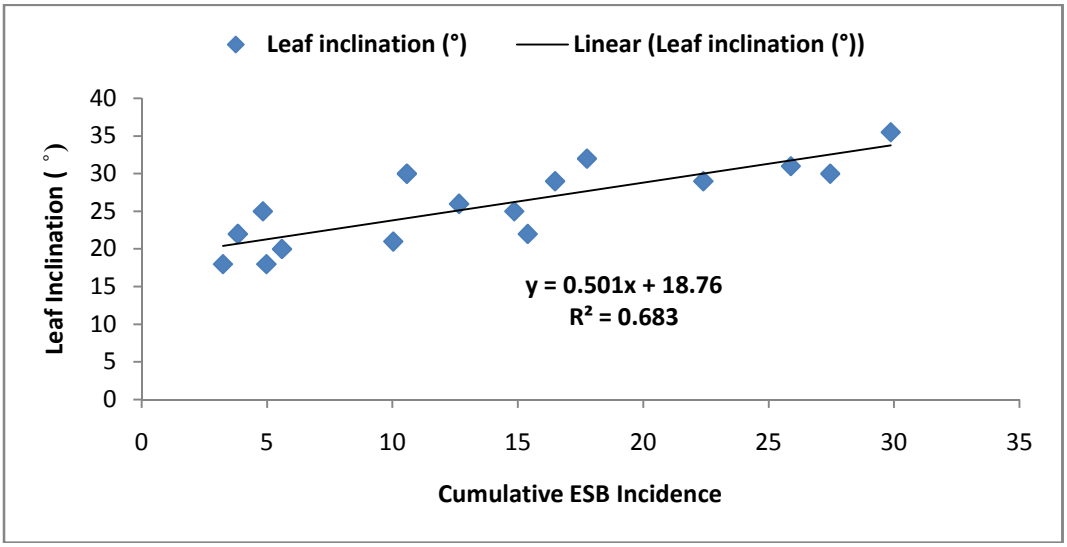

Figure 1. Correlation between leaf inclination of different sugarcane genotypes and Cumulative ESB incidence

Leaf sheath thickness: The leaf sheath thickness showed significant difference among the genotypes. Data presented in the Table (2) indicated that LS genotypes were having the thick leaf sheath ranging from 0.064 to 0.089 g/cm^2, with the cumulative ESB incidence of 3.24 to 14.85 per cent and MS genotypes were found having the thin leaf sheath (0.061 to 0.072 g/cm^2) with the cumulative ESB incidence of 15.39 to 29.86 per cent. Significantly maximum leaf sheath thickness (0.089 g/cm^2) was recorded in LS genotype, 009-64 (3.24 per cent cumulative ESB incidence). MS genotype, 10-38-06 (29.86 per cent of cumulative ESB incidence) recorded minimum (0.061g/cm^2) leaf sheath thickness and registered 29.86 percent cumulative incidence of ESB. Whereas check CoVC 99463 and Co 86032 registered 0.070 g/cm^2 and 0.067 g/cm^2 of leaf sheath thickness with the cumulative ESB incidence 4.83% and 22.39%, respectively (Table 2). Leaf sheath thickness showed significant negative correlation (r= -0.67) with the cumulative incidence of ESB (Table 3 and Figure 2).The present results on leaf sheath thickness of different genotypes revealed that all less susceptible genotypes with thick leaf sheath have recorded less ESB infestation as compared to moderately susceptible genotypes. The results obtained were in conformity with that of [2] who reported that genotypes with thick leaf sheath were found less susceptible to ESB. This is mainly due to the difficulty in boring the hard thick leaf sheath as reported [7].

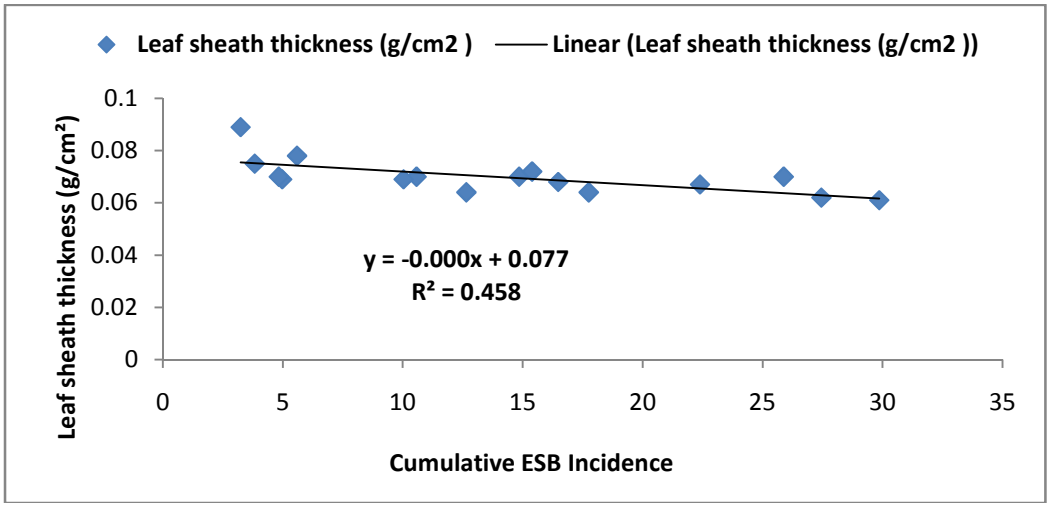

Figure 2. Correlation between leaf sheath thickness of different sugarcane genotypes and Cumulative ESB incidence

Girth of shoot: The thick shoot girth was recorded in LS genotypes and it ranged from 4.09 to 5.72 cm with a cumulative ESB incidence of 3.24 to 14.85 per cent. Whereas thin shoot girth was recorded in MS genotypes and it ranged from 3.98 to 4.78 cm with a cumulative incidence of ESB ranging from 15.39 to 29.86 per cent. Significantly thick shoot (5.72cm) was recorded in genotype, 009-64 with a cumulative ESB incidence of 3.24 per cent. The thin shoot (3.98cm) was recorded in MS genotype, 06-09-03 with a cumulative ESB incidence of 27.45 per cent. Whereas check CoVC 99463 and Co 86032 registered 4.83 cm and4.34 cm of shoot thickness with the cumulative ESB incidence of 4.83% and 22.39%, respectively (Table 2). A significant negative correlation was observed between shoot girth (r=-0.54) and ESB infestation in different genotypes (Table 3 and Figure 3).The present findings are in contrast to those findings (2) which showed that shoot girth had significant positive correlation with ESB infestation. The present studies revealed that higher leaf sheath thickness was recorded in least susceptible genotypes so thickness of leaf sheath directly contributes to more girth and offered higher resistance against ESB.

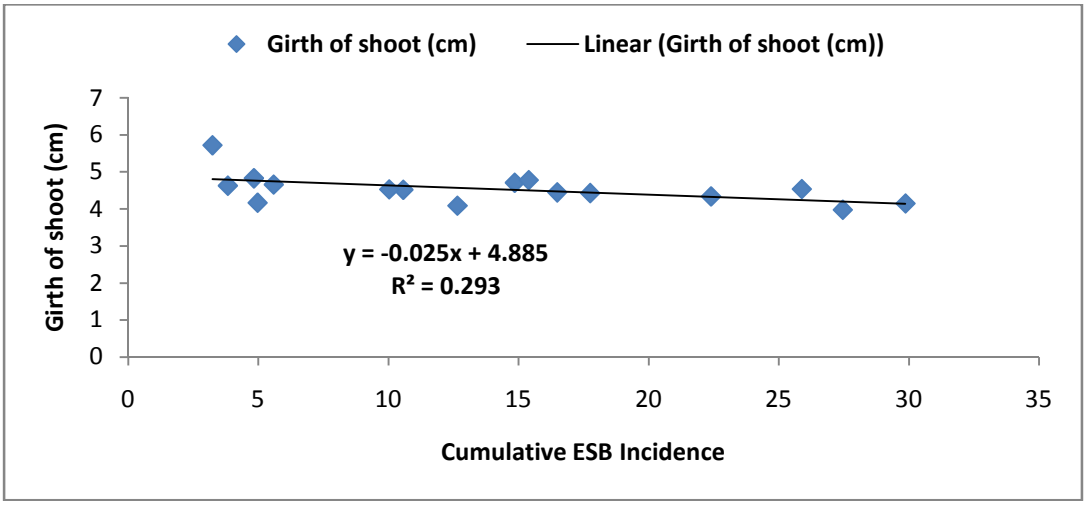

Figure 3. Correlation between shoot girth of different sugarcane genotypes and Cumulative ESB incidence

Plant height: The plant height in LS genotypes ranged from 123.40 to 139.85cm, with a cumulative ESB incidence of 3.24 to 14.85 per cent. The plant height in MS genotypes ranged from 119.80 to 131.10cm with a cumulative ESB incidence of 15.39 to 29.86 per cent. A non significant negative correlation (r = -0.31) was observed between plant height and ESB infestation of different genotypes [27].

Table 1 Cumulative incidence of ESB, *C. infuscatellus* up to 120 DAPS in different sugarcane genotypes during 2014-2015.

Sl. No	Genotypes	Cumulative Incidence	Sl. No	Genotypes	Cumulative Incidence
1	09-60-06	0.00(0.00)	30	09-63-01	7.90(20.64)
2	Co 0323	0.87(6.68)	31	10-38-15	7.91(21.04)
3	09-65-02	1.29(8.38)	32	09-29-04	7.96(21.06)
4	11-02-09	1.35(8.62)	33	09-61-07	8.05(21.20)
5	7-62-01	1.78(9.79)	34	09-30-01	8.46(21.76)
6	10-28-16	1.84(9.78)	35	10-14-16	9.44(22.40)
7	09-60-28	1.90(10.06)	36	07-21-04	9.59(22.97)
8	10-28-08	2.36(10.87)	37	07-10-02	10.57(24.41)
9	11-11-06	2.59(11.84)	38	10-28-02	10.03(23.72)
10	Co62175	2.64(12.08)	39	09-60-10	10.26(24.04)
11	09-61-05	3.10(12.84)	40	09-60-08	10.52(24.15)
12	10-12-14	3.12(13.15)	41	09-60-04	10.72(24.50)
13	009-64	3.24(12.82)	42	10-14-15	11.50(25.42)
14	12-41-25	3.43(13.81)	43	10-20-08	12.03(26.09)
15	10-33-16	3.83(14.55)	44	10-38-08	12.55(26.61)
16	VCF 0517	4.11(15.09)	45	10-57-07	12.65(25.83)
17	10-17-08	4.97(16.53)	46	09-61-02	14.85(28.99)
18	09-10-03	5.08(16.82)	47	10-58-05	15.38(29.55)
19	10-38-07	5.21(16.79)	48	10-17-05	15.39(29.57)
20	7-82-10	5.39(17.01)	49	07-06-05	16.48(30.30)
21	11-23-05	5.47(17.27)	50	10-33-33	17.75(31.76)
22	10-65-01	5.59(17.68)	51	10-20-11	18.87(32.34)
23	10-20-06	5.86(18.07)	52	08-15-06	25.88(38.73)
24	10-43-06	6.69(19.32)	53	06-09-03	27.45(39.77)
25	10-14-17	6.73(19.41)	54	10-38-06	29.86(41.04)
26	08-04-01	6.75(19.42)	55	Co99463	4.83(16.41)
27	10-35-04	7.45(20.45)	56	Co 86032	22.39(35.09)
28	09-65-04	7.74(20.83)	SEm±	1.5	
29	11-11-02	7.88(20.83)	CD @ P=0.05	4.2	

Table 2:Influence of morphological parameters of different sugarcane genotypes on the cumulative incidence of *C.infuscatellus*

Genotype		Cumulative ESB Incidence (%)	Number of leaves /plant	Length of leaf (cm)	Breadth of leaf (cm)	Leaf inclination (°)	Leaf sheath thickness (g/cm²)	Girth of shoot (cm)	Height of the plant (cm)
LS	009-64	3.24(12.82) ^{a}	7.40	91.10	1.93	18.00 ^{a}	0.089 ^{a}	5.72 ^{a}	139.85
	10-65-01	5.59(17.68) ^{abcd}	7.00	90.20	2.50	20.00 ^{b}	0.078 ^{b}	4.66 ^{bcd}	128.40
	10-33-16	3.83(14.55) ^{ab}	7.00	78.40	1.66	22.00 ^{c}	0.075 ^{bc}	4.63^{bcd}	123.40
	10-17-08	4.97(16.53) ^{abc}	6.10	93.40	1.93	18.00 ^{a}	0.069 ^{cde}	4.17 ^{cde}	130.10
	10-57-07	12.65(25.83) ^{abcdef}	7.00	79.80	2.19	26.00 ^{d}	0.064 ^{def}	4.09 ^{de}	128.10
	07-10-02	10.57(24.41)^{abcde}	6.90	83.70	2.02	30.00 ^{ef}	0.070 ^{cd}	4.52 ^{bcde}	126.10
	10-28-02	10.03(23.72) ^{abcde}	6.80	72.70	2.22	21.00 ^{bc}	0.069 ^{cd}	4.53 ^{bcde}	124.90
	09-61-02	14.85(28.99) ^{abcdef}	6.20	99.80	2.21	25.00 ^{d}	0.070 ^{cd}	4.71 ^{bc}	137.30
MS	10-17-05	15.39(29.57) ^{cdefg}	6.50	88.20	2.32	22.00 ^{c}	0.072 ^{bc}	4.78 ^{b}	131.10
	07-06-05	16.48(30.30) ^{cdefg}	7.10	82.80	1.98	29.00 ^{e}	0.068 ^{cdef}	4.45 ^{bcde}	125.70
	10-33-33	17.75(31.76) ^{defg}	6.70	79.80	2.22	32.00 ^{g}	0.064 ^{def}	4.43^{bc}	126.60
	10-38-06	29.86(41.04) ^{g}	7.20	86.70	1.98	35.50 ^{h}	0.061 ^{f}	4.15^{bc}	131.00
	08-15-06	25.88(38.73)^{fg}	7.50	77.80	1.78	31.00^{fg}	0.070 ^{cd}	4.54 ^{bcde}	121.60
	06-09-03	27.45(39.77) ^{fg}	7.10	74.60	1.74	30.00 ^{ef}	0.062 ^{ef}	3.98 ^{cde}	119.80
Checks	CoVC 99463	4.83(16.41)^{abc}	7.30	93.70	2.53	25.00 ^{d}	0.070 ^{cd}	4.83 ^{bcde}	129.50
	Co 86032	22.39(35.09) ^{efg}	6.80	90.22	2.11	29.00 ^{e}	0.067 ^{cd}	4.34 ^{d}	130.10
SEM ±		2.4	NS	NS	NS	0.77	0.2	0.27	NS
CD (5%)		7.2				1.65	0.01	0.57	

LS: Less susceptible; MS: Moderately susceptible; ESB: Early shoot borer; NS: Non significant

Values in the column followed by common letters are non-significant at p=0.05 as per Tuckey's HSD (Tukey, 1965). Figures in the parentheses are arcsine √x transformed values

Table 3:Correlation between morphological characters of different genotypes and cumulative incidence of ESB

Morphological parameter	Correlation with cumulative incidence of ESB
No. of leaves/plant	0.17
Length of leaf (cm)	-0.29
Breadth of leaf (cm)	-0.28
Leaf inclination (˚)	0.81*
Leaf sheath thickness	-0.67*
Girth of shoot	-0.54*
Height of the plant(cm)	-0.31

*** Correlation is significant at the 0.05 level**

CONCLUSION

The results of field screening of different genotypes for resistance to ESB revealed that the genotypes *viz*., 009-64(3.44%), 10-65-01(5.59%), 10-65-01(3.83%), 10-17-08(4.97%), 10-57-07(12.65%), 07-10-02(10.57%), 10-28-02(10.03%) and 09-61-02(14.85%) which recorded less than 15 per cent of incidence were graded as least susceptible while genotypes 10-17-05(15.39%), 07-06-05(16.48%), 10-33-33(17.75%), 10-38-06(29.86%), 08-15-06(25.88) and 06-09-03(27.45) have recorded 15 to 30 per cent incidence of ESB were graded as moderately susceptible (MS), whereas check CoVC 99463(4.83%) and Co 86032(22.39%) have recorded per cent incidence of ESB. Morphological characters of different genotypes on ESB incidence revealed that the ESB incidence was highly influenced by leaf angle, leaf sheath thickness and shoot girth. Leaf sheath thickness (r= -0.674) and shoot girth (r= -0.541) had negative correlation with ESB infestation in different genotypes. Correlation studies revealed no relationship between number of leaves, length of leaf, breadth of leaf, plant height and per cent incidence with ESB. Among the morphological parameters, leaf angle showed positive correlation (r= 0.819) with ESB incidence.

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