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Investigation on Antibiosis 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 checksCoVC99463(4.83%) and Co 86032(22.39%) were selected to find out the antibiosis mechanism associated with them.

Correlation study on the biochemical constituents of 16 selected genotypes and checks with the cumulative incidence of ESB revealed positive correlation with total sugars (r= 0.80) and reducing sugars (r= 0.82*). Whereas phenols (r= -0.84*), cellulose (r= -0.80*), silica (r= -0.82*) and lignin (r= -0.79*) showed negative correlation with ESB incidence. So biochemical analysis of the genotypes indicated lower quantity of total sugars and reducing sugar and higher quantity of phenols, cellulose, lignin and silica were found imparting resistance to ESB of sugarcane.*

Key words: *Sugarcane, Lepidopteran, Shoot borer, Jaggery*

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[5] in India. Among the major species of borers, the early shoot borer (ESB), *Chilo infuscatellus* Snellen is 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.

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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[6,13]. As reported by Patil and Hapase[20] 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 mechanism that imparts 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 setts 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 Rao and Krinshamoorthy[23].

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, *Chiloinfuscatellus* 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, *Chiloinfuscatellus*

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[28] at 120 DAP.

Based on the cumulative per cent incidence, the sugarcane varieties were grouped in to three categories[23].

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.

Biochemical studies

To study the biochemical differences among sixteen selected genotypes, plant samples were collected from the field at 60 DAP. Total phenols, total sugars, reducing sugars, cellulose, lignin and silica contents in shoot tissues were estimated. The data obtained was subjected to ANOVA[8,9] and was correlated with the cumulative incidence of early shoot borer to calculate 'r' value.

Extraction of plant tissue in ethanol for estimation of Phenols and sugars

Extractions were prepared following the method suggested by Mahadevan and Sridhar[16]. One gram of fresh shoot was made into small bits and boiled immediately in 80 per cent ethyl alcohol (5-10ml) kept in a water bath for about 5-10 minutes. The sample was

taken out from water bath and cooled in a pan of cold water. The material was homogenized by grinding in a pestle and mortar and later filtered through a muslin cloth. The residue was again re-extracted with small quantity of ethyl alcohol (2-3ml) to ensure complete removal of alcohol traces. The first and the second extracts were pooled, filtered through Whatman No.41 filter paper. The final volume was adjusted with 80 per cent ethanol or reduced the extract by evaporating it to represent 10ml of the extract for every one gram of tissue used.

Estimation of total sugars

The total sugar content in plant samples was estimated as suggested by Dubois *et al*.[7]. Ethanol extract (0.2ml) was taken into a volumetric flask and 1.8 ml of triple glass distilled water was added. Then 0.25 ml of 80 per cent phenol was added. The sample was shaken and 5ml of concentrated H_2So_4 was added immediately and allowed to stand for 30 minutes. Per cent absorbance at 490 nm was measured using Spectronic-20. Blank without sugar extract was used to adjust to zero. The absorbance scale and sample values were corrected for the mean of three reaction blanks. Standard curve of glucose concentration versus absorbance was used to convert sample absorbance to per cent sugar. The average value of plant sample was recorded as the total sugar in mg/g of sample.

Estimation of reducing sugars

Reducing sugar content of the plant samples was estimated by adopting Nelson and Somogyi method[15]. For one ml. of ethanol extract, one ml. of Copper reagent was added. The mixture was heated for 20 minutes in a water bath, cooled and one ml. of arsenomolybdate reagent was added. The intensity of blue colour developed was read against a blue in Spectrometric-20 at 520 nm and was expressed in terms of glucose equivalents. Standards with different concentrations (i.e., 25, 50, 75, 100 and 125) were prepared from the working standard and their absorbance was read by taking one ml aliquots.

Per cent total soluble sugar was calculated by using the formula:

$$\frac{\text{Conc. of Std.}}{\text{Absorbance of Std.}} \times \text{Ab. of 1 ml extract} \times \frac{1}{1000000} \times \frac{3\text{ml}}{0.1\text{ g}} \times 100$$

Estimation of total phenols

Total phenols were determined by adopting the method suggested by Mallik and Singh[18]. One ml of ethanol extract was taken in a graduated test tube and one ml. of Folin-Ciocalteu reagent and two ml. of 20 per cent Sodium carbonate were added. The mixture was heated in a water bath for about one minute. Then the sample was taken out from the water bath and cooled under a running tap water. The sample was diluted to 25 ml with distilled water. The absorbance of the resultant blue colour solution was read at 650 nm in a spectrometric -20. A reagent blank was maintained with one ml of distilled water in place of ethanol extract. Total phenols were calculated from Catechol standard curve and expressed in mg/g of sample.

Cellulose estimation

3 ml acetic/nitric reagent was added to a known amount (0.5 g) of the sample in a test tube and mixed in a vortex mixer. Test tube was placed in a water-bath at 100°C for 30 min. and cooled. Then centrifuged the contents for 15–20 min, discarded the supernatant wash the residue with distilled water. 10 ml of 67% sulphuric acid was added and allowed to stand for 1 h. 1 ml of the above solution was diluted to 100 ml. To 1 ml of this diluted solution, 10 ml of anthrone reagent was added and mixed well. The tubes were heated in a boiling water-bath for 10 min. The colour was measured using Spectrometric-20 at 630 nm. Set a blank with anthrone reagent and distilled water. 100 mg cellulose was in a test tube and proceeded from the begaining for standard. Instead of just taking 1 ml of the diluted solution a series of volumes taken (say 0.4–2 ml corresponding to 40–200 μg of cellulose) and the colour was developed[29].

Isolation of Lignin

Sugarcane was cut into small pieces and shade dried. The shade dried samples were ground to make powder. Then the sugarcane powder was first extracted with toluene-ethanol (2:1, v/v) in a soxhlet apparatus for 6h. Samples free of wax were then dried in an oven at 60° C for 16h. All weights and calculations were made on an oven-dried (60° C, 16 h) basis.

Lignin fractions were isolated by sequential extraction[31]. The dewaxed sugarcane powder was then soaked in 1 M aqueous NaOH solution with a 1:100 powder to extractant ratio (g/ml). the dispersions were allowed to stir gently for 18h at 30° C in a glass beaker, respectively, the residue was filtered off and washed thoroughly with water and 95% ethanol until the filtrate was neutral, and then dried in an oven at 60° C for 16h. The alkali lignins were obtained by precipitation at pH 1.5 adjusted with 6M HCL from the corresponding supernatants after evaporation of ethanol. The isolated lignin preparations were purified by washing with acidified water (pH 2.0), and then freeze-dried and kept at 5 °C until analysis.

Silica extraction

While extracting silica from sugarcane an acid washing step was used to remove the small quantities of minerals prior to silica extraction from shade dried sugarcane powder ash in the following manner. Two grams of sugarcane ash samples were dispersed in 40 ml of distilled water, and the pH was adjusted to 7 using 1 N HCl. These dispersions were stirred for 2 h, filtered through Whatman No. 41 ashless filter paper and then the sugarcane ash residues were washed with 100 ml of water. The residues were used for silica extraction. The filtrate and washings at 7 pH were collected and dried in an evaporating dish. Silica was extracted from sugarcane ash adapting the method of Kamath and Proctor[11].

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 biochemical studies (Table 1). Similar results were also reported by the earlier workers Rajendran and Giridharan[21], Kumar and Bhavani*et al*.[2].

Biochemical constituents

Total sugars

The amount of total sugars in shoot tissues showed significant difference among the genotypes and the differences ranged from 3.72 to 6.84% in LS genotypes and 4.92 to 7.66 % in MS genotypes. Total sugar was highest (7.66%) in the shoot tissues of MS genotype, 06-09-03 with the cumulative ESB incidence of 27.45 per cent and was lowest (3.72%) in LS genotype, 10-65-01 with the cumulative ESB incidence of 5.59 per cent. Whereas standard CoVC 99463 and Co 86032 registered 3.92% and 7.56% of total sugars with the cumulative ESB incidence 4.83% and 22.39% respectively (Table 2). An increasing trend of total sugar contents of shoot tissues of different genotypes was observed with increase in susceptibility of genotypes to ESB. The correlation study between these two factors revealed significant positive relationship (r= 0.85) (Table 3 and Figure 1).

The results obtained are in agreement with earlier reports by Bhavani*et al*.[2] and Vemuri*et al*.[30]. They have reported that sugarcane genotypes susceptible to *chiloinfuscatellus* contained higher percentage of total sugars than resistant ones. This is mainly because, sugar is considered as one of the vital nutrients in plants and also sugar contents reflect the metabolic state of the sugarcane shoot, the difference in the relative amounts of sugars between different genotypes with differential susceptibilities to ESB indicate that these compounds might act as phagostimulant to *C. infuscatellus* feeding on sugarcane.

Reducing sugar

A similar trend was observed with respect to reducing sugars. The shoots of LS genotypes contained significantly less amount of reducing sugars and it ranged from 0.059 to 0.110% and the shoots of MS genotypes contained significantly higher amount of reducing sugars (0.080 to 0.140%). The reducing sugars present in higher amount (0.140%) in the shoot tissues of MS genotype, 06-09-03 with the cumulative ESB incidence of 27.45 per cent. Lowest reducing sugars (0.059%) were found in the shoot tissue of LS genotype, 10-65-01 with the cumulative ESB incidence of 5.59%. Whereas check CoVC 99463 and Co 86032 registered 0.061% and 0.141% of reducing sugars with the cumulative ESB incidence of 4.83% and 22.39% respectively (Table 2).

An increasing trend of reducing sugar contents of shoot tissues of different genotypes was observed with increase in susceptibility of hosts to ESB incidence. The correlation study established significant positive relationship between reducing sugars and ESB incidence (r= 0.80) (Table 3 and Figure 1). The results obtained are in agreement with earlier reports by Bhavani*et al*.[2] and Vemuri*et al*.[30]. They have reported that sugarcane genotypes susceptible to *chiloinfuscatellus* contained higher percentage of reducing sugars than resistant ones. The reducing sugars are considered to be an essential component in insect nutrition, and play a vital role in host selection by phytophagous insects; their concentration in host plant is positively correlated with feeding behavior of insects. Similar observations were also reported by Knapp *et al*.[14] against *Helicoverpazea*in corn.

Total phenol

The LS genotypes contained higher phenols in the shoot tissue and it ranged from 7.15 to 9.85 mg/g and the MS genotypes contained lesser amount of phenols in the shoot tissue and it ranged from 6.77 to 8.02 mg/g. The LS genotype, 009-64 contained significantly maximum amount of phenol (9.85mg/g) with the cumulative ESB incidence of 3.24%. Minimum amount of phenols were found in MS genotype, 06-09-03 (6.77mg/g) with the cumulative ESB incidence of 27.45 per cent. Whereas, check CoVC 99463 and Co 86032 registered 8.56mg/g and 7.14 mg/g of phenols with the cumulative ESB incidence 4.83% and 22.39% respectively (Table 2). Phenol content of shoot tissues showed significant difference among different genotypes and also showed a significant inverse relation (r=-0.86) with ESB susceptibility (Table 3, Figure 2).

The results obtained are in agreement with the earlier reports by Bhavani*et al*.[2] and Vemuri*et al*.[30]. They have reported that sugarcane genotypes resistance to *chiloinfuscatellus* contained higher amount of phenol. Phenols are one of the important group of plant defense chemicals responsible for antifeedant and/or antibiotic effects on insects[12,27]. Aphid in wheat[19] whitefly in cotton[4] aphid on mustard[24] and stem borer Chilopartellus in maize[10] have also recorded similar observation in relation to stem borer resistance.

Cellulose

The amount of cellulose in shoot tissues showed significant difference among the genotypes. The cellulose content in LS genotype ranged from 15.09- 22.00 per cent. The cellulose content in MS genotype ranged from 13.89-17.12 per cent. The least susceptible genotype, 009-64 recorded significantly had higher amount of cellulose (22.00%) with the cumulative ESB incidence of 3.24 per cent. Lower amount of cellulose (13.89%) was found in the moderately susceptible genotype, 10-38-06 with the cumulative ESB incidence of 29.86 per cent. Whereas check CoVC99463 and Co 86032 registered 20.11% and 15.08% of cellulose with the cumulative ESB incidence of 4.83% and 22.39% respectively (Table 2 and Figure 2).

This indicates a decreasing trend in cellulose content in shoot tissues in genotypes with the susceptibility and it is negatively correlated with ESB susceptibility. Significant inverse relationship (r= -0.83) was found between cellulose content of the genotypes and the incidence of ESB (Table 3).Sharma and Chatterji[26] have also reported negative association between biochemical constituents like the NDF, ADF, Phenol, cellulose and lignin content in leaf sheath and stalk with susceptibility to top borer *C. auricilius* in sugarcane.

Lignin

The lignin content in the shoot tissues of LS genotypes varied from 5.70 to 8.05% and in MS genotype varied from 4.80 to 6.70%. The LS genotype, 10-65-01 contained significantly maximum amount of lignin (8.05%) with the cumulative ESB incidence of 5.59 per cent and significantly minimum amount of lignin 4.80 per cent was found in the MS genotype, 10-38-06 with the cumulative ESB incidence of 29.86%. Whereas check CoVC 99463 and Co 86032 registered 7.00% and 5.03% of lignin with the cumulative ESB incidence 4.83% and 22.39% respectively (Table 2). The amount of lignin in shoot tissues showed significant difference among the genotypes indicating a negative correlation between lignin content and ESB susceptibility (r=-0.88) (Table 3and Figure 3).Lignin is the key factor in plant which imparts toughness to tissue, more the lignin content, tougher the tissue. In brief, increased toughness and concentration of toxic by-products of lignin synthesis (phenoloxidase activity) seems to be the most likely mechanism for the lignin associated protection of plant tissue from pests[25].

Silica

The silica content in the shoot tissues of LS and MS genotypes varied from 2.54-3.25 per cent and 2.30-2.91 per cent, respectively. The LS genotype, 009-64 contained significantly maximum amount of silica (3.25%) with the cumulative ESB incidence of 3.24 per cent. Significantly minimum amount of silica (2.30%) was found in the MS genotype, 06-09-03 with the cumulative ESB incidence of 27.45%. Whereas check CoVC 99463 and Co 86032 registered 3.10% and 2.41% of silica with the cumulative ESB incidence of 4.83% and 22.39% respectively (Table 2). Rao and Siva (1962) reported similar results: a negative correlation between silica content and shoot borer incidence. The varieties with a higher number of silica cells per unit area in the leaf sheath portion, 2-3 inches from the base of the shoot, were found to shoot borer infestation

The difference in silica content in different groups of genotypes were significant and showed decreasing trend with susceptibility and exhibited significantly negative relationship with ESB susceptibility (r=-0.86) (Table 3 and Figure 3).

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 biochemical constituents of different sugarcane genotypes on the cumulative incidence of *C. infuscatellus*

Genotypes		Cumulative Incidence of ESB (%)	Total sugars (%)	Reducing sugars (%)	Phenol (mg/g)	Cellulose (%)	Lignin (%)	Silica (%)
LS	009-64	3.24(12.82) ^{a}	4.85 ^{ab}	0.075 ^{bc}	9.85 ^{a}	22.00 ^{a}	7.09 ^{ab}	3.25 ^{a}
	10-65-01	5.59(17.68) ^{abcd}	3.7 2 ^{a}	0.059 ^{a}	8.25^{fgh}	21.12^{ab}	8.05 ^{a}	2.91^{abcd}
	10-33-16	3.83(14.55) ^{ab}	4.65 ^{abc}	0.078 ^{c}	9.13^{ab}	19.45 ^{b}	6.70 ^{abcd}	3.01^{abc}
	10-17-08	4.97(16.53) ^{abc}	4.73^{abc}	0.080 ^{c}	8.85 ^{bc}	17.02 ^{c}	6.80 ^{abc}	2.88 ^{bcde}
	10-57-07	12.65(25.83) ^{abcdef}	5.35 ^{abc}	0.083 ^{c}	7.72^{efg}	16.59 ^{c}	6.20 ^{bcde}	2.54 ^{efgh}
	07-10-02	10.57(24.41)^{abcde}	6.22 ^{abc}	0.110 ^{d}	8.10 ^{cde}	15.45 ^{cd}	5.90 ^{bcde}	2.70 ^{cdefg}
	10-28-02	10.03(23.72) ^{abcde}	5.65 ^{abc}	0.090 ^{c}	7.21 ^{fgh}	15.85 ^{cd}	6.01 ^{bcde}	2.60 ^{defgh}
	09-61-02	14.85(28.99) ^{bcdef}	6.84 ^{abc}	0.090 ^{c}	7.15 ^{gh}	15.09 ^{cd}	5.70 ^{bcde}	2.55 ^{efgh}
MS	10-17-05	15.39(29.57) ^{cdefg}	6.02 ^{abc}	0.120 ^{de}	8.02 ^{def}	16.13 ^{cd}	6.66 ^{abcd}	2.79 ^{bcdef}
	07-06-05	16.48(30.30) ^{cdefg}	4.92 ^{abc}	0.080 ^{c}	8.00 ^{def}	17.12 ^{c}	6.70^{abcd}	2.91 ^{abcd}
	10-33-33	17.75(31.76) ^{defg}	7.12 ^{bc}	0.125 ^{de}	7.10 ^{gh}	14.85 ^{cd}	5.20 ^{cde}	2.46 ^{fgh}
	10-38-06	29.86(41.04) ^{g}	7.23 ^{c}	0.130 ^{ef}	6.85 ^{i}	13.89 ^{d}	4.80 ^{e}	2.33 ^{h}
	08-15-06	25.88(38.73)^{fg}	5.90 ^{bc}	0.112 ^{d}	7.00 ^{gh}	14.00 ^{d}	5.00 ^{de}	2.60 ^{defgh}
	06-09-03	27.45(39.77) ^{fg}	7.66 ^{c}	0.140 ^{f}	6.77 ^{h}	15.11 ^{cd}	5.85 ^{bcde}	2.30 ^{h}
Checks	CoVC 99463	4.83(16.41)^{abc}	3.92 ^{abc}	0.061 ^{ab}	8.56 ^{bcd}	20.11^{ab}	7.00^{ab}	3.10 ^{ab}
	Co 86032	22.39(35.09) ^{efg}	7.56 ^{abc}	0.141 ^{f}	7.14 ^{gh}	15.08 ^{cd}	5.03 ^{de}	2.41 ^{gh}
SEm ±		2.4	6.28	5.12	5.44	5.15	8.60	3.75
CD @ P=0.05		7.3	1.03	0.01	1.21	2.46	1.51	0.29

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 biochemical constituents of different genotypes and cumulative incidence of ESB

Biochemical constituent	Correlation with cumulative incidence of ESB
Total sugar (%)	0.80*
Reducing sugar (%)	0.82*
Phenol (mg/g)	-0.84*
Cellulose (%)	-0.80*
Lignin (%)	-0.79*
Silica (%)	-0.82*

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

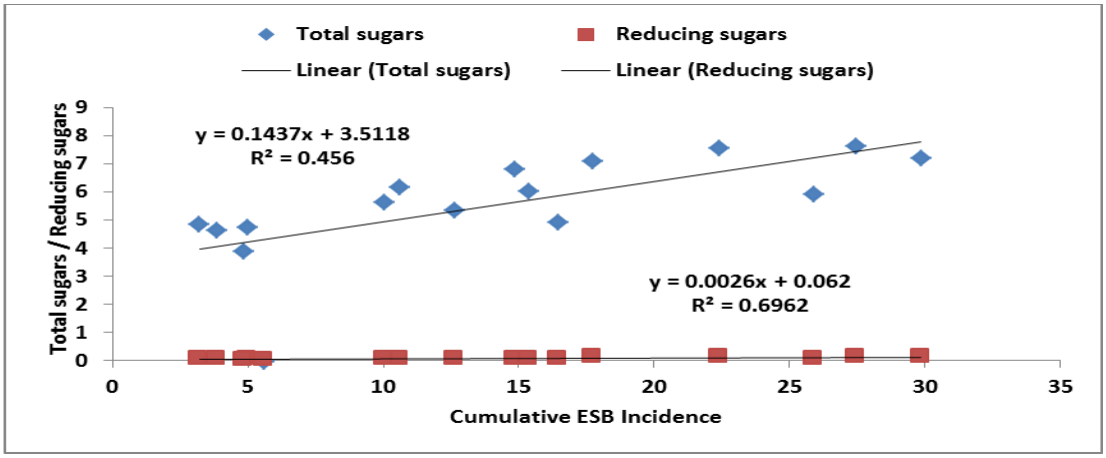

Fig. 1: Correlation between total sugars and Reducing Sugars contents in shoot tissues of different sugarcane genotypes and Cumulative ESB incidence

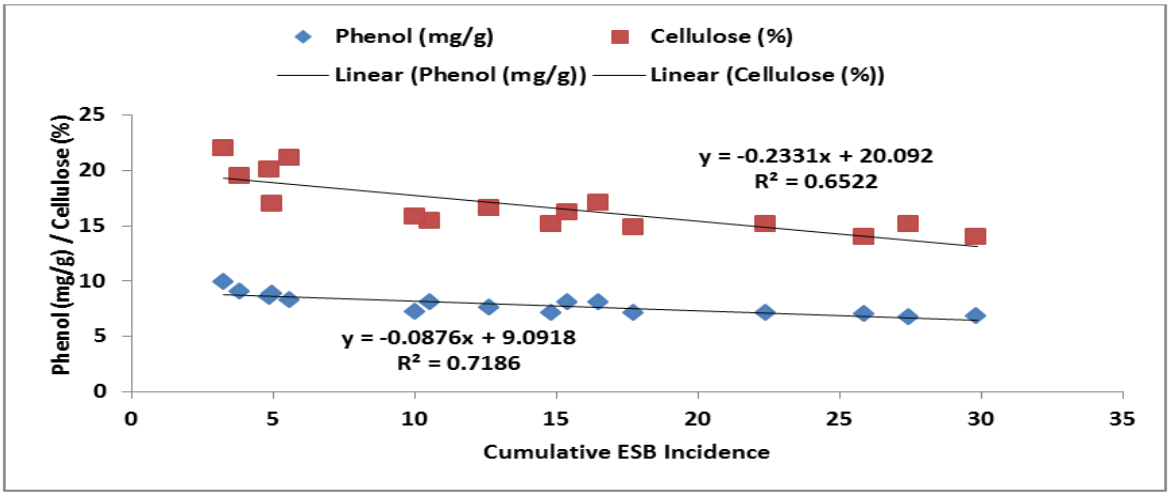

Fig. 2: Correlation between Phenol and Cellulose contents in shoot tissues of different sugarcane genotypes and Cumulative ESB incidence

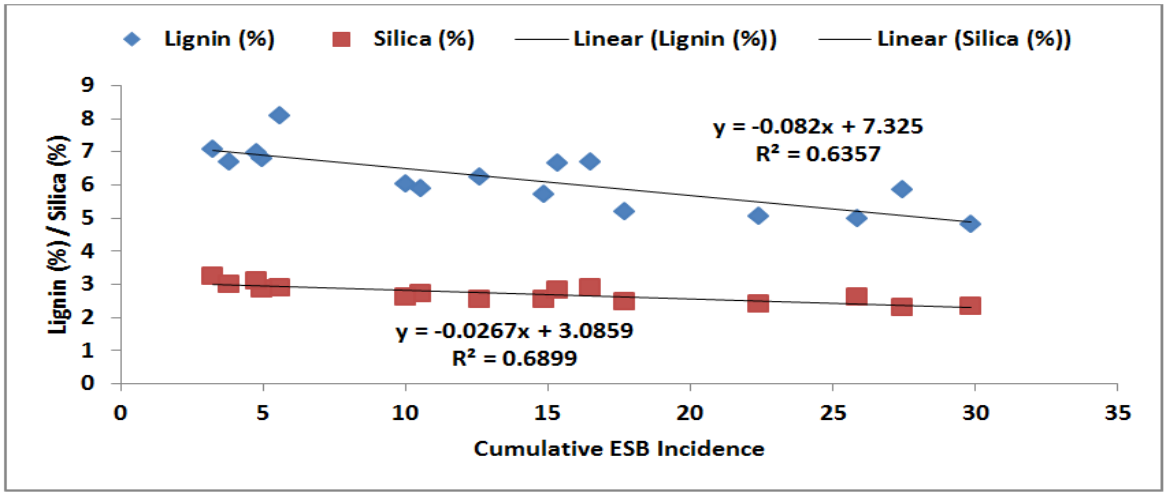

Fig. 3: Correlation between Lignin and Silica contents in shoot tissues of different sugarcane genotypes and Cumulative ESB incidence

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.

Biochemical constituents of different genotypes on ESB incidence revealed that the ESB incidence was positively correlated with total sugars and reducing sugars and negatively correlated with phenols, cellulose, lignin and silica. The minimum of 3.72 per cent of total sugars was recorded in less susceptible genotype, 10-65-01. Whereas maximum of 7.66 per cent of total sugar was recorded in moderately susceptible genotype, 06-09-03. Similarly, minimum of 0.059 per cent of reducing sugars was recorded in less susceptible genotype, 10-65-01. Whereas maximum of 0.141per of reducing sugars was recorded in moderately susceptible genotype, Co 86032.

Moderately susceptible genotype, 06-09-03 recorded the lowest phenols (6.77

mg/g), while less susceptible genotype, 009-64 recorded highest phenol content (9.85 mg/g).Moderately susceptible genotype, 10-38-06 recorded the lowest cellulose (13.89 %), while less susceptible genotype, 009-64 recorded highest cellulose content (22.00 %).The minimum of 4.80 per cent of lignin was recorded in moderately susceptible genotype, 10-38-06. Whereas maximum of 8.05per cent of lignin was recorded in less susceptible genotype, 10-65-01. Similarly, minimum of 2.30 per cent of silica was recorded in moderately susceptible genotype, 06-09-03.Whereas maximum of 3.25per cent of silica was recorded in less susceptible genotype, 009-64.

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