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Effect of nitrogen and potash on Early shoot borer (*Chilo infuscatellus* Snellen) incidence in differently maturing varieties of sugarcane

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Abstract
It has been argued that fertilization may influence the susceptibility of insect pests, and thus, can increase the crop production by lowering the incidence of insect-pest. Here, the present investigation was carried out to study the influence of nitrogen and potash levels on the incidence of early shoot borer, *Chilo infuscatellus* Snellen in sugarcane varieties at Regional Research Station CCSHAU Uchani farm, Karnal. The experiment was laid out in split-split plot design with three differently maturing varieties viz., Co 0238, CoH 119 and CoH 150 as main plot, three doses of nitrogen viz., 150, 200 and 250 kg per hectare (kg/ha) as sub plot and two doses of potash *viz.*, 0 and 50 (kg/ha) as sub-sub plot. The early shoot borer mean per cent incidence recorded in April, May and June, 2015 was highest (7.68, 12.19 and 6.35, respectively) in Co 0238 while, lowest (5.16, 8.51 and 5.40, respectively) in CoH 119 followed by CoH 150 (6.29, 8.79 and 5.43, respectively). In relation to nitrogen application, maximum mean per cent incidence (7.12, 11.19 and 6.48, respectively) in April, May and June, 2015 of early shoot borer was recorded at 250 kg N/ha and the minimum (5.68, 8.57 and 5.23, respectively) at 150 kg N/ha. Application of potassium significantly reduced the shoot borer infestation with mean per cent incidence lower at 50 kg K_2O/ha (5.90, 9.24 and 5.33, respectively) in April, May and June, 2015 compared to control i.e., no application of potassium (6.85, 10.42 and 6.12, respectively). Results revealed that application of potassium with optimum dose of nitrogenous fertilizer along with selection of suitable variety acted as preventive measures to avoid shoot borer infestation.

Keywords: Early shoot borer, Incidence, Nitrogen, Potash, Sugarcane

INTRODUCTION

Sugarcane *Saccharum officinarum,* family *Poaceae* is the most important and industrial crop of India. It is the main source of white industry which is considered the second largest industry after textile in India. Sugarcane is mostly grown in provinces of country namely Uttar Pradesh, Punjab, Haryana, Coimbatore and Ooty over an area of 4.5 million hectares with an annual production of 288 million metric tonnes (Anonymous 2017). The introduction of high yielding varieties and the associated technology have caused tremendous change in the insect pest complex of sugarcane. Only insect-pests cause 20 per cent loss in yield to the sugarcane crop (Dhaliwal *et al*., 2004). The most important species causing damage to the sugarcane crop are the sugarcane borers, particularly the sugarcane shoot borer (Gul *et al.,* 2008). Early shoot borer, *Chilo infuscatellus* Snellen is a cosmopolitan pest distributed throughout the India, having a wide host range, is also referred to as polyphagous borer species. Shoot borer is a serious pest during summer months *i.e.* pre-monsoon period. The shoot borer, *C. infuscatellus* is more active during hot periods of the year both in tropical (Murthy, 1953; Sulaiman, 1954; Jaganatha Rao and Jagannath Rao, 1960; Varadharajan *et al.,* 1972) and subtropical India (Khan and Singh, 1942; Agarwala and Huque, 1955; Gupta, 1959a; Bains and Dev Roy, 1981). The pest multiplies rapidly in hot and dry weather (April to June). The larvae after hatching enter the young shoots and as a result of its feeding the central leaf whorl dries up and forms a dead heart. Some studies revealed that losses caused by sugarcane stem borers are up to 36.51 per cent (Ahmad *et al.,* 2011). This borer has been also found to cause mortality of mother shoots to the extent of 50 per cent (Gupta, 1959b) and 6.4, 27.0 and 75.0 per cent of primary, secondary and tertiary tillers, respectively. It causes loss of 0.3-33.0 per cent in yield, 12.0 per cent in sugar recovery, 2.0 per cent in CCS and 27.0 per cent in jaggery. In terms of cane yield it is equivalent to 0.6- 38.78 tonnes/ha and 0.4-4.2 units of sugar recovery (Chaudhary, 2008).

Gul *et al.* (2002) reported that the variety Mardan-93 significantly received more infestation of shoot borer in both plant and ratoon crops as compared to other candidate varieties in early maturing group. Munir *et al*. (2008) reported that dead heart percentage was 2.97, 3.30 and 18.34 in early, mid and late maturing varieties, respectively. Vemuri *et al.* (2013) also found variable rate of infestation in differently maturing sugarcane varieties and reported that genotypes Co 0110, 98A 165, Co 6806 and 98A 125 were least susceptible.

Among the major nutrients, nitrogen enhances tillering and growth of canes, however, high levels of N fertilisation resulted in heavy damage by shoot borer (Mishra *et al*., 2004) in sugarcane. Kennedy and Nachiappan (1992) have found that greater contents of potassium increased resistance to *C. infuscatellus* in sugarcane. Agarwal (1959) reported that hardy canes showed minimum attack of shoot borer. Sithanantham and Srinivasan (1972) studied the foliar application of potash for protecting sugarcane against shoot borer and reported that high level of potassium confer resistance to shoot borer.

Efforts are being made to minimize the incidence and the losses caused by borers through integrated pest management. However, information on the comparative susceptibility of differently maturing sugarcane varieties to the early shoot borer under varying levels of nitrogen and potash is quite meager. Therefore, the present investigation was undertaken with the objective to estimate the effect of nitrogen and potash on shoot borer, *C. infuscatellus* Snellen, infestation from Haryana.

MATERIALS AND METHODS

A field investigation was carried out at Research Area of CCS HAU Regional Research Station, Karnal located at 29º 42′ N latitude and 77º 02′ E longitude during crop season 2015-16 (March-July, 2015). Three genotypes namely Co 0238, CoH 119 and CoH 150 which are early, mid and late maturing genotypes, respectively were selected as the test genotypes. Genotypes were planted in 3rd week of March, 2015 with a plot size of 9 m x 4.5 m and seed rate was 90 thousand two budded sett/ha with row to row distance of 75 cm. The experiment was replicated thrice in a split-split plot design with a total of 18 treatments and a total number of 54 plots. Three doses of nitrogen at the rate of 150, 200 and 250 kg per hectare were applied. 1/3rd dose of nitrogen was applied at the time of planting in all the plots and remaining 2/3rd dose was applied at 2nd and 4th irrigation in the month of May and June, respectively. Application of Potash (K_2O) 50 kg/ha was done as basal dose in half the number of plots (27) and in other half (27) no potash was applied. Incidence of early shoot borer was recorded in post-germination phase at 30 days interval up to 120 days (at 30, 60, 90 and 120 DAP). Meteorological data was also recorded during the study period and has been presented in Table 1. The observations on the total number of shoots and number of dead hearts due to the early shoot borer was recorded from two middle rows (3rd row and 4th row) in each plot and per cent incidence was calculated as per the following formula :

% incidence = Total no. of dead heart / Total no. of shoots × 100 ……….Eq. 1

Data obtained was tabulated and subjected to statistical analysis as per requirement. Before the analysis, the data was converted into percentage. Angular transformation was applied for these parameters.

RESULTS AND DISCUSSION

Incidence of early shoot borer (*C. infuscatellus* Snellen)

Effect of varieties on early shoot borer (ESB): The mean incidence of early shoot borer recorded in April May and June, 2015 are presented in Table 2. The maximum per cent incidence (7.68, 12.19 and 6.35) of ESB was recorded in variety Co 0238, followed by that in variety CoH 150 (6.29, 8.79 and 5.43) while, minimum incidence (5.16, 8.51 and 5.40) of ESB was recorded in variety CoH 119, during April, May and June 2015, respectively for each month. The present findings are in agreement with the observations made by Singh *et al.* (2002) who reported that among one hundred thirty one genotypes tested against early shoot borer (*C. inluscatellus* Snellen), 30 genotypes were rated as tolerant, 48 as moderately tolerant, 52 as susceptible and 1 as highly susceptible. Rao (1962) also reported that the varieties resistant to shoot borer were more vigorous in

Table 1. Meteorological observations during the study period from 1st week of April to 4th week of June, 2015.

Months/ week	Standard weeks	Weekly Mean Temperature		Weekly Mean Relative Humidity		Weekly Mean Sun-shine Hours
		Minimum T (℃)	Maximum T (℃)	RH Morning (%)	RH Evening (%)	
April I, 2015	15	15.1	29.1	85	39	10.5
II	16	17.9	31.2	82	40	8
III	17	19.3	39.6	61	20	9.6
IV	18	20.7	34.9	65	33	9.2
May I, 2015	19	20.9	40.1	51	15	8.4
II	20	21.5	37.1	70	38	8.4
III	21	22.9	39.9	62	23	10.1
IV	22	24	42.8	48	16	9.2
June I, 2015	23	22.8	38.1	61	31	7.3
II	24	24.9	40.9	58	24	8.4
III	25	24.8	37.3	70	39	8.3
IV	26	25	34.5	77	57	8.5

Table 2. Mean per cent incidence of early shoot borer in sugarcane varieties as influenced by nitrogen and potash levels.

Treatment	Mean per cent incidence of Early Shoot Borer		
Varieties	**April**	**May**	**June**
Co 0238	16.03 (7.68)	20.36 (12.19)	14.56 (6.35)
CoH 119	13.09 (5.16)	16.93 (8.51)	13.41 (5.40)
CoH 150	14.48 (6.29)	17.20 (8.79)	13.43 (5.43)
S.E.(m) ±	0.18	0.22	0.06
C.D. @5 %	0.70	0.85	0.23
Nitrogen levels			
150	13.73 (5.68)	16.97 (8.57)	13.19 (5.23)
200	14.50 (6.33)	18.09 (9.72)	13.51 (5.47)
250	15.37 (7.12)	19.43 (11.19)	14.70 (6.48)
S.E.(m) ±	0.28	0.18	0.11
C.D. @5 %	0.87	0.56	0.33
Potash levels			
0	15.08 (6.85)	18.72 (10.42)	14.29 (6.12)
50	13.99 (5.90)	17.60 (9.24)	13.31 (5.33)
S.E.(m) ±	0.12	0.15	0.12
C.D. @5 %	0.36	0.46	0.36

Figures in parentheses represent original values and those outside are angular transformed values

Table 3. Mean per cent incidence of early shoot borer in sugarcane varieties as influenced by nitrogen and potash levels in the month of April during 2015-2016.

Variety × Nitrogen				Nitrogen × Potash				Variety × Potash		
Nitrogen (kg/ha)	**Variety**			**Potash (kg/ha)**	**Nitrogen (kg/ha)**			**Variety**	**Potash(kg/ha)**	
	Co 0238	**CoH 119**	**CoH 150**		**150**	**200**	**250**		**0**	**50**
150	14.88 (6.62)	12.69 (4.84)	13.63 (5.58)	**0**	14.32 (6.15)	14.92 (6.70)	16.00 (7.70)	**Co 0238**	16.90 (8.50)	15.16 (6.86)
200	16.10 (7.73)	12.95 (5.04)	14.44 (6.23)	**50**	13.15 (5.21)	14.07 (5.97)	14.75 (6.54)	**CoH 119**	13.61 (5.55)	12.58 (4.77)
250	17.09 (8.69)	13.65 (5.60)	15.38 (7.07)					**CoH 150**	14.74 (6.50)	14.23 (6.08)
Mean	16.03 (7.68)	13.09 (5.16)	14.48 (6.29)	**Mean**	13.73 (5.68)	14.50 (6.33)	15.37 (7.12)	**Mean**	15.08 (6.85)	13.99 (5.90)

S-Significant, N.S.-Non significant, C.D. at 5 %, Variety = 0.70 (S), Nitrogen = 0.87 (S), Potash = 0.36 (S), Variety × Nitrogen = N.S., Nitrogen × Potash = N.S., Variety × Potash = 0.63 (S), Variety × Nitrogen × Potash = N.S.

growth and had greater green leaf area than the susceptible varieties.

Effect of Nitrogen and Potash fertilizer levels on early shoot borer (ESB): Data on mean per cent incidence of early shoot borer are presented in Table-2 and data revealed that the mean per cent incidence of early shoot borer was influenced due to different levels of N and potassium fertilizer application. The highest early shoot borer incidence (7.12%) was recorded in 250 kg N/ha while, the lowest incidence (5.68%) of ESB was recorded in 150 kg N/ha and it was statistically at par with 200 kg N/ha (6.33%).The incidence of shoot borer in potash treated plots (5.90%) was

Table 4. Mean per cent incidence of early shoot borer in sugarcane varieties as influenced by nitrogen and potash levels in the month of May during 2015-2016.

Variety × Nitrogen				Nitrogen × Potash				Variety × Potash		
Nitrogen (kg/ha)	Variety			Potash (kg/ha)	Nitrogen (kg/ha)			Variety	Potash (kg/ha)	
	Co 0238	CoH 119	CoH 150		150	200	250		0	50
150	18.50 (10.10)	16.27 (7.88)	16.14 (7.75)	**0**	17.27 (8.87)	18.77 (10.44)	20.13 (11.96)	**Co 0238**	21.03 (12.95)	19.68 (11.42)
200	20.19 (11.95)	16.86 (8.43)	17.22 (8.79)	**50**	16.68 (8.28)	17.41 (9.01)	18.72 (10.43)	**CoH 119**	17.37 (8.94)	16.49 (8.08)
250	22.37 (14.51)	17.66 (9.23)	18.25 (9.84)					**CoH 150**	17.77 (9.36)	16.64 (8.22)
Mean	20.36 (12.19)	16.93 (8.51)	17.20 (8.79)	**Mean**	16.97 (8.57)	18.09 (9.72)	19.43 (11.19)	**Mean**	18.72 (10.42)	17.60 (9.24)

Figures in parentheses represent original values and those outside are angular transformed values; S-Significant, N.S.-Non significant, C.D. at 5 %, Variety =0.85 (S), Nitrogen =0.56 (S), Potash = 0.46 (S), Variety × Nitrogen = 0.97 (S), Nitrogen × Potash = N.S., Variety × Potash = N.S., Variety × Nitrogen × Potash = N.S.

Table 5. Mean per cent incidence of early shoot borer in sugarcane varieties as influenced by nitrogen and potash levels in the month of June during 2015-2016.

Variety × Nitrogen				Nitrogen × Potash				Variety × Potash		
Nitrogen (kg/ha)	Variety			Potash (kg/ha)	Nitrogen (kg/ha)			Variety	Potash (kg/ha)	
	Co 0238	CoH 119	CoH 150		150	200	250		0	50
150	13.92 (5.80)	13.15 (5.19)	12.50 (4.70)	**0**	13.63 (5.67)	13.81 (5.71)	15.41 (7.09)	**Co 0238**	14.95 (6.69)	14.17 (6.01)
200	14.17 (6.00)	13.22 (5.24)	13.15 (5.18)	**50**	12.75 (4.89)	13.21 (5.24)	13.99 (5.87)	**CoH 119**	13.99 (5.86)	12.83 (4.94)
250	15.59 (7.24)	13.86 (5.77)	14.66 (6.42)					**CoH 150**	13.92 (5.82)	12.95 (5.05)
Mean	14.56 (6.35)	13.41 (5.40)	13.43 (5.43)	**Mean**	13.19 (5.23)	13.51 (5.47)	14.70 (6.48)	**Mean**	14.29 (6.12)	13.31 (5.33)

Figures in parentheses represent original values and those outside are angular transformed values; S-Significant, N.S.-Non significant, C.D. at 5 %, Variety = 0.23 (S), Nitrogen = 0.33 (S) Potash = 0.36 (S), Variety × Nitrogen = 0.58 (S), Nitrogen × Potash = N.S., Variety × Potash = N.S., Variety × Nitrogen × Potash = N.S.

significantly less as compared to control plots (6.85%) during April. The interaction effects of early shoot borer with variety and nitrogen levels (V×N), nitrogen levels and potash levels (N×K) and variety, N levels of fertilizer and K levels of fertilizer (V×N×K) were found to be non-significant, while, the interaction effects of early shoot borer with varieties and K levels of fertilizer (V×K) was found to be significant and has been shown in Table 3. The lowest per cent incidence of ESB was recorded in variety CoH 119 (4.77%) at 50 kg K/ha while, it was highest in variety Co 0238 (8.50%) with K levels of 0 kg/ha.

In May, 2015 early shoot borer incidence was significantly the highest (11.19%) in 250 kg N/ha followed by (9.72%) in 200 kg N/ha, while, the lowest incidence (8.57%) of ESB was recorded in 150 kg N/ha. The incidence of shoot borer in potash treated plots (9.24%) was significantly less as compared to control plots (10.42%). The interaction effects of early shoot borer with variety and nitrogen levels (V×N) was found to be significant and are represented in Table 4. Among the three nitrogen levels significantly lowest (7.75%) incidence of ESB was recorded in variety CoH 150. While, it was highest in Co 0238 (14.51%) at 250 kg N/ha, while, the interaction effects of early shoot borer with nitrogen levels and potash levels (N×K), varieties and K levels of fertilizer (V×K) and variety, N levels of fertilizer and K levels of fertilizer (V×N×K) was found non-significant.

During June, 2015 similar observations were recorded as incidence was highest (6.48%) in 250 kg N/ha, while, the minimum incidence (5.23%) of ESB was recorded in 150 kg N/ha and it was statistically at par with that in 200 kg N/ha (5.47%). The incidence of shoot borer in potash treated plots (5.33 %) was significantly less as compared to control plots (6.12%). The interaction effects of early shoot borer with variety and nitrogen levels (V×N) was found to be significant and are presented in Table 5. Among the three nitrogen levels significantly lowest (4.70%) incidence of ESB was recorded in variety CoH 150 at 150 kg N/ha. While, it was highest in Co 0238 (7.24%) at 250 kg N/ha, while, the interaction effects of early shoot borer with nitrogen levels and potash levels (N×K), varieties and K levels of fertilizer (V×K) and variety, N levels of fertilizer and K levels of fertilizer (V×N×K) with early shoot borer was found non-significant. The present study is strongly supported by the findings of Pandey and Kumar (2014) who reported that the highest incidence of *C. infuscatellus* was recorded during May, 2009 at

Hisar, Haryana. Kumar *et al.* (2004) also observed that the peak active period of the *C. infuscatellus* was in the month of May, 2003 in Andhra Pradesh. The present findings are also in agreement with the observations of Pandya *et al.* (1996) who reported that no incidence of early shoot borer was recorded during July, August, September and October, 1994. The present study is strongly supported by the findings of Mishra *et al*. (2004) who reported that lesser number of irrigation with higher N levels cause favourable effect on multiplication of shoot borer in sugarcane ratoon. Similar observations were recorded by Sithanantham and Srinivasan (1972) that the high level of potassium confer resistance to shoot borer in sugarcane at coimbatore.

Conclusion

Field experiment based on the effect of nitrogen and potash on the incidence of shoot borer, *C. infuscatellus* Snellen in different maturity groups of sugarcane genotypes revealed that early shoot borer incidence was highest (7.68, 12.19 and 6.35) in Co 0238 whereas lowest (5.16, 8.51 and 5.40) in CoH 119 in April, May and June, 2015, respectively. Regarding fertilizer application, shoot borer incidence was more (7.12, 11.19 and 6.48) under higher level of nitrogen i.e. 250 kg N/ha while reverse case in potassium fertilization i.e lower (5.90, 9.24 and 5.33) incidence at higher level of potassium in April, May and June, 2015, respectively. Hence, balanced fertilizer is not only important for soil health perspectives but also helps in management of insect-pest in sugarcane crop.

REFERENCES

1. Agarwal, R.A. (1959). Insect resistance in Coimbatore canes - A review. *Indian Sugar*, 8(12): 785-796.
2. Agarwala, S.B.D. and Huque, M.W. (1955). Studies on *Argyria sticticraspis* Hmpsn., the early shoot borer of sugarcane in Bihar. *Indian Journal of Entomology,* 17: 307-314.
3. Ahmad, S., Ashfaq, M., Afzal, M., and Aqeel, A. (2011). IPM module for the sustainable management of sugarcane stem borer in Pakistan. *International Journal of Agriculture and Applied Sciences*, 3:76-79.
4. Anonymous (2017). Sugar Annual. *https://gain.fas.usda.gov/Recent%20GAIN*
5. Bains, S.S. and Dev Roy, J.C. (1981). Integrated management of sugarcane pests in the Punjab. "*Proceedings of the National Symposium on Stalk borer, Chilo auricilius* Dudgeon" 20-22 April, 1981, H.A.U. Regional Research Station, Karnal, pp 147-155.
6. Chaudhary, O.P. (2008). Control of different Borers in sugarcane crop. *Co-operative Sugar*, 40(3): 29-38.
7. Dhaliwal, G.S., Arora, R. and Dhawan, A.K. (2004). Crop losses due to insect-pests in Indian Agriculture: An update. *Indian Journal of Ecology*, 31(1): 1-7.
8. Gul, F., Ahmad, G., Khan, M. and Ikramulla. (2002). Studies on preference/non-preference of sugarcane varieties to the attack of different borers in Peshawar Valley conditions of NWFP. *Pakistan Sugar Journal*, 22(4): 18-21.
9. Gul, F., Nadeem, M. and Inayatullah. (2008). Effect of different control methods on the infestation of borer in sugarcane plant and ratoon crop. *Sarhad Journal of Agriculture*, 24: 34-39.
10. Gupta, B.D. (1959a). The Insect pests of sugarcane in India. V. The shoot borer, *Chilotraea infuscatellus* Snell. *Indian Sugar,* 9:445-465.
11. Gupta, B.D. (1959b). Insect pest of sugarcane in India-V. The shoot borer, *Chilotraea infuscatellus* Snell. *Indian Sugar*, 10(1): 67-68.
12. Jaganatha Rao, E. and Jagannath Rao, R. (1960). Some studies on the control of shoot borer (*Chilotraea infuscatellus* Snell.) in Bobbili tract (Andhra Pradesh). *Indian Journal of Sugarcane Research and Development,* 5:149-154.
13. Kennedy, F.J.S. and Nachiappan, R. (1992). Certain anatomical, physical and chemical basis for different preference of early shoot borer (*Chilo infuscatellus*) in sugarcane. *International Symposium on Crop Protection*, 57: 637-644.
14. Khan, Rahman, A. and Singh, D. (1942). Bionomics and control of sugarcane stem borer, *Argyria sticticraspis. Proceedings of the Indian Science Congress,* 29: 177.
15. Kumar, S., Maheshwari, T.U. and Rao, N.V. (2004). Biology and seasonal incidence of sugarcane early shoot borer *Chilo infuscatellus* Snellen in Southern zone of Andhra Pradesh. *Indian Journal of Entomology*, 66(3): 246-250.
16. Mishra, D.N., Kumar, K. and Singh, L.R. (2004). Effect of irrigation and nitrogen levels on the incidence of shoot borer and their impact on yield of sugarcane ratoon. *Environment and Ecology*, 22(1): 95-97.
17. Munir, M., Afzal, M., Chatta, A.A. and Khan, H.W.A. (2008). Screening of early and medium/Late maturing sugarcane varieties/lines against borer complex infestation in central Punjab. *Pakistan Journal of Agricultural Research*, 46(4): 373-378.
18. Murthy, D.V. (1953). Cultural and mechanical methods of control of early shoot borer in sugarcane. *Proceedings of Annual Convention the Sugar Technologists' Association of India,* 22: 119-124.
19. Pandey, S.K. and Kumar, R. (2014). Impact analysis of weather factors in relation to early shoot borer (*Chilo infuscatellus* Snellen) incidence in summer planted sugarcane after wheat harvest in sub tropics. *Indian Journal of Agricultural Research*, 48(3): 227-231.
20. Pandya, H.V., Patel, C.B., Patel, J.R., Patel, M.B., Patel, K.K., Patel, J.M. and Mehta, V.R. (1996). Assessment of losses due to root borer in sugarcane. *Bhartiya Sugar*, 21(3): 19-20.
21. Rao, D.V.S. (1962). Studies on the resistance of sugarcane to the early shoot borer, *Chilotraea infuscatellus* Snell. M. Sc. Thesis, Andhra University, Waltairs.
22. Singh, M., Madan, Y.P., Singh, D., and Mahla, J.C. (2002). Incidence of early shoot borer, *Chilo infuscatellus* in different sugarcane genotypes under field conditions. *Agricultural Science Digest,* 22(4).
23. Sithanantham, S. and Srinivasan, T.R. (1972). Influence of foliar application of potash with endrin protecting sugarcane from shoot borer, *Chilo infuscatellus*. *Indian Journal of Agricultural Chemistry*, 5:25-31

24.Sulaiman, M. (1954). The influence of climate on the population of sugarcane borer in Hyderabad State. *Proceedings of the Biennial Conference of Sugarcane Research and Development Workers, India,* 2: 155-16.

25.Varadharajan, G.K., Saivaraj, K., Sathiamoorthy, A.S., Subramaniam, A. and Kuppuswami, N.T. (1972). Sugarcane borers at Cuddalore (Tamil Nadu). *Indian Sugar,* 21: 817-820.

26.Vemuri, S., Suresh, K. and Kumar, M.V. (2013). Evaluation of sugarcane germplasm against early shoot borer (ESB), *Chilo infuscatellus* Snellen. *ZENITH International Journal of Business Economics & Management Research,* 3(9): ISSN 2249- 8826