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Evaluating the effect of nitrogen and potash on Stalk borer (*Chilo auricilius* Dudgeon) incidence in differently maturing varieties of sugarcane

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Abstract
Present study was conducted to determine the effect of nitrogen and potash application on the incidence of *Chilo auricilius* in differently maturing sugarcane varieties *viz.*, Co 0238, CoH 119 and CoH 150 at Regional Research Station CCSHAU, Karnal during 2015-16. The stalk borer mean per cent incidence, per cent intensity and infestation index was highest (49.56, 16.12 and 8.11, respectively) in Co 0238 while, lowest (33.22, 12.48 and 4.18, respectively) in CoH 150. In relation to nitrogen application, maximum mean per cent incidence, per cent intensity and infestation index (45.44, 15.65 and 7.27, respectively) was recorded at 250 kg N/ha and the minimum (34.44, 13.28 and 4.60, respectively) at 150 kg N/ha. Potash application significantly reduced the mean per cent incidence, lower at 50 kg K_2O/ha (36.96) compared to control. Hence optimum dose of Nitrogen integrated with potassium application significantly reduced the incidence of stalk borer and subsequently, improve cane yield.

Keywords: Incidence, nitrogen, potash, stalk borer, sugarcane

1. Introduction
Sugarcane (*Saccharum officinarum* L.) is one of the most important cash crop in India. Worldwide**,** it is cultivated over an area of 265.2 lakh ha in 2017 [1]. It is the second major industry after textile. It is being utilized as the chief source of sugar, gur and khandsari and hence, assumes special importance in India. Besides sugar production, uses of sugarcane plant are multi-dimensional *viz*., top for fodder, trash for fuel, molasses for ethanol, bagasse is used in paper and card board industry etc. Sugarcane is cultivated in India under diverse agro-climatic conditions and various biotic and abiotic factors limit its potential productivity. In case of biotic factors, borers causes significant reduction in sugarcane all most all over the world depending on types of agro-climatic condition, nature of cultural practices adopted such as selection of variety, time and amount of fertilizer application etc [2-4]. Stalk borer (*Chilo auricilius* Dudgeon) is one of the most serious pests limiting sugarcane production especially in northern India, which can cause a loss up to 33 per cent in cane yield and causes up to 20.4 per cent reduction in sucrose in juice [5]. The larvae of stalk borer usually feed on the leaf-sheaths followed by penetration into an internode by making a fine circular hole on the rind. So attack of this pest in early stages of the crop growth results in the formation of dead-hearts resembling those of shoot borer, and subsequently the infested shoots ultimately dry up.
Stalk borer incidence varied significantly with differently maturing varieties of sugarcane [4, 6]. Sugarcane early maturing varieties with more sugar content and soft rind are preferred by the sugarcane stalk borer [4, 7]. So rind hardness of sugarcane variety and recoverable sucrose may be a valuable trait for imparting plant resistance that can be utilised in sugarcane improvement programme which also differ significantly with nature and amount of fertilizer application [6]. Different levels of nitrogen and potash also influence the incidence and intensity of stalk borer insect [8]. However, balanced fertilization is the key to realise the potential sugarcane productivity. Nitrogen enhances tillering and growth of canes and subsequently improves millable cane production while, the higher amount of N resulted in soft canes susceptible to heavy damage [4, 6, 8]. However, little information is available on the incidence of stalk borer in differently maturing sugarcane varieties in relation to different levels of nitrogen and potash under Haryana conditions. Keeping this in view, the present study was carried out to evaluate the effect of nitrogen and potash on Stalk borer incidence in differently maturing varieties of

2. Materials and Methods

A field experiment was conducted at the farm of CCS Haryana Agricultural University Regional Research Station, Uchani (Karnal) located at 29º 42′ N latitude and 77º 02′ E longitude during 2015-16 crop season. The experiment was laid out in split-split plot design with three differently maturing varieties *viz*., Co 0238, CoH 119 and CoH 150C, which are early, mid and late maturing varieties, respectively as main plot, three doses of nitrogen *viz*., 150, 200 and 250 kg per hectare as sub plot and two doses of potash *viz*., 0 and 50 kg per hectare as sub-sub plot. The experiment was replicated thrice. Varieties 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 a row to row distance of 75 cm. Three doses of nitrogen at the rate of 150, 200 and 250 Kg/ha were applied. At the time of planting, 1/3rd dose of nitrogen was applied 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 and the other half were left as control (without potash). Incidence of Stalk borer, *Chilo auricilius* Dudgeon was recorded at harvest. Twenty five canes were selected randomly from two middle rows (3rd row and 4th row) of each plot and the total number of internodes and internodes affected due to stalk borer in each cane were counted. Per cent incidence, intensity and infestation index for stalk borer was calculated as per following formula:

$$\% \text{ incidence} = \frac{\text{Total no. of infected cane}}{25 \text{ (canes)}} \times 100$$

$$\% \text{ intensity} = \frac{\text{Total no. of affected internodes}}{\text{Total number of internodes}} \times 100$$

$$\text{Infestation index} = \frac{\% \text{ incidence} \times \% \text{ intensity}}{100}$$

Intensity of stalk borer was observed at harvest from 25 canes by splitting the canes and the number of internodes damage internally by stalk borer were recorded. Data obtained was tabulated and subjected to statistical analysis as per requirement with angular transformation.

3. Results and Discussion

The data regarding per cent incidence, per cent intensity, infestation index of sugarcane stalk borer, *Chilo auricilius* Dudgeon with respect to different varieties, nitrogen levels and potash levels is presented in Table 1.

3.1 Varietal response on incidence, intensity and infestation index of stalk borer

The stalk borer mean per cent incidence, per cent intensity and infestation index was recorded highest (49.56, 16.12 and 8.11, respectively) in early maturing variety Co 0238, followed by (38.44, 15.05 and 5.81, respectively) in mid maturing variety CoH 119 and (33.22, 12.48 and 4.18, respectively) in late maturing variety CoH 150. The mean per cent incidence, per cent intensity and infestation index was influenced significantly due to different varieties. Furthermore, it was observed that the early maturing sugarcane variety with higher sugar content and soft rind was more preferred by the sugarcane stalk borer insect, similar results are reported by [2]. The present findings are also in agreement with [6] who reported that the mean per cent incidence of stalk borer was highest in early maturing genotype followed by mid maturing genotype and lowest in late maturing genotype.

3.2 Effect of nitrogen and potassium levels on incidence, intensity and infestation index of stalk borer

In relation to nitrogen fertilization, the minimum mean per cent incidence, per cent intensity and infestation index of stalk borer was observed with the application of 150 kg N/ha (34.44, 13.28 and 4.60, respectively) and it was followed by that at 200 kg N/ha (41.33, 14.72 and 6.24, respectively). While the maximum mean per cent incidence, per cent intensity and infestation index of stalk borer was observed with the application of 250 kg N/ha (45.44, 15.65 and 7.27, respectively). The results have shown that nitrogen application significantly affect mean per cent stalk borer incidence, per cent stalk borer intensity, infestation index and all these parameters increase with higher application of nitrogen for all the varieties, similar findings reported by [9, 10]. Excessive application of nitrogen may enhance levels of growth hormone indole acetic acid in sugarcane during formative and grand growth phase [11] and subsequent luxuriant growth of the crop might have proved conducive for shelter, fecundity, growth and development of the stalk borer [12]. Sugarcane fields fertilized with higher rate of nitrogen result into softening of canes which were susceptible to heavy damage by *C. auricilius* [13, 14].

Table 1: Mean per cent incidence, per cent intensity and infestation index of stalk borer in sugarcane varieties as influenced by nitrogen and potash levels

Treatment	Mean per cent incidence, per cent intensity and infestation index of stalk borer		
Varieties	**Incidence (%)**	**Intensity (%)**	**Infestation index**
Co 0238	44.73 (49.56)	23.63 (16.12)	(8.11)
CoH 119	38.23 (38.44)	22.81 (15.05)	(5.81)
CoH 150	35.14 (33.22)	20.65 (12.48)	(4.18)
S.E.(m) ±	0.67	0.13	0.19
C.D. @5 %	2.62	0.52	0.74
Nitrogen levels			
150	35.85 (34.44)	21.32 (13.28)	(4.60)
200	39.92 (41.33)	22.52 (14.72)	(6.24)
250	42.33 (45.44)	23.26 (15.65)	(7.27)
S.E.(m) ±	0.57	0.16	0.20
C.D. @5 %	1.77	0.49	0.60
Potash levels			
0	41.40 (43.85)	22.68 (14.93)	(6.71)
50	37.33 (36.96)	22.06 (14.17)	(5.36)
S.E.(m) ±	0.43	0.12	0.15
C.D. @5 %	1.28	0.36	0.44

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

Regarding potassium fertilization, the stalk borer mean per cent incidence, per cent intensity and infestation index was significantly less (36.96, 14.17 and 5.36, respectively) in potash treated plots than in control plots (43.85, 14.93 and 6.71, respectively). The present studies are strongly in conformity with [3] who indicated a significant reduction in

Eldana damage with increasing levels of K application. [15] also reported negative relation between top borer incidence and phosphorus and potassium contents in cane.

The interaction effect of varieties and nitrogen levels was found significant on the per cent incidence, per cent intensity and infestation index of stalk borer in sugarcane crop and are presented in Table 2, 3 and 4, respectively. At 250 Kg N/ha, variety Co 0238 showed maximum per cent incidence (56.00), per cent intensity (17.93) and infestation index (10.07) of stalk borer which varies significantly with other varieties, while, at 150 kg N/ha, the variety CoH 119 showed minimum per cent incidence (30.67) of stalk borer and the variety CoH 150 showed minimum per cent intensity (10.99) and infestation index (3.44). Thus, the variety Co 0238 was found susceptible to stalk borer at all the levels of nitrogen application**.** While, the interaction effects of stalk borer incidence, stalk borer intensity and stalk borer infestation index between nitrogen levels and potash levels (N×K), between varieties and K levels of fertilizer (V×K) and interaction effects of variety, N levels of fertilizer and K levels of fertilizer (V×N×K) was found to be non-significant.

Table 2: Mean per cent incidence of stalk borer in sugarcane varieties as influenced by nitrogen and potash levels 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	39.97 (41.33)	33.57 (30.67)	34.01 (31.33)	0	37.59 (37.33)	42.01 (44.89)	44.60 (49.33)	Co 0238	47.17 (53.78)	42.28 (45.33)
200	45.77 (51.33)	39.59 (40.67)	34.41 (32.00)	50	34.10 (31.56)	37.83 (37.78)	40.05 (41.56)	CoH 119	40.20 (41.78)	36.25 (35.11)
250	48.45 (56.00)	41.52 (44.00)	37.02 (36.33)					CoH 150	36.83 (36.00)	33.46 (30.44)
Mean	44.73 (49.56)	38.23 (38.44)	35.14 (33.22)	Mean	35.85 (34.44)	39.92 (41.33)	42.33 (45.44)	Mean	41.40 (43.85)	37.33 (36.96)

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

C.D. at 5 % Variety = 2.62 Nitrogen = 1.77 Potash = 1.28

Variety × Nitrogen = 3.06 Nitrogen × Potash = N.S. Variety × Potash = N.S. Variety × Nitrogen × Potash = N.S.

Table 3: Mean per cent intensity of stalk borer in sugarcane varieties as influenced by nitrogen and potash levels 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	22.03 (14.09)	22.57 (14.75)	19.35 (10.99)	0	21.52 (13.51)	22.97 (15.28)	23.54 (16.02)	Co 0238	24.00 (16.60)	23.26 (15.64)
200	23.83 (16.34)	22.85 (15.11)	20.88 (12.73)	50	21.12 (13.05)	22.07 (14.17)	22.98 (15.29)	CoH 119	23.14 (15.46)	22.49 (14.64)
250	25.04 (17.93)	23.02 (15.31)	21.73 (13.73)					CoH 150	20.88 (12.74)	20.42 (12.22)
Mean	23.63 (16.12)	22.81 (15.05)	20.65 (12.48)	Mean	21.32 (13.28)	22.52 (14.73)	23.26 (15.65)	Mean	22.68 (14.94)	22.06 (14.17)

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

C.D. at 5 % Variety = 0.52 Nitrogen = 0.49 Potash = 0.36

Variety × Nitrogen = 0.85 Nitrogen × Potash = N.S. Variety × Potash = N.S. Variety × Nitrogen × Potash = N.S.

Table 4: Mean infestation index of stalk borer in sugarcane varieties as influenced by nitrogen and potash levels during 2015-16

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	5.84	4.52	3.44	0	5.07	7.01	8.06	Co 0238	9.04	7.19
200	8.44	6.18	4.09	50	4.13	5.46	6.49	CoH 119	6.49	5.14
250	10.07	6.74	5.01					CoH 150	4.61	3.75
Mean	8.11	5.81	4.18	Mean	4.60	6.24	7.27	Mean	6.71	5.36

C.D. at 5 % Variety = 0.74 Nitrogen = 0.60 Potash = 0.44

Variety × Nitrogen = 1.04 Nitrogen × Potash = N.S. Variety × Potash = N.S. Variety × Nitrogen × Potash = N.S.

4. Conclusion

From the findings of research conducted, it was observed that the stalk borer incidence was lowest in CoH 150 followed by CoH 119, while maximum for the variety Co 0238. Higher doses of nitrogenous fertilizers make plants more susceptible to borer due to softening of tissue and subsequent luxurious growth provides congenial environment for survival, growth and development of borer. Potash fertilisation greatly reduced borer per cent incidence, per cent intensity and infestation index. Hence, selecting the stalk borer tolerant varieties with balanced fertilization holds the key for the sustainable sugarcane production.

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