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Effect of duration of varieties of sugarcane on top, early shoot and stalk borer infestation

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Abstract
At research farm of Regional Research Station, Uchani, Karnal, CCS Haryana Agricultural University, Hisar during year 2017-18, an experiment was conducted to evaluate the effect of duration of varieties of sugarcane on the incidence of shoot borer, *Chilo infuscatellus* Snellen, top borer, *Scirpophaga nivella* Walker and stalk borer, *Chilo auricilius* Dudgeon in three differently maturing sugarcane varieties CoH 160 (early maturing), CoH 167 (mid maturing) and CoH 150 (late maturing). Results revealed that the incidence of shoot borer was maximum (7.14, 12.03 and 5.37%) in CoH 160 and the minimum (3.45, 4.81 and 2.96%) in CoH 167 during April, May and June, 2017, respectively. Similarly, incidence of top borer was highest (8.66, 10.88 and 12.22%) in CoH 160 and lowest (3.55, 5.11 and 6.44%) in variety CoH 167 during July, August and September, respectively. The mean per cent incidence, per cent intensity and infestation index of stalk borer was recorded maximum (36.00, 16.22 and 5.96, respectively) in CoH 160 and minimum (29.55, 12.16 and 3.68, respectively) in CoH 150. Cane yield (t/hac), No. of millable canes (000'/hac) and commercial cane sugar per cent were also recorded during the experiment.

Keywords: Shoot borer, top borer, stalk borer, incidence, yield, CoH

Introduction
Sugarcane (*Saccharum officinarum* L.) is one of the most important commercial crops in India which has played a major role in Indian agricultural and industrial economy. It is cultivated under diverse agro-climatic conditions in India. India tops in the world in total area under sugarcane cultivation. Total area under sugarcane cultivation 43.89 lakh ha with average cane productivity of 69.88 t/ha and production was 3067.2 lakh tonnes [4]**.** Cane and sugar yields as well as juice quality could be affected by nitrogen fertilizer levels. The issue of the nitrogen nutrition of sugarcane plants has been controversial because views vary as regards the form of nitrogen that is utilized best by plants. Sugarcane crop is exposed to several depredatories during the course of its germination, growth and maturity. Among these, insects are one of the important sources. More than 200 species of insects causing damage to sugarcane crop, out of which, about two dozen species are considered of economic importance. More than 170 pests of sugarcane causing damage to sugarcane crop at different stages of crop growth have been reported [6]**.** Out of total losses, up to 50 per cent in cane yield and sugar recovery have been reported to cause by these sugarcane pests [1]. Different pests appear during different seasons and they are called pre-monsoon, monsoon and post-monsoon pests. Among tissue borers, shoot borer, *Chilo infuscatellus* (Snellen); top borer, *Scirpophaga nivella* Fabricius and stalk borer, *Chilo auricilius* Dudgeon are the major pests in subtropical region. Since the studies on effect of duration of varieties on moth borer incidence was lacking so far from Haryana state. Efforts are being made to minimize the incidence and the losses caused by stalk borer through integrated pest management. Balanced use of fertilizers especially nitrogen should be done as preventive measures for its control.
Keeping in view the importance of the above three pests, a trial was conducted to estimate the effect of duration of varieties on incidence of major moth borers in sugarcane. The prime concern of cane growers and the sugar industry is to achieve higher cane productivity and high sugar recovery both of which support maximum economic return. In India, widely varying soil fertility domains are major limitation to reaching this goal.

Materials and Methods
Place of work: Laboratory and research area of Regional Research Station, Karnal, CCS HAU Hisar. All the facilities required for this research work were available.

Planting of sugarcane genotypes: Three varieties namely CoH 160, CoH 167 and CoH 150 which are early, mid and late maturing genotypes, respectively were selected and planted in first fortnight of March, 2017 with a plot size of 7 x 4.2 m and seed rate was 90 thousand two budded setts/ha.

Experimental details

Treatments: Varieties

V_1 : CoH 160 (early)

V_2 : CoH 167 (mid)

V_3 : CoH 150 (late)

Plot size	:	7.0 X 4.2m
Date of planting	:	First fortnight of March, 2017
Seed rate	:	90,000 setts/ha (two budded)
Design	:	Split plot
No. of replications	:	3
No. of treatments	:	3
No. of plots	:	9

Methods of recording observations

Following observations during the different period of crop growth were recorded on different parameters and incidence of shoot, top and stalk borers was observed. The data on borers was recorded from two middle rows (3rd and 4th row) of each plot.

Early shoot borer, *Chilo infuscatellus* Snellen

Incidence of shoot borer was recorded in post-germination phase at 30 days interval up to 120 days (At 30, 60, 90 and 120 DAP). 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 in each plot and the per cent incidence was calculated as per the following formula.

$$\% \text{ incidence} = \frac{\text{Total no. of dead heart}}{\text{Total no. of shoots}} \times 100$$

Top borer, *Scirpophaga excerptalis* Walker

Incidence of top borer was recorded during the 3rd and 4th broods (July, August and September). Twenty five canes were selected randomly from two middle rows from each plot at each observation and per cent incidence was calculated as per following formula.

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

Stalk borer, *Chilo auricilius* Dudgeon

Incidence of Stalk borer was recorded at harvest. Twenty five canes were selected randomly from two middle rows from each plot and 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.

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

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

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

Observations at harvest

At harvest, following observations were recorded.

a) Total number of millable canes and yield per plot.
b) Intensity of stalk borer from 25 canes by splitting the canes and recorded the number of internodes damage by stalk borer internally.
c) Commercial cane sugar (CCS) percentage.

Cane yield (t/ha)

Each plot was harvested separately. The milliable canes were taken by cutting the top portion. These milliable canes were weighted plot wise in kilogram and then data was converted to tons per hectare.

Number of millable canes (000´/ha)

Total number of millable canes were recorded at harvest from 3rd and 4th rows of each plot and average was recorded to find number of millable canes per plot and were converted in to hectare basis.

Commercial cane sugar per cent

The commercial cane sugar percentage (CCS) was recorded as described by Meade and Chen (1977) by using following formula:

$$CCS\ \% = [S - 0.4\ (B - S)] \times 0.74$$

Where,

S= Sucrose per cent juice

B= Corrected juice brix

Analysis of data

Data obtained under various heads were tabulated and subjected to statistical analysis (opstat) as per requirement. Before the analysis of data, the data on germination, shoot, top and stalk borer was converted into percentage whereas the data on tillers and millable canes and yield were converted into hectare basis. Appropriate transformations were applied for these parameters.

Results

Effect of varieties of sugarcane on germination

Germination percentage in different treatments was recorded two months after planting. The observations recorded are presented in Table 1. The data revealed that the highest (43.05%) germination was observed in variety CoH 150 followed by variety CoH 167 (39.11%) and lowest (38.27%) germination was recorded in CoH 160.

Table 1: Mean per cent germination of sugarcane varieties

Varieties	
CoH 160	38.19 (38.27)
CoH167	38.69 (39.11)
CoH 150	40.98 (43.05)
S.E.(m) ±	0.23
C.D. @5%	0.75

Effect of varieties on incidence of early shoot borer (ESB) during April-July, 2017

During April, 2017

The mean per cent incidence of early shoot borer observed in April, 2017 is presented in Table 2. Incidence of shoot borer was influenced significantly due to different varieties. Significantly higher incidence (7.14%) was observed in variety CoH 160 while the minimum incidence was observed in variety CoH 167 (3.45%) which is at par with the incidence in variety CoH 150 (3.82%).

During May, 2017

The recorded mean per cent incidence of ESB in May, 2017 is presented in Table 2. The mean per cent incidence of ESB was ranging from 4.81 to 12.03 in varieties CoH 160, CoH 167 and CoH 150. The maximum incidence (12.03%) was recorded in variety CoH 160 while the minimum incidence (4.81%) was observed in variety CoH 167.

During June, 2017

The mean per cent incidence of shoot borer recorded in June, 2017 are presented in Table 2 Column 4. The mean per cent incidence of ESB ranged from 2.96 to 5.37 in variety CoH160, CoH 167 and CoH 150. The maximum incidence (5.37%) was observed in variety CoH 160 while the minimum incidence (2.96%) was observed in variety CoH 167 and it was statistically at par with variety CoH 150 (3.26%).

During July, 2017

There was no incidence of early shoot borer recorded during July month of 2017.

Table 2: Mean per cent incidence of early shoot borer in sugarcane varieties from April to June, 2017

Treatment	Mean per cent incidence of Early Shoot Borer			
Varieties	April	May	June	July
CoH 160	15.16 (7.14)	20.22 (12.03)	13.25(5.37)	-
CoH167	9.54 (3.45)	12.48 (4.81)	9.75(2.96)	-
CoH 150	11.09 (3.82)	15.48 (7.36)	10.15(3.26)	-
S.E.(m) ±	0.88	0.58	0.24	-
C.D. @5%	2.78	1.85	0.76	-

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

Effect of varieties on incidence of Top borer (*S. nivella* Walker) during July-September, 2017

During July 2017

Observations on mean per cent incidence in different varieties recorded in July, 2017 are presented in Table 3. The top borer incidence was highest (8.66%) in variety CoH 160 followed by CoH 150 (5.11%), which is statistically at par with CoH 167 (3.55%).

During August 2017

Observations on mean per cent incidence of top borer in different varieties recorded in August, 2017 are presented in Table 3. Top borer incidence was highest (10.88%) in CoH 160 followed by CoH 150 (9.33%), while the lowest incidence was recorded in CoH 167 (5.11%).

During September 2017

The mean per cent incidence of top borer in different varieties was recorded in September, 2017 (Table 3). It was found that top borer incidence was highest (12.22%) in early maturing variety CoH 160 followed by CoH 150 (10.44%) and lowest (6.44%) incidence was observed in CoH 167.

Table 3: Mean per cent incidence of top borer in sugarcane varieties

Varieties	Mean per cent incidence of top borer		
	July	August	September
CoH 160	16.62 (8.66)	18.93 (10.88)	20.06 (12.22)
CoH167	9.14 (3.55)	12.09 (5.11)	14.46 (6.44)
CoH 150	12.03 (5.11)	17.38 (9.33)	18.44 (10.44)
S.E.(m) ±	0.67	0.61	0.49
C.D. @5%	2.12	1.94	1.55

Effect of varieties on incidence (%), intensity (%) and infestation index of Stalk borer

Incidence (%)

The mean per cent incidence of stalk borer was influenced significantly due to different varieties (Table 4). Maximum (36.00%) incidence of stalk borer was recorded in variety CoH 160 followed variety CoH 167 (32.77%), while, it was minimum (29.55%) in variety CoH 150.

Intensity (%)

The mean per cent intensity of stalk borer was differing significantly due to different varieties. The maximum (16.22%) intensity (Table 4) was observed in variety CoH 160 followed by variety CoH 167(14.03%), while, the intensity was minimum (12.16%) in variety
CoH 150.

Infestation index (%)

The highest infestation index (5.96) was recorded on sugarcane variety CoH 160 and it was followed by variety CoH 167 (4.67) and in variety CoH 150 (3.68).

Table 4: Mean per cent incidence, per cent intensity and infestation index of stalk borer in sugarcane varieties

Varieties	Mean per cent incidence, per cent intensity and infestation index of stalk borer		
	Incidence (%)	Intensity (%)	Infestation index
CoH 160	36.79 (36.00)	23.68 (16.22)	5.96
CoH 167	34.87 (32.77)	21.94 (14.03)	4.57
CoH 150	32.80 (29.55)	20.35 (12.16)	3.68
S.E.(m)	0.42	0.27	0.19
C.D. @5%	1.33	0.86	0.62

Effect of varieties on cane yield

The data on cane yield in sugarcane varieties is presented in Table 5. Significantly the highest (81.75 t/ha) cane yield was recorded in variety CoH 150 followed by variety CoH 167 (75.69 t/ha) and it was minimum (71.27 t/ha) in variety CoH 160.

Table 5: Mean cane yield of sugarcane varieties as influenced by planting methods and nitrogen levels

Varieties	Mean cane yield (ton/ha)
CoH 160	71.27
CoH167	75.69
CoH 150	81.75
S.E.(m)	0.54
C.D. @5%	1.70

Effect of varieties on number of millable canes (000´/ha)

The data regarding the number of millable canes related to sugarcane varieties is presented in the Table 6. It was found

that the number of millable canes was differing significantly with different varieties. Highest (100.31 thousand/ha) millable canes were obtained from variety CoH 150 and it was followed by the variety CoH 167 (87.87 thousand/ha) and variety CoH 160 (74.65 thousand/ha).

Table 6: Mean number of millable canes of sugarcane varieties

Varieties	Mean number of millable canes (,000 canes/ha)
CoH 160	74.65
CoH167	87.87
CoH 150	100.31
S.E.(m)	1.37
C.D. @5%	4.34

Effect of varieties on Commercial cane sugar (CCS)

The data related to commercial cane sugar is presented in Table 7. The commercial cane sugar was influenced significantly with respect to different varieties. The maximum (11.78%) commercial cane sugar was observed in variety CoH 167 followed by variety CoH 150 (10.84%). The minimum commercial cane sugar was observed in variety CoH 160 (10.70%).

Table 7: Mean CCS per cent of sugarcane varieties as influenced by planting methods and nitrogen levels

Varieties	Mean CCS per cent
CoH 160	10.70
CoH 167	11.78
CoH 150	10.84
S.E.(m)	0.01
C.D. @5%	0.05

Discussion

Germination of different sugarcane varieties

Per cent germination observed two months after planting ranged from 38.27 to 43.05 per cent corresponding to different genotypes. The variation in germination per cent in different varieties is their genetic character. The same has been observed by Anonymous [3].

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

From present study, it was observed that the shoot borer incidence in April, May and June, 2017 was highest (7.14, 12.03 and 5.37%, respectively) in CoH 160. Whereas, the lowest incidence (3.45, 4.81 and 2.96%) was observed in CoH 167 during April, May and June, respectively. The present investigation is in accordance with the findings of Pandey and Kumar [12] who reported that the highest incidence (8.8%) of early shoot borer observed during May. The peak active period of *C. infuscatellus* was in the month of May in Andhra Pradesh as observed by Kumar and co-workers [9]. The present findings are also in accordance with the findings of Pandya and co-workers [12] who observed that no incidence of *C. infuscatellus* was recorded during July, August, September and October.

Variation in the incidence of *C. infuscatellus* in different varieties was recorded in the present investigation. It was observed that the behaviour of different varieties is different in case of shoot borer incidence. The present findings are in accordance with the observations Singh and co-workers [17] who observed that among one hundred thirty one genotypes checked against early shoot borer, thirty genotypes were rated as tolerant, forty eight as moderately tolerant, fifty two as susceptible and one as highly susceptible. Rao [16] also observed that genotypes resistant to *C. infuscatellus* had greater green leaf area and were more vigorous in growth as compared to susceptible genotypes.

Incidence of top borer (*S. excerptalis* Walker)

From the present study it can be concluded that the *S. excerptalis* incidence ranged from 3.55 to 8.66 per cent in the month of July and in August, it ranged from 5.11 to 10.88 per cent and in September, 2017 it ranged from 6.44 to 12.22 per cent in different varieties. Different varieties behaved in a different manner in case of top borer incidence. Maximum incidence of top borer was observed in early maturing genotype, CoH 160 followed by late maturing, CoH 150 and-lowest incidence in mid. maturing genotype, CoH 167. The present findings are in accordance with the findings of Gupta [7] who reported that early maturing genotypes were more susceptible to the attack of top borer.

Incidence, Intensity and Infestation index of stalk borer (*C. auricilius* Dudgeon)

Results of present study revealed that stalk borer mean per cent incidence, per cent intensity and infestation index was highest (36.00, 16.22 and 5.96, respectively) in early maturing variety CoH 160, followed by (32.77, 14.03 and 4.57 respectively) in mid maturing variety CoH 160 and (29.55, 12.16 and 3.68, respectively) in late maturing variety CoH 150. Therefore, it was observed that the early maturing variety with soft rind and higher sugar content was preferred by *C. auricilius*. The present findings are in accordance with Randhawa [15] who observed maximum mean per cent incidence of stalk borer in early maturing genotype CoJ 85 (35.15) followed by mid maturing genotype, CoH 119 (29.28) and late maturing genotype, Co 89 (24.50). Similar results were also recorded by King [8], Brokensha [5] and Albert and co-workers [2].

Cane yield of sugarcane genotypes

Results of the present study revealed that the cane yield varied significantly with different genotypes. Highest (81.75 t/ha) cane yield was obtained from the CoH 150 (late maturing variety), followed by the mid maturing variety CoH 167 (75.69 t/ha) and early maturing variety CoH 160 (71.27 t/ha). This showed that the genetic potential is different of different genotypes. The present findings are strongly supported by Randhawa [14] that the cane yield varied significantly with different genotypes. Highest (591.63 q/acre) cane yield was obtained from the mid season maturing variety CoH 119 and this was closely followed by CoJ 89 (512 q/acre) which is a late maturing variety and CoJ 85 (476.20 q/acre) which is an early maturing variety. The present investigation is also in accordance with Ojha and co-workers [11] who reported that though genotypes behave according to their inherent potential, but the other factors like nutrient management practices also have one of the major impact in crop growth, cane yield and accumulation of sugar in the canes.

Number of millable canes

Results of the present study revealed that the numbers of millable canes were differing significantly with different varieties. Highest number of millable canes (100.31 thousand/ha) were obtained from the variety CoH 150 (late maturing variety), followed by the mid maturing variety CoH 167 (87.87 thousand/ha) and then early maturing variety CoH 160 (74.65 thousand/ha). This shows that different genotypes

have their own genetic potential. Zende and Kibe [18] observed that the numbers of millable canes are significantly and positively correlated with the cane yield.

Commercial cane sugar (CCS)

Results of the present investigation showed that significantly the maximum commercial cane sugar (11.78%) was found in variety CoH 167, followed by CoH 150 (10.84%), whereas minimum CCS (10.70%) was obtained from variety CoH 160. Commercial cane sugar is a function of cane yield and available sugar. It followed the trend almost similar to that of cane yield. So, the maximum CCS per cent was observed in variety CoH 167. Similar observations were recorded by Kumar and co-worker [9].

Conclusion

The genotype CoH 150 was found to be good in germination as highest (43.05%) germination was found in this as compared to other genotypes CoH 167 (39.11%) and CoH 160 (38.27%). The incidence of early shoot borer was highest in CoH 160 during April, May and June, 2017 (7.14, 12.03 and 5.37%). While it was lowest (3.45, 4.81 and 2.96%) in CoH 167 during April, May and June, respectively. The mean per cent incidence of top borer was highest in early maturing genotype CoH 160 (8.66, 10.88 and 12.22) followed by CoH 150 (5.11, 9.33 and 10.44) which is a late maturing genotype. Lowest (3.55, 5.11 and 6.44%) incidence was observed in mid maturing genotype CoH 167 during July, August and September, respectively. Highest mean per cent incidence, per cent intensity and infestation index of stalk borer was found in early maturing genotype CoH 160 (36.00, 16.22 and 5.96, respectively), followed by mid maturing genotype CoH 167 (32.77, 14.03 and 4.57, respectively) and lowest in late maturing genotype CoH 150 (29.55, 12.16 and 3.68, respectively). Cane yield obtained was highest (81.75 t/ha) in CoH 150 followed by CoH 167 (75.69 t/ha) and lowest cane yield (71.27 t/ha) was obtained from CoH 160. The number of millable canes obtained were highest (100.31 thousand/ha) in CoH 150 followed by (87.87 thousand/ha) CoH 167 and lowest (74.65 thousand/ha) in CoH 160. Commercial cane sugar obtained was highest (11.78%) in CoH 167 followed (10.84%) by CoH 150 and lowest (10.70%) in CoH 160.

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