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COMPARATIVE POPULATION TRENDS OF SUGARCANE BORERS ON DIFFERENT COMMERCIALLY GROWN SUGARCANE VARIETIES AT DISTRICT JHANG, PAKISTAN

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ABSTRACT

Sugarcane borers are devastating pests of sugarcane crop and often cause economic damage. The study was conducted in five different locations of district Jhang during 2012 aiming to evaluate some commercially grown sugarcane varieties (CP-77-400, NSG-59, SPF-213, HSF-240 and SPF-234) towards different sugarcane borer species in terms of field infestation levels, spatial distribution and their impact on brix percentage. There was no significant difference in populations of top borer (*Scirpophaga nivella*) among the five sugarcane varieties. The highest abundance of stem borers (*Chilo infuscatellus*) was recorded in NGS-59 while it was the lowest in HSF-240 and SPF-234. Gurdaspur borer (*Acigona steniella*) was the highest in abundance in CP-77-400. The maximum number of root borer (*Emmalocera depressella*) was recorded in CP-77-400 and NGS-59 and the minimum in HSF-240. The mean borer population was also the maximum in CP-77-400 and NGS-59 while it was the minimum in HSF-240 and SPF-234. The brix percentage of CP-77-400, NGS-59 and HSF-240 was significantly reduced by borer infestation. Except top borer, the populations of all the three borer species were significantly distributed among the five locations. The variety SPF-234 proved most successful as it was least attacked by borers and its brix percentage was also least affected.

Keywords: Sugarcane borers, Brix percentage, Sugarcane varieties, Sugarcane borer infestation.

INTRODUCTION

Sugarcane is an important sugar crop and a source of raw material for various agro-based industries in Pakistan. It is cultivated on about 1 million hectares with average sugar recovery of 9.01 percent (Anonymous, 2010). The average cane yield of Pakistan (46 to 48 tons per hectare) is much lower than the competing countries e.g., United States of America (80 tons per hectare), India (69 tons per hectare) and Egypt (107 tons per hectare). Several reasons of low yield of sugarcane have been reported including improper cultural practices, climate barriers, less availability of irrigation water, adaption of uncertified seed, late sowing and harvesting, imbalance nutrition, poor rationing, insect pests and diseases (Gul *et al.*, , 2010).

About 1300 insect pests feed on sugarcane crop around the world while 61 are known from Pakistan (Hashmi, 1994). Borers are the most deleterious of all and can decrease the yield and sugar recovery by 30-80% and 0.25-1.25%, respectively (Bhatti *et al.,* 2008). The most important borers species reported from Pakistan include top borer, *Scirpophaga excerptalis* and *S. nivella*; stem borer, *Chilo infuscatellus* and *C. auricilius*; root borer, *Emmalocera depressella* and Gurdaspur borer, *Acigona steniella* (Kalra and Sidhu, 1955).

Borers make tunnels into the stalks, stubbles and internodes, causing death of the shoots by blocking food supply to aerial parts of stem and leaves (Gul *et al.,* 2008). The infected stalks lose weight and eventually wither away. The weaker stalks are often broken through the wind action (Dinardo-Miranda *et al.,* 2012). Brix is one of the three parameters used in calculating Commercial Cane Sugar (CCS) i.e. total sugar (%) (Brix) adjusted for purity (Pol) and stalk fiber content. The borers infestation can significantly decrease the brix contents, pol, fiber contents, cane weight and ultimately CCS (Gupta and Singh, 1997; Khaliq *et al.*, 2005; Afghan *et al.*, 2006). On the other hand, reducing sugar contents and fiber (%) increase with borers attack (David and Ranganathan 1960; Singh *et al.,* 2004; El-Dein *et al.*, 2009). However, Huang-Guang *et al.* (2006) could not establish any relationship between number of dead hearts and sugarcane juice brix.

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Khaliq *et al.* (2005) attributed brix as the most important factor in predicting borers infestation followed by pol, CCS and fiber contents when computing these factors together for multivariate regression model and principal component analysis. Singh *et al.,* 2004 reported 3rd generation of *S. excerptalis*as the most devastating in terms of brix and pol% loss. Borer-rot disease complex (micro-organisms) associated with borers attack, is mostly responsible for the reduction in brix and pol (Ayquipa *et al.,* 1980).

The occurrence of sugarcane borers has been reported to be significantly different on different cultivars of sugarcane depending on physiomorphic (number of trichomes, hard midrib and erect or narrow leaves etc.) and chemical characteristics (e.g. plant volatiles and secondary metabolites) of cane varieties (Gul *et al.,* 2008; Dinardo-Miranda *et al.,* 2012). Moreover, their distribution may also vary on different spatial scales i.e. within field, farm, region and zone (Rossi and Fowler, 2003). Understanding spatial variations for better insight into population dynamics is very important in making pest management decisions e.g. biological control (Dinardo-Miranda *et al.,* 2011).

To understand spatial distribution among the borer populations and their ultimate impact on cane brix percentage in farmer fields, a study was conducted on five commercially grown sugarcane varieties in five different locations at district Jhang, Pakistan.

MATERIALS AND METHODS

The study was conducted in five different locations of district Jhang (Punjab), Pakistan (31.306ºN and 72.328ºE) during October-November, 2012 i.e. sugarcane fields along Bhakkar, Faisalabad, Toba Tek Singh, Sargodha and Gojra roads, within the radius of 10 km from the main city.

Five commercially grown sugarcane varieties in the area were selected for the study i.e. CP-77-400, NSG-59, SPF-213, HSF-240 and SPF-234. In each location, two acre plots of each variety were selected and at the time of loading harvested cane on the trolley, twenty canes were randomly pulled out i.e. 5 canes from each of the four sides of a trolley from different heights. For each variety, two trolleys were surveyed in each location yielding a sample of 40 canes per variety. Care was taken to choose the canes of comparable length and girth.

The sampled canes were observed for any borer attack. Borer infested canes were dissected longitudinally with the help of a sharp knife in search of any larva or pupa and recording their number and damage. In each location, the juice of 10 infested canes having three internodes bored of each variety was extracted followed by brix percentage measurements with the help of a refractometer. Ten healthy internodes of each variety were also sampled randomly for brix percentage (as a control).

The borer populations were compared among the five locations and among the five varieties by using Analysis of Variance (ANOVA) and subsequently the means were separated by using LSD test at 5% level of significance. Paired sample comparison test (t-test at alpha= 0.05) was used to compare the brix percentage of healthy and infested (due to different borer species) cane varieties.

RESULTS AND DISCUSSION

All except top borers (*S. nivella*) varied significantly among the five locations (Table I). The maximum population of stem borer (*C. infuscatellus*) was recorded in NSG-59 followed by CP-77-400 and SPF-213 whereas minimum populations were recorded in HSF-240 and SPF-234. However, gurdaspur borers (*A. steniella*) were the highest in CP-77-400 followed by SPF-213 and SPF-234 while it was the lowest in SPF-240. On the other hand, root borer (*E. depressella*) populations were the maximum in CP-77-400 and NSG-59 followed by SPF-213 and SPF-234 while it was the minimum in HSF-240. The overall results suggest that varieties CP-77-400 and NSG-59 held the maximum borer populations followed by SPF-213, HSF-240, and SPF-234.

Most of the studies have shown a great variability in populations of different borer species on different sugarcane cultivars (Teran *et al.,* 1986; White *et al.,* 2011). To date, no sugarcane variety has been reported completely resistant against any sugarcane borer species, however different varieties exhibit various levels of resistance against borers. The possible explanation of host plant resistance in sugarcane is the presence of trichomes. Trichome-based antixenosis is a very broad-based defense in sugarcane against borers of Pyralidae (Smith, 2005). Number of trichomesper unit area of host affects oviposition behavior or deterring females to lay eggs (Ramaswamy, 1988). Other host plant resistance mechanism is the release of plant volatile secondary metabolites as a result of complex biochemical processes e.g., fatty-acid derived products. These can serve as signals to attract or repel insects (Turlings *et al.*, 1998; Ferry *et al.*, 2004).

Borer populations significantly lowered the brix percentage of all the sugarcane varieties (p<0.05) (Table 2). This phenomenon was stronger in HSF-240 followed by CP-77-400 and NSG-59 while weaker in SPF-234 and SPF-213. Different varieties suffer different degrees of losses for the same degree of infestation (Charpentier *et al.*, 1965). Most of the studies have shown a significantly negative correlation between infestation index and brix, pol, purity and sugar contents (David and Ranganathan, 1960; Perez-Gonzalez *et al.*, 1977). The reduction in sugar quality could also be linked to the presence of a fungus associated with *Eldana saccharina* borings, which is known to cause deterioration of sucrose molecules (Ogunwolu *et al.*, 1991).

All except top borer, varied significantly among the locations (Table 3). This among location non-significance in top borer population is mainly due to high variation in data collected which is a possible outcome of among varietal non-significance in top borer population due to high variation in data collected (Table 1).The maximum population of stem borer was observed along Bhakkar road followed by Sargodha and Faisalabad roads whereas the minimum populations were recorded along Toba Tek Singh and Gojra roads. On the other hand, Gurdaspur borer population was the maximum along Sargodha road followed by Bhakkar and Faisalabad roads while it was the minimum along Toba Tek Singh and Gojra roads. In case of root borer, the population was the highest along Bhakkar road followed by Sargodha and Toba Tek Singh roads while along Faisalabad and Gojra roads, it was comparatively low. The overall results suggest that the borer populations were higher along Bhakkar, Sargodha and Faisalabad roads as compared to Toba Tek Singh and Gojra roads.

The uneven distribution of sugarcane varieties grown among the locations could be the possible explanation of such a spatial variation in borer populations. This can further be confirmed by our previous finding that all except top borer varied significantly among the sugarcane varieties. There is little doubt that multiple factors are responsible for spatial scale distribution of species e.g. abiotic, biotic, biogeographic and movement related factors etc (Levin, 1992). However little is known about how the determinants of the distribution of single species vary across spatial scale (Hortal *et al.*, 2010). A most recent account of theoretical framework perhaps was presented by Soberon (2010) in which he incorporated three important elements in a single formal mathematical definition i.e. Scenopoetic, Bionomic, and Occupancy dynamics factors. Other possible reasons of spatial variation in the study area may include the variation in sowing dates (sowing lasts from start of September to end of February), area under sugarcane cultivation (due to different cropping patterns) and different crop management practices.

Table I: Population of four borer species on five commercially grown sugarcane varieties at district Jhang during October to November, 2012

Varieties	**Top borer**	**Stem borer**	**Gurdaspur borer**	**Root borer**	**Mean borer population**
CP-77-400	0.83	0.83 ab	1.33 a	1.00 a	1.00 a
NSG-59	0.75	1.25 a	0.62 ab	0.75 a	0.844 a
SPF-213	0.5	0.67 ab	1.00 ab	0.33 ab	0.62 ab
HSF-240	0.42	0.33 b	0.39 ab	0.18 b	0.33 b
SPF-234	0.33	0.5 b	0.5 ab	0.33 ab	0.41 b
ANOVA results *F: d.f: P*	0.81 : 4 : 0.523	3.33 : 4 : 0.016	2.20 : 4 : 0.081	3.02 : 4 : 0.025	5.98:4:0.00

Mean values sharing same letter in respective columns show non-significant differences (P<0.05)

Table 2: Effect of sugarcane borers on brix percentage of different sugarcane varieties

	CP-77-400	NSG-59	SPF-213	SPF-234	HSF-240
Mean brix infected	15.96	14.70	13.91	16.68	16.03
Mean brix healthy	20.26	20.58	20.53	21.20	21.58
t (observed value)	-5.886	-4.668	-3.470	-3.785	-10.847
t (critical value)	2.571	2.366	2.571	2.571	2.037
Two-tailed p-value	0.002	0.002	0.018	0.013	< 0.0001
Alpha	0.05	0.05	0.05	0.05	0.05

Table 3: Population of four borer species in five different location of district Jhang during October to November, 2012

Locations	Top borer	Stem borer	Gurdaspur borer	Root borer
Bhakkar Road	0.67	0.78 a	0.44 ab	0.56 a
Sargodha Road	0.45	0.55 ab	0.82 a	0.36 ab
Faisalabad Road	0.27	0.33 ab	0.53 ab	0.07 b
Toba Tek Singh road	0.25	0.13 b	0.13 b	0.13 ab
Gojra Road	0.19	0.13 b	0.19 b	0.06 b
ANOVA results *F: d.f: P*	0.93:4:0.455	1.69:4:0.166	1.43:4:0.234	2.39:4:0.061

Mean values sharing same letter in respective columns show non-significant differences ($P<0.05$)

CONCLUSION

Among five considered sugarcane varieties, HSF-240 and SPF-234 were least attacked by stem borer while HSF-240 was also least attacked by root borer. NGS-59 was highly attacked by stem borer and CP-77-400 was highly attacked by Gurdaspur borer while both the varieties were also highly attacked by root borer. The overall population of borers was also the maximum on these two varieties. Based on area wide distribution of borer populations, we can decide which variety to grow or not to grow in upcoming season. For example, HSF-240 and SPF-234 are recommended for the fields along Bhakkar road as the maximum population of Stem borers was recorded over there. Likewise, CP-77-400 and NGS-59 should be avoided growing near Bhakkar road and Sargodha road as the maximum populations of Gurdaspur borer and root bores were recorded over there. SPF-234 seems successful as it was least attacked by the entire borer species and its brix% also remained unaffected by borers attack.

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