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SCREENING OF SOME NEW HYBRID GENOTYPES OF MAIZE FOR THEIR RESISTANCE/SUSCEPTIBILITY AGAINST *CHILO PARTELLUS* (SWINHOE) (LEPIDOPTERA: PYRALIDAE) AND *ATHERIGONA SOCCATA* (RONDANI) (DIPTERA: MUSCIDAE)

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ABSTRACT

Maize stem borer, *Chilo partellus* (Swinhoe) and shoot fly, *Atherigona soccata* (Rondani) are major insect pests of maize. Management of these insect pests by using traditional chemicals is not encouraged due to occurrence of pest-resistance pest-resurgence and environmental pollution associated with their successive use. Maximum available varieties are attacked by *C. partellus* and *A. soccata* and receive huge yield losses by these insects. Screening of ten new hybrid genotypes of maize (FH-949, FH-930, FH-925, FH963, FH-985, 32-F-10, 6525, NK-8441, DK-6124 and FH-810) against *C. partellus* and *A. soccata* is the main purpose of this research project. Physico-morphic plant characters of the selected hybrid genotypes has been studied. Experiments were carried out at the research farms of University of Agriculture, Faisalabad by using Randomized Complete Block Design. All the hybrid lines differed significantly regarding plant infestation percentage for the both pests. The hybrid lines FH-810 showed comparatively resistant trend with minimum infestation i.e. 0.92 and 0.16% for maize stem borer and shoot fly, respectively, whereas FH-949 appeared as susceptible hybrid lines showing maximum plant infestation caused by maize stem borer (6.67%) and shoot fly (3.00%). Cob height, stem diameter and leaf trichomes exerted negative and significant correlation with both the insect pests under test. Whereas number of nodes per plant, plant height, length of central spike and cob length did not show significant correlation, but the response of these characters were found to be negative on the pests' infestation.

Keywords: Maize, *Chilo partellus, Atherigona soccata*

INTRODUCTION

Maize (*Zea mays* L.) is one of the major Kharif crops in Pakistan with highest yield among the cereals. It is cultivated approximately on an area of 1015 thousand hectare with total annual grain production of 3313 thousand tons and an average yield of 3264 kg/hectare (Anonymous, 2007). Maize contributes about 6.4% of the total production of the country. Its grain contains considerably more starch, fat and vitamin A as compared to other cereal. Maize is recommended to heart patients due to cholesterol free nature. (Maitti and Wische-Ebelling, 1998). The most important insect pests in maize are the maize and jowar stem borer (*Chilo partellus* Swinhoe) (Lepidoptera: Pyralidae), Shoot fly (*Atherigona soccata* Rondani) (Diptera: Muscidae), Army worm (*Mythimna separata* Walker) (Lepidoptera: Noctuidae) and many other species of aphids. The infestation ultimately results in total failure of crop (Singh and Sharma, 1984). In the most infested area, the insect damages in maize crop are up to 50% which is then liable to secondary attack by another pathogen (Lisoweiz, 2000).

Maize stem borer, *C. partellus* (Swinhoe) is the most notorious pest of maize crop. Almost 75% damage of 50% crop occurs due to attack of maize stem borer (Latif *et al*., 1960). In case of severe infestation, it causes the total failure of crop (Rafique, 1986). It is one of the major limiting factors responsible for low yield in Pakistan. In Pakistan, there is no maize cultivar resistant to borers. Generally, it is controlled by

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insecticides which not only cause environmental pollution and hazards to human beings and animals, but also increases the cost of production. Resistant maize can be effective and safe solution for minimizing the pesticide use, improving natural balance and enhancing the activity of bio-control agents. It can also reduce the cost of production.

The maize shoot fly, *Atherigona soccata* Rondani (Diptera: Muscidae), is economically an important pest of maize in Asia, Mediterranean Europe and Africa. It infests the maize seedlings between the first and fourth weeks after emergence by ovipositing eggs on the abaxial surface of the third to sixth basal leaves. On hatching, the maggot moves down between the leaf sheath and cuts through the central meristematic tissue of the developing leaf resulting in withering of the central shoot known as dead heart. The maggot feeds on the decaying tissue of the growing point (Ponnaiya, 1951). The growth and development of the larva is completed within the infested seedling. Loss in plant stand and grain yield due to shoot fly damage is high under delayed plantings, especially in high yielding cultivars (Rai *et al*., 1978). The levels of shoot fly infestation in sorghum may reach as high as 90% under delayed sowing (Hiremath and Renukarya, 1966; Rao and Gowda, 1967).

Insecticides have been shown to kill the natural enemies of many insects which result in the outbreak of secondary pests and health hazard effects (Mathews, 1983). Tolstava and Atanove (1982) observed low percentage of predators and parasites in chemical-based field in Russia. It has been clinically diagnosed that person actively engaged in pesticide manufacturing business have higher cholesterol and pesticides in their body (Krawinnkel *et al*., 1989).

Keeping these factors in mind, current study on screening of ten hybrid genotypes of maize against *C. partellus* and shoot fly, *A. soccata* was conducted. A resistant source against these insects was identified through screening and evaluation under natural conditions by correlating the data with the plant physical characters.

MATERIALS AND METHODS

Experimental layout

Experiments were conducted on the Experimental farm of University of Agriculture, Faisalabad. Ten advanced hybrid genotypes of maize (FH-949, FH-930, FH-925, FH963, FH-985, 32-F-10, 6525, NK-8441, DK-6124 and FH-810) were sown on well prepared ridges with R x R and P x P distances of 75 cm and 22.86 cm, respectively following Randomized Complete Block Design with three repeats. No plant protection coverage was provided in the test material to create the optimum condition for pest multiplication. All the recommended agronomic practices were adopted during the experimentation uniformely. The infestation was determined on the basis of dead hearts. The observations were taken at weekly intervals. The various physico-morphic plant characters of these hybrid genotypes were also studied. Data collected for pest infestation and various physico-morphic plant characters were analyzed statistically by using statistic software. Comparison of the susceptible/ resistant varieties was carried out using DMR Test $\alpha = 0.05$.

Physico-morphic Plant Characters

Following physico-morphic plant characters of these hybrid genotypes were also studied

Cob height

Randomly selected 10 plants were measured with the help of measuring tape from the position of cob and then average was taken for each plot.

Stem Diameter

Stem diameter was measured from ten randomly selected plants of hybrid line of maize verities.

Leaf Trichomes

Leafe trichomes were also examined from randomly selected plants

Cob length

Length of each cob was measured from 10 randomly selected plants and average was taken to get the mean cob length from each treatment.

Length of 3rd internode

Length of 3rd internode was measured from the same randomly selected plants, then averaged to get mean length from each plot.

Number of Internodes

Number of internodes per plant was calculated from the samples of 10 plants in each plot.

Plant height

Ten plants from each treatment were selected randomly at the time of maturity of the crop, then height was measured with the help of measuring tape. Finally, average was taken.

Length of central spike

Length of central spike from 10 randomly selected maize plants were measured and then averaged to get mean length of central spike for each plot.

RESULTS

The data on percent infestation caused by *C. partellus* and shoot fly were recorded at weekly interval. Various physico-morphological plant characters were correlated with population of both pests to determine their role towards population fluctuation on hybrid maize. The results are described under the following sub-sections.

Infestation caused by *Chilo partellus*

The data regarding plant infestation percent caused by *C. partellus* in different new hybrid lines of maize at various dates of observation are presented Table-1. The difference of *C. partellus* infestation in hybrid lines was found highly significant (Table 1). The amaximum infestation of *C. partellus* was found on FH-949 (6.67%) which was found significantly different from infestation observed in all other hybrid lines. The hybrid line FH-810 proved comparatively resistance with the lowest *C. partellus* infestation (0.92%) and exhibited resistance statistically similar to hybrid lines DK-6124, NK-8441, FH-6525 and 32-F-10 with 1.50, 1.50, 1.67 and 1.58% infestation, 5.0, 4.0, 3.25 and 2.42% *C. infestation*, respectively and showed intermediate resistance trend. Furthermore, the hybrid lines FH-930 and FH-925 did not show significant difference with each other. Similarly, non-significant difference was found to exist between FH-925 and FH-963 (Table 1). From these results. it was concluded that FH-949 proved relatively susceptible with maximum infestation of *C. partellus* whereas FH-810 proved comparatively resistant with minimum *C. partellus* infestation (Table 1).

Infestation caused by shoot fly (*A. soccata*)

The data regarding percent infestation caused by shoot fly are presented in Table 2 which reveals that highly significant difference existed among hybrid lines. The maximum *A. soccata* infestation was recorded on FH-949 (3.00%) which differed significantly from *A. soccata* infestation observed in all other hybrid lines. The minimum *A. soccata* infestation was observed on FH-810 (0.16%) which did not exhibited significant difference with those of recorded on DK-6124, NK-8441, FH-6525, 32-F-10 and FH-985 with 0.33, 0.50, 0.50, 0.83 and 0.83% *A. soccata* infestation, respectively. The hybrid line FH-930 showed 2.0% plant infestation and did not differ significantly from those of FH-925 and FH-963 with 1.50 and 1.33% *A. soccata* infestation. Furthermore, *A. soccata* infestation recorded on FH-963 also showed non-significant difference from those observed on FH-985, 32-F-10, FH-6525, NK-8441 and DK-6124 (Table 2). From these results it was concluded that FH-810 proved comparatively resistant with minimum *A. soccata* infestation while FH-949 proved susceptible with maximum *A. soccata* infestation (Table 2).

Correlation between infestation and plant characteristics

All the morpho-physical plant characters viz. number of nodes per plant, plant height, cob height stem diameter, length of central spike, cob length and leaf trichomes differed significantly among hybrid lines. Cob height, stem diameter and leaf trichomes exerted negative and significant correlation with both the insect pests under test. Whereas number of nodes per plant, plant height, length of central spike and cob length did not show significant correlation, but the response of these characters were found to be negative on the pests' infestation (Table 3).

DISCUSSION

Ten hybrid lines of maize viz., FH-949, FH-930, FH-925, FH-963, FH-985, 32-F-10, FH-6525, NK-8441, DK-6124 AND FH-810 were tested for resistance/susceptibility against maize stem borer, *C. partellus* (Swinhoe) and shoot fly, *A. soccata* under field conditions. The data on dead heart were recorded for both the pests at regular interval. Various morpho-physical plant characters of the plant viz., number of nodes per plant, Plant height, Cob height, Stem diameter, length of central spike, cob length and leaf trichomes were correlated with the pest's infestation. The maximum infestation of shoot fly was observed in the middle of March and least in the month of April. These results are different from Khan et al. (2016) who noted the maximum infestation of shoot fly in the month of May due to change in climatic condition. Sparks and Yates (1997) stated that the change in the climatic conditions has greatly affected the agricultural systems along with the insect pests. In the present results densities of insect pests on the ten maize cultivars were lower than that reported by some earlier researchers like Sparks and Yates (1997); Mensah and Madden (1999); Dhillon et al. (2006), which might be due to the fact that host plant resistance has played its role in suppressing insect pests populations.

The results reveal that all the hybrid lines differed significantly regarding infestation percentage for both the pests. The hybrid lines FH-810 showed comparatively resistant trend with minimum infestation *C. partellus* (0.92%) and *A. soccata* (0.16%), whereas FH-949 was found susceptible hybrid lines showing maximum *C. partellus* (6.67%) and *A. soccata* infestation(3.00%). The susceptibility ranking order of hybrid lines towards *C. partellus* : is FH-949 > FH-930 > Fh-925 > fh-963 > FH-985 > 32-F-10 > FH-6525 > NK-6124 > FH-810

Similarly, susceptibility ranking order of hybrid lines against *A. soccata* is FH-949 > FH-930 > FH-925 > FH-963 > FH-985 > 32-F-10 > NK-8441 > DK-6124 > FH-810. The present findings cannot be compared with those. The maximum infestation of maize stem borer was recorded to be 4.87% whereas of shoot fly it was 2.0%.

The results of Kundu (1985) also support the present findings. He conducted trial in Somalia on 20 maize cultivars for resistance against stem borer on the basis of leaf injury, dead hearts and stem tunnelling and identified least susceptible cultivars. The present findings are also agreement of Saeed et al. (2006) who screened 23 genotypes and reported that the genotypes IS-18363 was highly susceptible while IS-18463 and IS-2146 to be moderately susceptible, IS-4660 and IS-2205 to be moderately resistant, IS-1044 to be highly resistant against maize stem borer. Similarly Kishore (1991) reported that out of 17 sorghum cultivars four cultivars were resistant to *C. partellus*. The present findings also uphold the view of Kakar et al., (2003) who reported that maize cultivars i.e. local, sadaf, sultan and akbar shown resistant against maize stem borer.

All the morpho-physical plant characters viz. number of nodes per plant, plant height, cob height stem diameter, length of central spike, cob length and leaf trichomes differed significantly among hybrid lines. Cob height, stem diameter and leaf trichomes exerted negative and significant correlation with both the insect pests under test. Whereas number of nodes per plant, plant height, length of central spike and cob length did not show significant correlation, but the response of these characters were found to be negative on the pests' infestation.

The results regarding the correlation coefficient values between infestation of plants caused by *C. partellus* and *A.soccata* and morphological plant characters is given in Table 3. These results revealed that stem diameter, cob height and leaf trichome exerted significant and positive correlation with the plant infestation showing r-values of 0.815**, 0.889**, 0.784**, 0.716**, 0.808** and 0.873**, respectively. Number of nodes per plant, plant height, cob length and length of central spike showed non-significant correlation with the plant infestation, however the response was found to be negative on the infestation of plants caused by *C. partellus* and *A. soccata.*

CONCLUSION

All the hybrid lines differed significantly regarding percent infestation of both the pests. The varieties with hard and hairy leaves showed maximum resistance against shoot fly and maize borer than other varieties.

Table 1.
Means comparison of the data regarding plant infestation (%) caused by *C partellus* (swinhoe) in different hybrid lines of maize at various dates of observation.

Hybrid Lines	Dates of Observation X Hybrid Lines (NS)								Means (LSD at 5% =1.26)
	10.03.09	17.03.09	24.03.09	31.03.09	07.04.09	14.04.09	21.04.09	28.04.09	
FH-949	7.33	2.67	4.67	10.00	10.67	8.67	7.33	2.00	6.67 a
FH-930	1.33	2.00	3.33	8.00	9.33	8.00	6.67	1.33	5.00 b
FH-925	0.67	1.33	4.67	4.67	7.33	6.67	5.33	1.33	4.00 bc
FH963	0.00	1.33	5.33	4.00	6.00	4.67	4.00	0.67	3.25 cd
FH-985	0.00	2.00	5.33	2.00	3.33	2.67	3.33	0.67	2.42 de
32-F-10	0.00	0.66	2.67	2.00	2.67	2.67	2.00	0.00	1.58 ef
6525	0.00	0.00	2.67	1.33	3.33	2.67	2.00	1.33	1.67 ef
NK-8441	0.00	0.00	2.00	3.33	2.00	2.67	1.33	0.67	1.50 ef
DK-6124	0.00	0.00	2.00	3.33	2.67	2.67	0.67	0.67	1.50 ef
FH-810	0.00	0.00	1.33	2.00	1.33	2.00	0.67	0.00	0.92 f
Means (LSD at 5% = 1.13)	0.93 c	1.00 c	3.40 b	4.07 ab	4.87 a	4.33 ab	3.33 b	0.87 c	

Means sharing similar letters are not significantly different by DMR Test at P = 0.05

Table 2.
Means comparison of the data regarding *A. soccata* infestation (%)in different hybrid lines of maize at various dates of observation.

Hybrid Lines	Dates of Observation X Hybrid Lines (NS)				Means LSD at 5% = 0.91
	10.03.09	17.03.09	24.03.09	31.03.09	
FH-949	3.33	4.67	2.67	1.33	3.00 a
FH-930	1.33	4.00	2.00	0.67	2.00 b
FH-925	0.67	3.33	2.00	0.00	1.50 bc
FH963	1.33	2.67	1.33	0.00	1.33 bcd
FH-985	0.00	2.00	1.33	0.00	0.83 cde
32-F-10	1.33	1.33	0.67	0.00	0.83 cde
6525	0.00	1.33	0.67	0.00	0.50 cde
NK-8441	0.00	0.67	1.33	0.00	0.50 cde
DK-6124	0.00	0.00	1.33	0.00	0.33 de
FH-810	0.00	0.00	0.67	0.00	0.16 e
Means LSD at 5% = 0.57	0.80 c	2.00 a	1.40 b	0.20 d	

Means sharing similar letters are not significantly different by DMR Teast at P = 0.05.

Table 3.
Correlation coefficient values (r-values) between infestations (%)of maize stem borer and shootfly various plant associated characterisitics.

Physical Plant Characters	Maize Stem Borer	Shoot fly
Nodes per plant	0.566 NS	0.599 NS
Plant height	0.396 NS	0.485 NS
Cob height	0.784 **	0.716 **
Stem diameter	0.815 **	0.887 **
Length of central spike	0.545 NS	0.518 NS
Cob length	0.146 NS	0.020 NS
Leaf trichomes	0.808 **	0.873**

** = Significant at $P < 0.01$.
NS = Non-significant

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