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Screening of maize hybrids against insect pests with reference to plant physical characters

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Abstract
Eight maize hybrid/advanced lines i.e. FH-793, FH-810, FH-940, FH-963, FH-985, FH-1036, FH-1046 and NK-8711 were screened against insect pests during 2013 and 2014 at Maize section, AARI, Faisalabad. During 2013 minimum stem borer infestation (2.20%) was recorded on FH-810 while maximum (8.93%) on NK-8711 followed by FH-793 (8.40%), FH-940 (7.30%) and FH-985 (7.07%). Minimum shootfly infestation was recorded in FH-810 (7.31%) while maximum (16.27%) on FH-963. During 2014 minimum stem borer damage (0.89%) was recorded on FH-1046 while maximum (8.37%) on NK-8711. The minimum (7.98%) shootfly damage percentage recorded on genotype FH-810. Maximum (15.40%) shootfly damage percentage recorded on genotype FH-793 followed by FH-963 (14.26%) and FH-1046 (14.18%). During both year of study, Stem borer damage were found negatively correlated with leaf length, leaf width, plant height, number of nodes, leaf trichomes and stem diameter. In the case of shootfly infestation negative correlation was observed with leaf length and leaf trichomes while positive with leaf width, stem diameter and plant height.

Keywords: *Atherigona soccata*, *Chilo partellus*, Maize hybrids, plant morphological characters and Varietal screening

1. Introduction

In Pakistan maize is third most important cereal after wheat and rice. Maize accounts 4.8% of the total cropped area and 3.5% to the value addition in agriculture. In Pakistan, maize is grown over an area of 1022 thousand hectares with an average production of 3483 kg/ha [1] which is very low as compared to other countries. The grain of maize is a rich source of proteins, starch, vitamins. The long leaves and thicker stem make it higher fodder yielding crop and it contain much more nutrient than any other crop [2]. Edible oil is extracted from maize seeds. Despite high yielding varieties, maize annual production is not increasing. And the major barrier is the insect pests which destroy the maize plants. Maize is attacked by the 140 different species of insect pest which cause the reduction in the yield; out of these 10 species cause the major damage [3]. The major pests are stem borer (*Chilo partellus*), armyworm (*Mythimna separata*), shoot fly (*Atherigona soccata*) and many species of aphids. To overcome these problems, different pesticides are used to control these insect pests but as these pesticides have environmental threats so various other control measures are needed.

The maize shoot fly, *Atherigona soccata* (Diptera: Muscidae), is economically an important pest of grain, forage and sweet 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 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 [4] Maize is susceptible to *Chilo partellus* which causes severe damage to maize [5]. The loss reported by the alone stem borer is from 24-75 percent [6-8]. It is very difficult to control through insecticides and biological control agents. Because once the pest enter the plant tissue, it becomes almost impossible for biological control agents and pesticides to reach the target. Similarly the maize shootfly cause the loss up to 60 percent in the yield [9]. For the tactic of pest management use the resistant varieties which is environmentally safe, economically feasible and socially acceptable.

There are many plant characters, which are responsible for host plant resistance. The plant structures may influence positively as well as negatively on herbivours and their natural enemies [10-11]. These characters may be divided into morphological and biochemical. Morphological characters are most important in host plant resistance [12]. In maize these characters are responsible for suitability of a cultivar for feeding, oviposition and development. Trichome densities and surface waxes are considered to have negative effect on the oviposition and development of Chilo partellus [8].

Afzal *et al* [13] studied that genotype DK-6525 was most resistant against insect pests particularly *Chilo partellus* and shootfly, the genotype named Sahiwal 2002 was most vulnerable. Maximum damage was done in last of April while the minimum in last week of March. They also observed that number of nodes per plant, cob height, plant height, stem diameter, length of central spike, cob length, leaf length, leaf width and leaf trichomes.

2. Materials and Methods

Two years study (2013 and 2014) was carried out to screen eight available maize hybrid/advance lines viz., FH-793, FH-810, FH-940, FH-963, FH-985, FH-1036, FH-1046 and NK-8711 in the experimental area of Maize section, AARI, Faisalabad. The hybrids were sown in Randomize Complete Block Design (RCBD) in plot size of 5m x 3m with three repeats. Recommended row to row distance of 2.5ft and plant to plant distance of 7 inches was maintained. All recommended agronomic practice was followed uniformly with pesticide free conditions. Data regarding maize stem borer and shootfly infestation were recorded by counting damage plants from 25 randomly selected plants from each plot at weekly interval.

Percent infestation was calculated by formula

$$(\%)\ \text{Infestation} = \frac{\text{No. of infestated plants}}{\text{No. of total plants}} \times 100$$

The morphological plant characters were recorded at the end of season before harvesting from 10 randomly selected plants per plot. Above ground plant height was recorded with the help of a measuring tape. The stem diameter was taken with the help of a Vanier caliper by measuring from the center of the 3rd inter node. Leaf length and leaf width were taken from the leaf at cob node with the help of a measuring tape. Leaf trichomes were counted under a binocular microscope from an area of 1 cm at five different points of a leaf selected randomly. The data were analyzed statistically.

3. Results and Discussion

The data regarding stem borer and shootfly damage percentage recorded during 2013 is given in the table 1. Stem borer damage ranged from 2.20 to 8.93% that contradicts with the observations of Pervez *et al* [12] who recorded damage percentage from 12.95 upto 24.02%. In the present study minimum (2.20%) damage was recorded on FH-810 while maximum (8.93%) on NK-8711 followed by FH-940 (7.30%) and FH-985 (7.07%). Minimum shootfly damage was recorded in FH-810 with damage percentage of 7.31%. Maximum (16.27%) shootfly damage was recorded in FH-963 that was not significantly different from damage in FH-1046 (16.18%), FH-793 (16.07%) and FH-985 (15.38%).

The data regarding stem borer and shootfly damage percentage recorded during 2014 is given in the table 2. Stem borer damage ranged from 0.89-8.37% which is in line with the findings of Afzal *et al* [13]. They recorded a range of 3.92- 10.94% percent damage of stem borer. Minimum stem borer damage was recorded in FH-1046 while maximum in NK-8711 followed by FH-985, FH-793, Fh-940, FH-1036, FH-963 and FH-810 with damage percentage of 5.55%, 4.94%, 4.36%, 3.38%, 1.97% and 1.02%, respectively. Significant differences were observed regarding stem borer infestation among hybrids.

During the year 2013, leaf trichome density was found to be significantly different among the hybrids. Maximum (52.44) was observed on FH-810 and minimum (36.00) on FH-940. Maximum (8.99 cm) leaf width was recorded in FH-810 while minimum (7.25 cm) in hybrid NK-8711. Maximum stem diameter of 2.40cm was recorded in FH-810 followed by 2.39 cm in FH-1046. Minimum (2.09cm) stem diameter was recorded in FH-940. Maximum number of nodes per plant was recorded in FH-810 which 12.10 while minimum (11.50) recorded in FH-793. Maximum (81.50 cm) leaf length was recorded in FH-810 while minimum (62.40cm) in FH-940. Maximum plant height was recorded in FH-810 while minimum in FH-940.

During the year 2014, leaf trichome density was found to be significantly different among the hybrids. Maximum (54.40) was observed on FH-810 and minimum (41.00) on FH-1046. Maximum (8.41 cm) leaf width was recorded in FH-810 while minimum (7.58 cm) in hybrid FH-985. Maximum stem diameter of 2.63cm was recorded in NK-8711 followed by 2.39 cm in FH-810 and FH-940. Minimum (2.03cm) stem diameter was recorded in FH-793. Maximum number of nodes per plant was recorded in FH-810 which 12.10 while minimum (11.23) recorded in NK-87113. Maximum (80.00cm) leaf length was recorded in FH-810 while minimum (67.62cm) in NK-8711. Maximum (196.97 cm) plant height was recorded in FH-810 while minimum (182.24 cm) in FH-940.

Correlation coefficients of the data regarding stem borer and shootfly infestation percentage with some morphological characters are given in the table 5. During the year 2013 Stem borer damage were found negatively correlated with leaf length, leaf width, plant height, number of nodes and leaf trichomes significantly but non-significantly with stem diameter. But during 2014 damage was found to be negatively correlated with, leaf width and number of nodes significantly but non-significantly with leaf length, stem diameter, plant height and leaf trichomes.

During the year 2013, shootfly infestation were found to be negatively correlated with leaf length and leaf trichome density while positively correlated with leaf width, stem diameter, plant height and number of nodes. During the year 2014, shootfly infestation were found to be negatively correlated with leaf length, leaf trichome density and number of nodes while positively correlated with leaf width, stem diameter and plant height.

During the year 2013, stepwise multivariate regression analysis showed that leaf length and trichome density induced the maximum (52% and 85.2%) impact in regulating shootfly and stem borer population, respectively. On the other hand minimum role was of trichome density (0.1%) and number of nodes (0.3%) on the respective pest population.

During the year 2014 maximum role of 22.5% in the shootfly and 68.6% in stem borer population regulation was played by plant height and leaf width, respectively. On the other hand minimum role was of leaf width (7.92%) and trichome density (1.3%) on the respective pest population.

The present study results can't be compared with those of Panwar *et al* [14], Awan and Khaliq [15] and Khan and Monobrullah [16] because they used different varieties of maize other than used in this study, and found significant differences in infestation level of *Chilo partellus.* The minimum (7.98%) shootfly damage percentage recorded on genotype FH-810 followed by FH-940 (8.41%). Maximum (15.40%) shootfly damage percentage recorded on genotype FH-793 followed by FH-963 (14.26%) and FH-1046 (14.18%).

Plant physical character results are in accordance with those of Ahmad *et al* [17]. They recorded a negative correlation between borer infestation and plant height and stem thickness. The present findings are in line with those of Kumar [8] in which trichome density had a negative effect on oviposition and development of stem borer. The present study result contradicts with those of Pervez *et al* [12]. They stated that borer infestation is positively correlated with plant height and stem diameter.

Present findings are in line with those of Omori *et al* [18]. They too found trichome density negatively correlated with shootfly infestation. Present study results contradict somewhat with those of Tarun *et al* [19]. In their experiment shoot fly dead hearts were negatively correlated with leaf length, leaf width, plant height, but positively correlated with stem diameter.

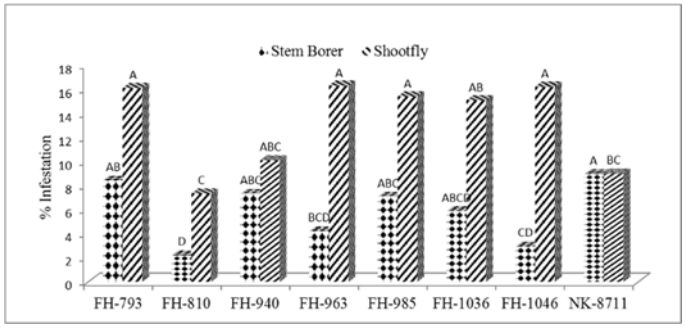

Fig 1: Data regarding Stem borer and shootfly damage percentage recorded on different maize hybrids during 2013

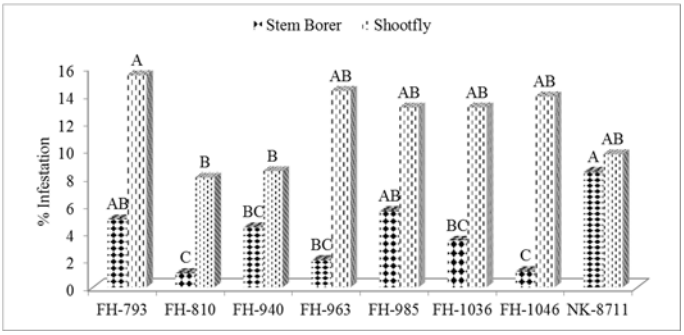

Fig 2: Data regarding Stem borer and shootfly damage percentage recorded on different maize hybrids during 2014

Table 1: Data regarding plant morphological characters of different maize hybrids recorded during 2013

Maize Hybrids		Leaf Trichomes/cm^2	Leaf Width (cm)	Stem Diameter (cm)	Number of Nodes/Plant	Leaf Length (cm)	Plant Height (cm)
V1	FH-793	39.30 BC	7.68 A	2.22 A	11.50 A	67.10 A	194.30 A
V2	FH-810	52.44 A	8.99 A	2.40 A	12.10 A	81.50 A	205.27 A
V3	FH-940	36.00 C	7.35 A	2.09 A	11.33 A	62.40 A	186.67 A
V4	FH-963	48.10 AB	8.41 A	2.38 A	11.93 A	69.50 A	203.60 A
V5	FH-985	40.50 BC	7.86 A	2.31 A	11.76 A	68.80 A	200.87 A
V6	FH-1036	40.21 BC	8.11 A	2.26 A	11.70 A	67.40 A	193.77 A
V7	FH-1046	48.20 AB	8.86 A	2.39 A	12.03 A	77.00 A	200.77 A
V8	NK-8711	38.30 BC	7.25 A	2.15 A	11.40 A	63.00 A	186.30 A
LSD at 5%		11.389	1.9336	0.38	2.282	21.739	19.12

Table 2: Data regarding plant morphological characters of different maize hybrids recorded during 2014

Maize Hybrids		Leaf Trichomes/cm^2	Leaf Width (cm)	Stem Diameter (cm)	Number of Nodes/ Plant	Leaf Length (cm)	Plant Height (cm)
V1	FH-793	42.46 AB	7.83 A	2.03 A	11.33 A	66.66 A	183.69 A
V2	FH-810	54.40 A	8.41 A	2.39 A	12.10 A	80.00 A	196.97 A
V3	FH-940	41.20 B	7.62 A	2.39 A	11.33 A	70.41 A	182.24 A
V4	FH-963	53.46 AB	8.14 A	2.10 A	11.60 A	67.90 A	191.29 A
V5	FH-985	43.00 AB	7.58 A	2.22 A	11.25 A	71.45 A	191.74 A
V6	FH-1036	43.33 AB	8.05 A	2.22 A	11.53 A	70.62 A	186.16 A
V7	FH-1046	41.00 B	8.33 A	2.18 A	11.70 A	70.08 A	190.11 A
V8	NK-8711	50.80 AB	7.81 A	2.63 A	11.23 A	67.62 A	184.36 A
LSD at 5%		12.56	2.03	0.64	2.663	19.354	19.563

Table 3: Correlation coeffients of the data regarding pest population and plant morphological characters

Plant Morphological Characters	2013		2014	
	Stem Borer Damage %	Shootfly Damage %	Stem Borer Damage %	Shootfly Damage %
Leaf Length	-0.8901 (0.0031)	-0.0634 (0.8815)	-0.4917 (0.2159)	-0.4724 (0.2372)
Leaf Width	-0.964(0.0001)	0.1272(0.764)	-0.789(0.0199)	0.0638(0.8806)
Stem diameter	-0.6032(0.1134)	0.5859(0.127)	-0.6756(0.0659)	0.0795(0.8515)
Plant Height	-0.7917(0.0192)	0.2866(0.4913)	-0.6092(0.1089)	0.0047(0.9912)
Number of Nodes	-0.9212(0.0012)	0.1779(0.6735)	-0.8421(0.0087)	-0.1158(0.7848)
Leaf Trichomes	-0.9232(0.0011)	-0.0243(0.9545)	-0.1126(0.7907)	-0.3863(0.3445)

Table 4: Stepwise multivariate regression analysis of the data regarding pest population and plant morphological characters

Regression Analysis for Shootfly vs Plant morphological characters, 2013			
Regression Model (p Value)	**100R^2 (%)**	**Effect Induced**	**Cummulative p Value**
Y=13.8 - 0.015X1(0.955)	0.1	0.1	0.955
Y= - 14.4 - 0.853X1(0.319) + 7.95 X2(0.302)	21.0	20.9	0.555
Y= - 38.4 - 0.932X1 (0.138) + 4.59 X2(0.381) + 23.7X4 (0.050)	73.0	52	0.124
Y= - 39.9 - 0.970 X1(0.221) + 3.52 X2(0.712) + 25.3 X3(0.165) + 0.120X4(0.885)	73.2%	0.2	0.291
Y= - 75 - 1.01X1(0.331)+ 2.8 X2(0.824)+ 23.3X3(0.367)+ 0.060X4(0.957)+ 4.4X5(0.875)	73.6%	0.4	0.535
Y= 66 - 1.04X1(0.381)+ 7.9 X2(0.600)+ 25.3X3(0.395) + 0.067X4(0.952)- 22.4X5(0.601)+ 0.650X6(0.436)	89.5	15.9	0.567
Regression Analysis for Stem Borer vs Plant morphological characters, 2013			

Y = 22.8 - 0.396 X1 (0.001)	85.2	85.2	0.001
Y = 34.5 - 0.050 X1 (0.758) - 3.28X2 (0.063)	93.1	7.9	0.001
Y = 32.2 - 0.057 X1(0.736) - 3.60 X2(0.071)+ 2.25 X3(0.451)	94.1%	1.0	0.006
Y=27.5 - 0.177X1(0.153)- 6.91 X2(0.012)+ 6.95 X3 (0.042) + 0.369X4 (0.046)	98.7	4.6	0.005
Y = 45.2 - 0.159 X1(0.273)- 6.57 X2(0.049) + 7.94 X3 (0.099)+ 0.398 X4(0.095)- 2.17X5 (0.578)	99.0%	0.3	0.237
Y = 68.5 - 0.164 X1 (0.179) - 5.74X2 (0.080) + 8.26 X3 (0.093)+ 0.400 X4 (0.093)- 6.58 X5 (0.195)+ 0.107 X6 (0.204)	99.9	0.9	0.131

X1:Trichomes; X2: Leaf width; X3: Stem Diameter; X4: Leaf Length; X5: Number of nodes; X6:Plant Height

Table 5

Regression Analysis for Shootfly vs Plant morphological characters, 2014			
Regression Model (p Value)	**100R² (%)**	**Effect Induced**	**Cummulative p Value**
Y=23.8 - 0.217 X1 (0.345)	14.9	14.9	0.345
Y = 2.8 - 0.294 X1(0.291) + 3.08 X2 (0.526)	22.1	7.2	0.535
Y = - 12.6 - 0.615 X1 (0.168)+ 8.79 X2 (0.251) - 7.17 X3 (0.308)	41.9	19.8	0.492
Y = - 1.1 - 0.503 X1 (0.267) + 9.61 X2 (0.231)- 5.75 X3 (0.416)- 0.373 X4 (0.348)	58.8	16.9	0.498
Y= - 109 - 0.612 X1(0.242) - 5.0X2 (0.769)- 8.02 X3 (0.330)- 1.11 X4 (0.278)+ 24.9 X5 (0.390)	74.1	15.3	0.527
Y = - 154 - 0.638 X1 (0.185)- 7.98 X2 (0.486)- 6.24 X3 (0.309)- 1.42 X4 (0.175)+ 23.7 X5 (0.291)+ 0.537 X6 (0.236)	96.6	22.5	0.337
Regression Analysis for Stem Borer vs Plant morphological characters, 2014			
Y = 6.14 - 0.050 X1 (0.791)	1.3	1.3	0.791
Y = 57.7 + 0.139 X1(0.312) - 7.56 X2 (0.020)	69.9	68.6	0.050
Y = 50.1 - 0.020 X1(0.918) - 4.74 X2 (0.219)- 3.54 X3 (0.310)	77.5	7.6	0.088
Y = 53.0 + 0.009 X1 (0.970)- 4.53 X2 (0.301)- 3.18 X3 (0.426) - 0.095 X4 (0.652)	79.2%	1.7	0.208
Y = 134 + 0.091X1 (0.625)+ 6.35X2 (0.418)- 1.49 X3 (0.634)+ 0.453 X4 (0.290)- 18.6 X5 (0.196)	92.7	13.5	0.174
Y = 151 + 0.101 X1 (0.536)+ 7.54 X2 (0.344)- 2.19 X3 (0.463)+ 0.578X4 (0.249)- 18.1X5 (0.232)- 0.211 X6 (0.336)	98.1	5.4	0.253

X1:Trichomes; X2: Leaf width; X3: Stem Diameter; X4: Leaf Length; X5: Number of nodes; X6:Plant Height

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