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INFLUENCE OF CERTAIN TRAITS AS RESISTANCE INDUCING FACTORS AGAINST SHOOT FLY (*Atherigona soccata*) AND STEM BORER (*Chilo partellus*) IN LEADING MAIZE (*Zea mays* L) GENOTYPES

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ABSTRACT

The alarming population growth rate in Pakistan has exacerbated the food security problem. Maize which is important source of dietary protein is the highest yield cereal crop in the world. The use of crop varieties resistant or tolerant to insect pests stress is an imperative approach in non-chemical crop protection. In the presented study, 9 genotypes of Maize hybrid/advanced lines *i.e.*, FH-793, FH-810, FH-949, NK-8711, P15-M43, FH-985, FH-988, FH-1036 and FH-1046 were screened out against insect pests during 2016. Minimum shoot fly percentage infestation (5.87%) was recorded on FH-810 while maximum (21.46%) on FH-1046. Minimum stem borer % damage was recorded in FH-810 (1.32%) while maximum (8.23%) on FH-1046. During this study physiomorphic characters (Plant height (cm), stem diameter (cm), leaf hair density (cm^2) and chlorophyll contents) of the available genotypes were also examined which revealed the plant anti-xenosis effect that ultimately leads to preference and non-preference which shows remarkable difference in yield within the testing genotypes. Results revealed that maximum yield was recorded in FH-810 (9818.75 Kg/ha) while minimum in FH-1046 (7154.42 Kg/ha). Study revealed that shoot fly and stem borer percentage infestation was negative correlated with plant height, leaf hair density, chlorophyll contents and stem diameter.

INTRODUCTION

Maize (*Zea mays* L.) belongs to family Gramineae which is a C4 plant, having high genetic potential and is a photosynthesis explorative crop. Maize is Pakistan's third most important cereal after wheat and rice (Govt. of Pakistan, 2008 and Muhammad, *et al.*, 2010). Maize grain contains about 72% starch, 10% protein, 4.8% oil, 5.8 % fiber, 3.0% sugar and 1.7% ash (Tahir *et al.*, 2010). It is grown from 58ºN to 40ºS, from below sea level to altitudes higher than 3000 m, and in areas with 250 mm to more than 5000 mm of rainfall per year (Dowswell *et al.*, 1996). It is an indispensable part of human diet and animal feed (Maitti and Wische Ebelling, 1998). In Asia the crop is attacked by about 139 species of insect pests. However, only about a dozen of these are quite serious (Siddiqui and Marwaha, 1993). The most important insects pest in maize are the maize stem borer (*Chilo partellus*) and Shoot fly (*Atherigona soccata*) their infestation ultimately results in total failure of crop (Singh and Sharma, 1984). Stem borer (*C. partellus*) and shootfly *(Atherigona soccata)* are most dominant destructive, contributing 90-95% of the total damage in kharif season (Jalali and Singh 2002). The yield losses caused by stem borer to maize vary from 25-40% (Khan *et al.*, 1997). Shoot fly is the major limiting factor for successful spring maize cultivation in Punjab (Sajjan *et al.,* 1983). The maggots of shoot fly attack the emerging seedlings and feed on the whorl leaves causing dead hearts in small and slowly growing plants and resulting in curled and distorted leaves in bigger plants (Panwar, 2005; Kanta *et al.,* 2006). Maize crop could be enhanced by nutrient use efficiency with the help of organic fertilizer (Mishra and Lal 2016). Dead heart incidence upto 85.8 per cent has been recorded in spring sown maize in Punjab or elsewhere (Sajjan and Sekhon, 1985; Panwar, 2005). Literature revealed that damage caused by stem borer viz. leaf injury percent, dead heart percent and stem tunneling has been significantly reported in all genotypes but the lowest damage was in Gird-8 (7.77%) (Unprotected) and in Gird-37(5.38%) (Protected). The stem borer dead heart was least in Gird-33 (58.33%) and Gird-3(48.18%) under unprotected and protected conditions respectively (Swathi *et al.*, 2016). Insecticides have been shown to kill the natural enemies of many insects which result in the outbreak of secondary pests (Mathews, 1983. Kumar *et al.*, 1997) reported that large number of maize genotype proved resistance to (*Chilo partellus)* have been identified and observed that ethanolic extract inhibit the growth and development of (*Chilo partellus*). Hari *et al.* (2008) studied that transgenic maize hybrid *i.e* Probal YG, Hishell YG, Double YG, evaluated in field and laboratory and check the resistance against (*Chilo partellus).*

MATERIALS AND METHODS

A field trial was conducted in randomized complete block design (RCBD) with three replications having plot size was 10m x 15m during Rabi Season 2016 at Maize section, Ayub

Agricultural Reseach Institute, Faisalabad. The crop was sown on February 20, 2016 and crop germination was completed in 10 days. Nine maize hybrids/ genotypes viz: FH-793, FH-810, FH-949, NK-8711, P15-M43, FH-985, FH-988, FH-1036 and FH-1046 were screened out against insect pests *i.e.* maize shoot fly and maize stem borer. Row to row distance of 75 cm and plant to plant distance of 21 cm was maintained. All recommended agronomic practices were followed uniformly with pesticide free conditions; however blanket application of pre-emergence weedicide were applied. Data regarding maize shoot fly and stem borer % infestation damage were taken from 20 randomly selected plants from each plot at 10 days interval. The data were analyzed statistically to find out genotypes showing comparatively resistant and susceptible response. Finally yield data were also recorded at the maturity of the crop during the 1st week of June, 2016.

Morphological plant characters

The morphological plant characters were recorded from 05 randomly selected plants per plot. These included plant height (cm), stem diameter (cm), leaf hair density (cm^2) and chlorophyll contents. The stem diameter was taken with the help of a Vernier caliper by measuring from the center of the 3rd inter node. Leaf trichomes and leaf hair density were counted under a binocular microscope from an area of $1cm^2$ at five different points of a leaf selected randomly and chlorophyll contents were measured with the help of chlorophyll meter from three different leaves selected at random from lower, middle and upper portion of the plant.

Percent infestation was measured by using the formula

No. of infested plants

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

Statistical analysis

Data were subjected to statistical analysis according to standard procedures methods described by Gomez & Gomez (1984). Randomized complete block design (RCBD) was employed for analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Shoot fly infestation percentage

Maize shoot fly infestation percentage recorded on different

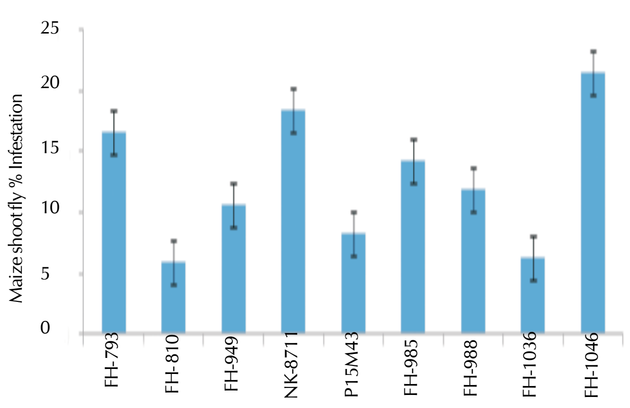


Figure 1:

maize hybrids ranged from 5.87-21.46%. Minimum infestation was recorded on FH-810 (5.87%) while maximum infestation was recorded on FH-1046 (21.46%). However, maize shoot fly infestation on FH-793, FH-949, NK-8711, P15-M43, FH-985, FH-988 and FH-1036 were recorded 16.53%, 10.63%, 18.33%, 8.24%, 14.26, 11.81% and 6.34% respectively.

Stem borer percentage infestation

Results revealed that FH-810 found to be resistant against maize stem borer. Stem borer percentage infestation recorded ranged from 1.3-7.1%. Minimum maize stem borer infestation was recorded on FH-810 (1.32%) and maximum infestation was recorded on FH-1046 (8.23%). The genotypes FH-793, FH-949, NK-8711, P15-M43, FH-985, FH-988, FH-1036 and FH-1046 showed percent infestation 5.98%, 4.21%, 6.54%, 5.76%, 2.54%, 7.15% and 3.87% respectively.

Plant Height

The maximum plant height recorded was 174.32cm in genotype FH-810 followed by 172.42cm, 168.96cm, 165.42cm, 164.37cm, 163.33cm, 158.12cm, 154.37cm and 151.87cm in FH-988, FH-793, FH-949, NK-8711, P15-M43, FH-985, FH-1036 and FH-1046 respectively. The genotype FH-1046 showed minimum plant height *i.e.,* 151.87cm.

Stem diameter

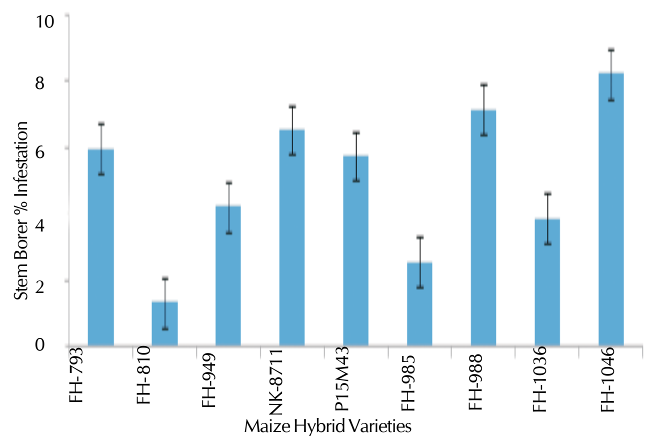
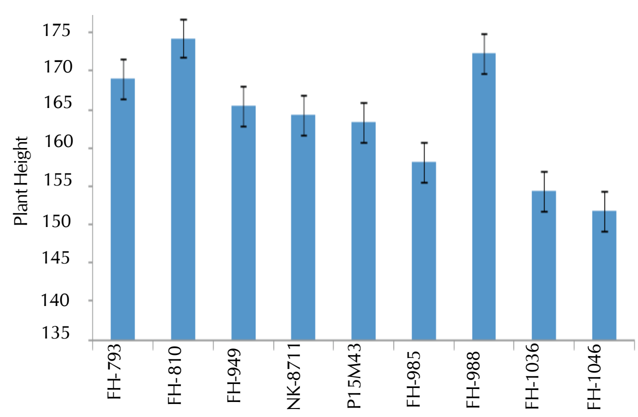


Figure 2:



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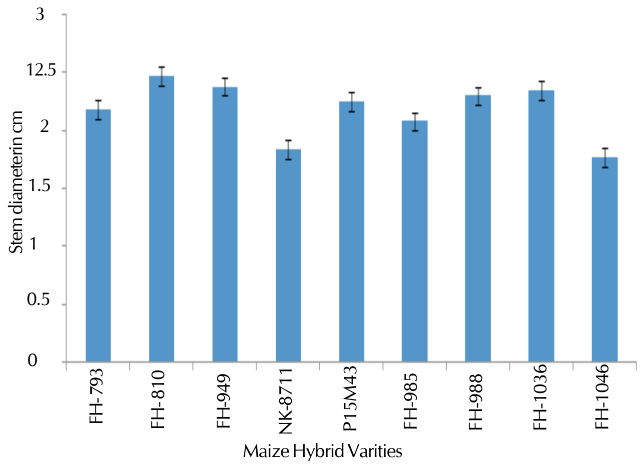

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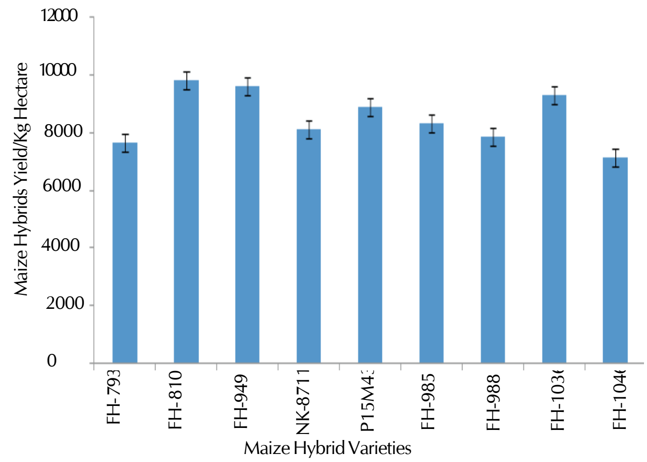

Figure 7:

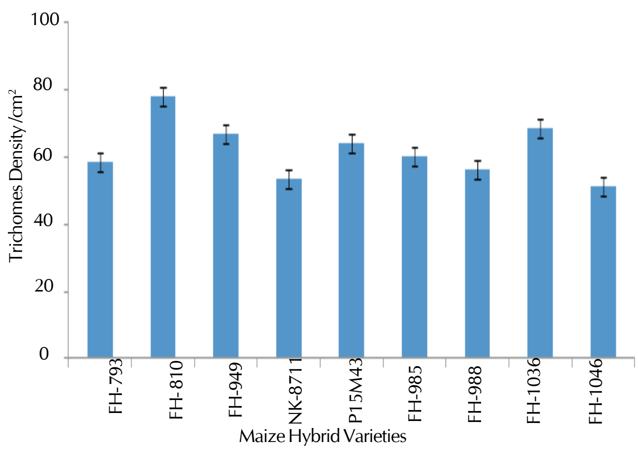

Figure 5:

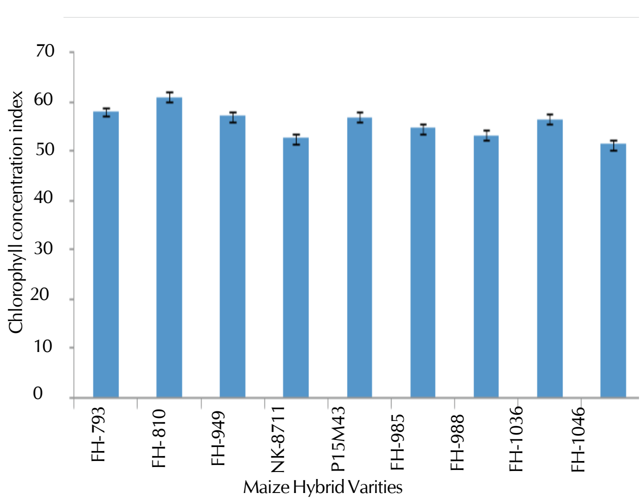

Figure 6:

Stem plays an important role in food transportation as well defensive role against stem borer the results revealed that observed genotypes shows a significant difference. The genotypes having high stem diameter found resistant against observed pest while those having low diameter were found susceptible. The genotype FH-810 showed maximum stem diameter *i.e.*, 2.47cm followed by 2.38cm, 2.35cm, 2.30cm, 2.25cm, 2.18cm, 2.08cm and 1.84cm in FH-949, FH-1036, FH-988, P15-M43, FH-793, FH-985 and NK-8711 respectively while minimum diameter was recorded 1.77 cm in genotype FH-1046.

Trichome Density

Leaf trichome density is considered a mechanism of defense in plants to prevent or diminish damage by insect pests (Levin, 1973; Juniper & South wood, 1986; Marquis, 1992). The data revealed that genotype having maximum density of hair have lowest pest infestation. The maximum hair density was recorded 78.13cm^2 in genotype FH-810 while minimum was observed in FH-1046 (51.46cm^2). Hair density of genotypes FH-793, FH-949, NK-8711, P15-M43, FH-985, FH-988 and FH-1036 is 57.00cm^2, 66.60cm^2, 53.63cm^2, 64.23cm^2, 58.20cm^2, 56.20cm^2 and 68.30cm^2 respectively.

Chlorophyll Contents

Leaf colour, as a function of chlorophyll content, can be used as an index to diagnose nutrient status acquired by the plant. Leaf colour can indicate the amount and proportion of chlorophyll in leaves which are closely related to plant nutrient status. We can estimate the nutrient content and health of the plant by estimating the chlorophyll content with the help of chlorophyll meter. The observed genotypes revealed result in relation to chlorophyll content were similar to height, hair density and stem diameter. The genotypes which were resistant against shot fly and stem borer have high contents of chlorophyll as compare to those which were susceptible. Maximum chlorophyll contents were recorded in genotype FH-810 *i.e.*, (60.90) followed by FH-793 (58.00), FH-949 (57.03), P15-M43 (56.90), FH-1036 (56.54), FH-985 (54.53), FH-988 (53.30) and NK-8711 (52.55). While minimum chlorophyll contents were observed in genotype FH-1046 *i.e.*, (51.46).

Yield

Maize is one of the most important crops worldwide and there are many reports in the literature on its constitutive and inducible defenses against pathogens and insects (Elvira *et al.,* 2014). Crop yield is an indicator to investigate that how much a genotype withstand against insect pest infestation in field to give optimum yield having good morphological and physiological characteristics. The observed genotypes revealed results of yield production were significant related to observed morphological characters of Maize crop. The genotypes having low infestation against shoot fly and stem borer produced good quality yield while those susceptible were low in yield production. Maximum yield were recorded in genotype FH-810 *i.e.,* (9818.75 kg/ha) followed by FH-949 (9627.00 kg), FH-1036 (9279.65 kg), P15-M43 (8876.56 kg), FH-985 (8340.34 kg), NK-8711 (8106.54 kg), FH-988 (7866.00 kg) FH-793 (7634.42 kg) and FH-1046 (7154.42 kg).

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