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SCREENING OF SUNFLOWER GENOTYPES FOR RESISTANCE TO *HELICOVERPA ARMIGERA* HUBNER (LEPIDOPTERA: NOCTUIDAE) IN PUNJAB, PAKISTAN

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ABSTRACT

Twenty diverse genotypes of sunflower viz. A-60, G-5, A-179, A-79, A-9, OR-103, OR-101, OR-100B, OR-44B, OR-92B, OR-102B, H-38, S-278, H-33, A-11, G-53, G-32, A-75, G-55 and G-7 were planted with RCBD lay out. Based on average egg count and larval population per 5 plants, three genotypes showing resistance (A-11, A-75, G-53), three showing intermediate (G-7, OR-102B, A-9) and three having susceptible response (OR-100B, G-5, OR-44B) were selected. Based on larval population of *Helicoverpa armigera,* the genotype OR-102B showed maximum HPSI i.e., 22 percent during 2008, OR-100B showed 21 percent HPSI during 2009 and on average of both the study years the maximum HPSI was recorded to be 21 percent on OR-100B. Thus OR-100B proved to be a susceptible genotype. The minimum HPSI was observed to be 5 percent on G-53, during 2008.Lower values of HPSI were recorded on resistant genotypes. These genotypes may be used as source of resistance for developing sunflower genotypes resistant to *H. armigera*.

Keywords: Genotypes, *H. armigera,* HPSI, screening

INTRODUCTION

Sunflower (*Helianthus annus* L.) belongs to the family compositae and is amongst the major oil seed crop grown for edible oil in the world. Sunflower oil is ranking fourth after palm, soya and rapeseed oil with a worldwide production of about 34.6 million tons (mt) of seed in 2010 (FAO-STAT, 2011).This crop is becoming popular among the farmers because of short duration, drought tolerance and high-income return (Khan *et al*., 2000). Pakistan is deficit in edible oil production and import bill of edible oil during current fiscal year is reaching up to $ 2 billion dollars (Anonymous, 2010), second largest after petroleum products and demand for edible oil is increasing at the rate of 11% per annum (Beg, 1983). Government emphasizing on increasing its production through incentives like provision of seed of high yielding varieties along with enhancement of procurement price. Sunflower has the potential to narrow the gap between the production and consumption of edible oil for ever increasing population of the country. Sunflower (*Helianthus annus* L.) has witnessed considerable growth in terms of area and production during the recent years. There is need of the day that its area, production and protection should be enhanced (Aslam *et al.,* 2000). In Pakistan, its average yield is lower as compared to advanced sunflower growing countries due to poor crop production and protection management.

Numbers of abiotic and biotic factors are involved in decreasing the yield of sunflower like hailstorm, windstorm, birds, diseases and insect pests attack (Khan *et al*., 2000). A diverse array of both beneficial and harmful insect species is associated with sunflower. This crop is reservoir of large number of predators, parasitoids and pollinators. As many as 251 insect and acarine species have been recorded on sunflower crop globally (Rajamohan, 1974). Sunflower is an introduced crop in Pakistan and pest complex is different from temperate region. This crop is attacked by a large number of insect pests depending on the season and adjacent crop. Major insect pests are *Bemisia tabaci* Gennand (Whitefly), *Amrasca* spp. (Leaf hopper) and *Helicoverpa armigra* Hub. (Cotton bollworm) (Sattar *et al*., 1984). Piracha (1989) found *Bemisia tabaci* Gennadius, *Amrasca devastans* Dist., *Aphis gossypii* Glover and semilooper (unidentified) attacking sunflower crop. The attack of *H. armigera* on sunflower has been reported by Singh *et al*., 1993 and Rajamohan, 1974 in India

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and (Makhdoomi, 1984; Sattar *et al*., 1984; Hassan *et al*., 1990) in Pakistan. In India *H. armigera* causing 120 kgs of seed loss (Panchabhavi and Krishnamurthy, 1978) in sunflower and resulting in yield losses up to 50% (Lewin *et al.,* 1973 and Rangarajan *et al*., 1975). The larvae have a preference for feeding on reproductive parts and growing points of host plants (Zalucki *et al*., 1986; Fitt, 1989). *Helicoverpa armigera* directly inflicts damage to sunflower by depriving the plant of ovaries and developing seeds (Bhat and Virupakshappa, 1993). Even one *H. armigera* larva per capitulum could cause economic damage (Margal, 1990). Despite the rising trend of annual investment of US $ 35000, for the application of three million tons of pesticides, further use of various biological and nonchemical control measures globally, crop losses remain a major concern (Pimentel, 2007, 2009). At present the control of sunflower head worm; *H. armigera* is primarily dependent on the use of synthetic insecticides. However, chemical control has led to disruption of beneficial fauna leading to pest resurgence and environmental contamination (White *et al*., 2005). Besides that, insect resistance to traditional pesticides is on the rise, and there are public fears about chemical residues in food and agricultural commodities. In Pakistan *H. armigera* has developed strong resistance to most classes of insecticides (Ahmad *et al*., 1997).

Harmful insects are being suppressed by plant defense mechanism by secreting toxic chemicals detrimental to insect pest biology. Host plant resistance is a key component in sustainable pest management. Host plant resistance is a nonchemical alternative strategy that will decrease economic losses caused by *H. armigera* while reducing input costs. The objective of this study was to evaluate diverse sunflower germplasm for potential resistance *to H. armigera* and to screen out available genotypes of sunflower based on the population of eggs and larvae.

MATERIALS AND METHODS

Studies regarding screening of germplasm were carried out during two growing seasons 2008-09 to screen sunflower germplasm based on egg and larval population. Experiments were laid out in a randomized complete block design (RCBD) tetra replicated. The row to row distance was kept at 60 cm and plant to plant distance 30 cm. The plot size was maintained at 9x15 m for field experiments during the study periods with the application of standard agronomic practices. Twenty diverse genotypes of cultivated sunflowers were sown in the experimental area of university of Agriculture, Faisalabad during March, 2008. No plant protection measures were applied. Out of twenty three genotypes each showing resistant susceptible and intermediate response were selected on the basis of egg count and larval population of *H. armigera* on randomly selected 5 plants from each cultivar with the help of hand lens for further experiments. Nine genotypes of sunflower based on egg and larval population of *H. armigera,* selected from preliminary screening trial. They were sown in the same experimental area during March, 2009. Same procedure for data recording was adopted in final screening experiment. Average temperature ranging from 25.4°C-33.66°C and relative humidity range was 25.4-33.66% during 2008 and average temperature range was 24.3-31.5°C along with R.H**%** 51-29.5 during study period. Number of eggs and larvae from randomly selected five plants in each genotype were recorded with the help of hand lens for ten dates at 3 days interval from 12 -04-2008 to 4-05-2008 for preliminary screening experiments, while there were 10 dates of observations for final screening experiments at 3 days intervals from 12-04-2009 to 04-05-2009.

Statistical analysis

The data was analyzed for analysis of variance to determine the significance of treatments. The means were separated by DMR test at P=0.05 (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Twenty genotypes of sunflower viz. A-60, G-5, A-179, A-79, A-9, OR-103, OR-101, OR-100B, OR-44B, OR-92B, OR-102B, H-38, S-278, H-33, A-11, G-53, G-32, A-75, G-55 and G-7 were sown. Based on egg count and larval population per 5 plants, three genotypes showing resistance (A-11, A-75, G-53), three showing intermediate (G-7, OR-102B, A-9) and three having susceptible response (OR-100B, G-5, OR-44B) were selected for final screening during 2009 in the same experimental area.

The analysis of variance of data regarding egg counts and larval population reveals significant variation ($P \geq 0.01$) among genotypes, dates of observation and in their interactions (Table 1&2) during 2009.The means were compared by DMR Test at P=0.05.

The results presented in Table 3 reveal that the genotype OR-100B showed maximum number of eggs i.e. 9.44±1.64 per 5 plants and differed significantly from those of observed on all other genotypes. The genotype G-5 and OR-44B resulted in 7.55±1.16 and 6.60±1.03 eggs per 5 plants respectively ranked at 2nd place in descending position from OR-100B and appeared relatively susceptible to *H. armigera*. The minimum number of eggs was recorded to be1 .70±0.38 per 5 plants on G-53 and also showed significant difference with those of observed on all other genotypes. The genotype G-7, OR-102B, A-9, A-11 and A-75 resulted in 4.93±0.83, 4.22±0.77, 3.15±0.49, 2.42±0.49 and 1.72±0.34 number of eggs per 5 plants and differed significantly from those of recorded on all other genotypes. The results shown in Table 3 reveal that the genotype OR-100B had maximum larval population 4.43±0.63a. The genotype G-5 and OR-44B showed 3.45±0.53 and 3.17±0.51 larvae per 5 plants, respectively and did not show significant difference with each other. These genotypes were found less susceptible after OR-100B.The minimum population of the larvae was recorded to be 0.91±0.22 per 5 plants on A-11 and also showed non significant difference with those of observed on A-75 with 1.42±0.34 larvae per 5 plants. The later mentioned figure also showed non significant difference with those of recorded on G-53, A-9 and OR-102B with 1.70±0.38, 1.73±0.33 and 1.75±0.34 larvae per 5 plants, respectively. The genotype G-7 showed 2.25±0.38 larvae per 5 plants and differed significantly from those of observed in all other genotypes. From these results it was observed that the genotype OR-100B was susceptible showing maximum larval population whereas A-11 appeared as comparatively resistant with

Table 1
Analysis of variance of the data regarding eggs counts *Helicoverpa armigera* (Hub.) per 5 plants on various genotype of sunflower at different dates of observation during 2009.

Source of Variance	Degree of Freedom	Mean Square	F. Ratio
Replication	3	12.373	8.23
Dates of Observation (D)	9	750.793	499.12**
Genotypes (G)	8	298.632	198.53**
D X G	72	27 .117	18.03**
Error	267	1.504	

CV= 60.93%.
** = Significant at P $\leq$ 0.01.

Table 2
Analysis of variance of the data regarding larval population of *Helicoverpa armigera* (Hub.) per 5 plants on various genotypes of sunflower at different dates of observation during 2009**.**

Source of Variance	Degree of Freedom	Mean Square	F. Ratio
Replication	3	0.950	1.10
Dates of Observation (D)	9	153.058	175.86**
Genotypes (G)	8	48.669	55.92**
D X G	72	3.336	3.83**
Error	267	0.870	

CV= 39.93%.
** = Significant at P $\leq$ 0.01.

Table 3
A comparison of means for the data regarding the egg count and larval population per 5 plants on different genotypes of sunflower during 2009.

Name of Genotypes	Means ±SE egg count/5plants	Means ± SE larvae/5plants
A-11	2.42 ±0.49a	0.91± 0.22e
A-75	1.72 ± 0.34h	0.84±0.23de
G-53	1.70± 0.38i	0.69 ±0.19g
G-7	4.93± 0.83d	2.25±0.38c
OR-102B	4.22± 0.77e	1.75±0.34d
A-9	3.15± 0.49g	1.73±0.33d
OR-100B	9.44 ±1.64a	4.43±0.63 a
G-5	7.55±1.16b	3.45±0.53 b
OR- 44B	6.60±1.03c	3.17± 0.51b
LSD Value at P = 5%	1.58	0.43
SE	$\pm$ 0.569	$\pm$ 0.154

minimum population of the pest respectively. The *H. armigera* females show distinct preference for different genotypes of the same host (Butter and Singh, 1996; Sharma *et al*., 2001, 2005).

Host Plant Susceptibility Indices (HPSI)

The HPSI were determined based on eggs count and larval population of *H. armigera* on sunflower plant during 2008, 2009 and on an average basis of 2008 and 2009 separately with the help of excel soft ware.

The results regarding HPSI based on eggs count per 5 plants on different genotypes of sunflower during 2008 and 2009 (average basis) are shown in Table1. It is evident that OR-100B showed maximum HPSI i.e. 21.5 percent followed by 16.5 and 15 percent in genotypes G-5 and OR-44B, respectively. The minimum HPSI was recorded to be 5.5 percent on G-53 and proved comparatively resistant. The other genotype viz. A-75, A-11, A-9, OR-102B and G-7 possessed 7.5, 8.5,9, 8.5 and 9.5 percent HPSI, respectively.

The results on HPSI based on larval population per 5 plants on different genotypes of sunflower calculated for 2008 and 2009 (average basis) are presented in Table 2. It is evident from the results that the genotype OR-100B appeared as susceptible showing maximum HPSI i.e., 21 percent followed by those of observed on G-5 and OR-102B with 16.5 and 14 percent HPSI, respectively. The minimum HPSI was recorded to be 5.5 percent each in G-53 A-11, with 6.5perent HPSI on A-75 appeared as resistant based on average larval population. The genotypes A-9, G-7 and OR-44B with 8 percent, 10 percent and 11.5 percent HPSI, respectively were categorized as intermediate.

Table 4

Host plant susceptibility indices based on egg counts for the years 2008 and 2009.

Genotypes	Years		
	2008	2009	Average
OR-100B	19	22	21.5
G-5	15	18	16.5
OR-44B	14	16	15
G-7	7	12	9.5
OR-102B	7	10	8.5
A-9	10	8	9
A-11	11	6	8.5
A-75	11	4	7.5
G-53	7	4	5.5

Table 5

Host plant susceptibility indices, based on larval population (%) for the years 2008 and 2009.

Genotypes	Years		
	2008	2009	Average
OR-100B	21	21	21
G-5	16	17	16.5
OR-44B	7	15	11.5
G-7	9	11	10
OR-102B	22	8	14
A-9	8	8	8
A-11	7	6	5.5
A-75	6	7	6.5
G-53	5	6	5.5

In final screening experiment, the genotype OR-100B was proved comparatively susceptible showing significantly maximum eggs count i.e., 9.44±1.64 per 5 plants and maximum larval population per 5 plants i.e., 4.43±0.63. The minimum HPSI was observed to be 5.5 percent on G-53. Based on larval population of *H. armigera,* the genotype OR-102B showed maximum HPSI i.e., 22 percent during 2008, OR-100B showed 21 percent HPSI during 2009 and on average of both the study years the maximum HPSI was recorded to be 21 percent on OR-100B. Thus OR-100B proved to be a susceptible genotype. The minimum HPSI was observed to be 5 percent on G-53, during 2008, 5 percent on A-11 during 2009 and on average basis of both the study years the minimum HPSI was recorded to be 6 percent each on A-11 and A-75. Thus based on larval population per 5 plants the genotype A-75 and A-11 was found to be comparatively resistant (Table 4&5).

Similarly varietal resistance in sunflower genotypes was studied by Aslam *et al*. (2000), Brewer and Charlet (1995), Gao and Brewer (1998), Rafiullah *et al*. (1998), Rogers (1980), Singh *et al*. (1993), Arora *et al*. (1998), Bhat *et al*. (1996) screened hundreds of germplasm accessions and cultivars against *H. armigera* and found that among them few accessions like KBSH–6789, TNSU-3, RHA- 263, 291B, EC-109281, EC-107285 and BRS-3 were found superior to the rest in recording lower eggs and larval density per plant. Sattar *et al*. (1984) who studied different genotypes/varieties of sunflower for their resistant/susceptibility under different ecological conditions as well as different methodologies and different materials.

CONCLUSION

Our investigation showed potential for developing sunflower *H. armigera* resistant genotypes that would reduce seed feeding injury, prevent yield loss, and increase grower profit.

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