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HOST PLANT RESISTANCE RELATIONSHIPHS IN CHICKPEA (*CICER ARIETINUM* L.) AGAINST GRAM POD BORER (*HELICOVERPA ARMIGERA* HUBNER)

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Abstract

Gram Pod borer (*Helicoverpa armigera* Hubner) is the most imperative constraint in chickpea (*Cicer arietinum* L.) production causing severe losses or there may be complete crop failure inspite of several rounds of insecticidal applications. Most importantly, the alternatives to chemicals comprise the selection and use of tolerant and high yielding varieties against this pest. In the present studies, the response of 10 chickpea genotypes to gram pod borer *H. armigera* was checked at the farm conditions. Results indicated that C-727 behaved the best for holding the least borer's population and damage while CM-88 proved sensitive and the least productive. A marked feeding behaviour of *Helicoverpa* on growing chickpea crop was recorded. Framers can be in the forefront of following host plant resistance and such eco-friendly practices may endow with an absolute foundation of holistic IPM (Integrated Pest Management) Programme.

Introduction

Chickpea (*Cicer arietinum* L.) is a major pulse crop grown in Pakistan. Being rich in protein, chickpea plant is susceptible to a number of insect pests, which attack on roots, foliage and pods. Gram Pod borer (*Helicoverpa armigera* Hubner) constitutes a worldwide pest of great economic importance on this crop. This pest is the major constraint in chickpea production causing severe losses upto 100% inspite of several rounds of insecticidal applications. Sometimes in serious cases, there may be a complete crop failure. It is a highly polyphagous pest, feeding on a wide range of food, oil and fiber crops. Due to its wider host range, multiple generations, migratory behaviour, high fecundity and existing insecticidal resistance, it has become a difficult pest to tackle. Amongst its major hosts are grain legumes such as chickpea that has been reported to suffer million rupees worth of damage. It selectively feeds upon growing points and reproductive parts of the host resulting in significant yield loss. In chickpea, it feeds on buds, flowers and young pods of the growing crop, the crop often fails to recover and yields extremely poor. The pest status of this species has increased steadily over the last 50 years due to agro-ecosystem diversification by the introduction of winter host crops such as chickpea (Knights *et al.,* 1980; Passlow, 1986). The noctuid *H. armigera* Hubner and *H. punctigera* Wallengren are among the most damaging pests of field crops (Fitt, 1989; Zalucki *et al.,* 1994). Commercial chickpea crops are important sources of *Helicoverpa* species (White *et al.,* 1995). Sequeira *et al.,* (2001) reported chickpea attractive to oviposition of *Helicoverpa* moths from as early as 14 days after planting and throughout the growth period. Of all *Helicoverpa* species larvae recorded from the entire samples and crop combinations, 98.3% were found on chickpea. The pod borer, *H. armigera*, is the most serious pest in causing economy loss to the chickpea crop (Singh & Yadav, 2006).

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Direct pollution due to agricultural activities is mainly related to increased use of chemical inputs such as fertilizers and pesticides. But the use of pesticides has lead to the development of pesticide resistant strains in insects, resurgence of pest species, direct toxicity to the applicator, destruction of parasites, predators and other beneficial organisms, accumulation of pesticide residues in the agricultural commodities, and poisoned food, water, air and soil (Lateef, 1985; Forrester *et al.*, 1993). To avoid ill effects of chemical abuse eco-friendly pest management is mainly concentrating on the maximum utilization of natural resources by integrating different non-chemical pest management portions and the adoption of need based chemical application. If a pest becomes dangerous, there are many safer alternatives than spreading poison. Traditionally, farmers have been using several practices to prevent the hazards of pests. During the current years, it is well recognized that certain strains of chickpea are attacked less by insect pests than the others, because of natural resistance they possessed. Therefore, development, selection and use of high yielding and insect pests tolerant cultivars are an urgent need of the day. By observance on this outlook, the variations in susceptibility and tolerance in some of gram genotypes to gram pod borer were recorded sown under similar environmental conditions.

Materials and Methods

To identify stable sources of host plant resistance in chickpea to *H. armigera*, 10 genotypes were evaluated for their susceptibility to *H. armigera* planted in two separate field trials at Nuclear Institute of Agriculture, Tandojam. The fields were planted at 2 different times during the 2002-2003 and 2003-2004 growing seasons. The seeds of all test genotypes were collected from the freshly harvested crop grown in the experimental fields of the research institutions. All seed samples were kept in polythene bags and sealed carefully. Out of 10 genotypes, first category comprised 7 already existing varieties (CM-72, CM-88, CM-98, Dokri-92, C-727, CM-1918, Jubiha-1) and 3 new derivatives (NIFA-88, NIFA-95, HASSAN-2K) received from Nuclear Institute of Food and Agriculture, Peshawar. The susceptibility of chickpea genotypes to gram pod borer was checked under field conditions. Each genotype was planted in 3 row plots, each 6 m long. There were three replications in a randomized complete block design. Normal agronomic practices were followed for raising the crop. No insecticide was applied during the crop-growing season even if the pest population reached to economic threshold level. Data on insect population was recorded from 10 randomly selected plants in each treatment at the seedling stage after 30 days of crop emergence. The observations recorded were number of larval population per plant from leaves and inflorescences at random in each plot. Such an exercise was repeated at 15 days interval to cover all the test genotypes. Observations were also recorded on feeding behaviour of *Helicoverpa* on growing chickpea crop by different larval instars. Data on pod damage (visual damage) and grain yield were also recorded. At harvest, the data were recorded on pod damage due to pod borer from samples taken at random. The material was appraised for *Helicoverpa* damage visually based on the number of healthy and damaged pods and seeds per 10 plants to work out % pod damage at maturity. At maturity, data were also recorded on crop yield to observe grain yield per plot (in 3 m^2). Data on Meteorological observations during both the studies periods were obtained from Regional Agromet Center, and Drainage Research Center Campus, Tandojam.

Data recorded were analyzed statistically. Larval population, pod damage and yield output data were analyzed separately. The error term for plots was used to examine the significance of overall differences. For the purposes of comparison, the genotypes were ranked according to pest damage and grain yield.

Results

The data on larval density and % pod damage by pod borer *H. armigera* in chickpea and its subsequent effects on seed yield are presented in Tables 1 & 2. Results indicated that genotype C-727 behaved the best for holding the least borers' population and damage, while CM-88 proved sensitive and the least productive. The larval population during both the years ranged from 0.71 to 1.00 in C-727, on the other hand 2.52 to 6.33 in CM-88. Borer's % pod damage ranged from 26.01% to 40.08% in CM-88, while 9.20% to 16.06% in C-727. Genotype CM-88 was observed the least yield producing (68.33 to 165.0 gm per 3 m^2), while genotype C-727 was the highest yielding (300.00 to 530.00 gm per 3 m^2). Of all the genotypes tested, rest of the genotypes showed intermediate tolerance level among tolerant and susceptible genotypes (Table 1).

In overall pooled data of all parameters (Table 2), the larval density was lower (0.85 larvae) in C-727 as compared with 1.28, 1.38 and 1.56 larvae in CM-1918, CM-98 and NIFA-95, respectively. CM-88 harbored 4.42 larvae compared to 3.14, 3.21 and 3.45 in CM-72, Jubiha-1 and HASSAN-2K, accordingly. At crop harvest, pod damage was 12.63% in C-727 as compared with 15.88% observed in CM-98. CM-88 suffered pod damage rating of 33.05% compared to 29.15% in CM-72, and 28.33% in HASSAN-2K. C-727 proved significantly the best towards obtaining maximum seed production (415.0 gm/ 3 m^2) (1383.3 kg/ he). The yield was minimum (116.7 gm) (389.0 kg/ he) in CM-88 due to severely damaged seeds as compared with other genotypes. The data showed that CM-88 produced significantly the least yield than rest of the genotypes, because the pod borers' population was multiplying rapidly on crop causing weakening of the plants, which ultimately reduced the yield. Some of the differences in pod borer damage and grain yield may be due to differences in the flowering and maturity periods of the genotypes tested. These results clearly confirmed the relative susceptibility of CM-88 and tolerance of C-727 to pod borer damage as observed under similar experimental conditions, although the genotypes were sown at the same time and location, even then the differences in their tolerance differed between the genotypes. During the year 2002-2003, the rainfall was negligible, but the temperature remained around 12.1-27.9^{0}C which was approximately 13.2-28.1^{0}C prevailing in 2003-2004, whereas, the relative humidity was 67.2 and 75.2%, respectively. The possible effects of ecological parameters on the pod borer's population, however, require further study. According to susceptibility, the test genotypes could be positioned in the sequence: CM-88, CM-72, HASSAN-2K, Dokri-92, NIFA-88, JUBIHA-1, NIFA-95, CM-1918, CM-98 and C-727.

The researchers may use these findings where host plant resistance has been detailed for effective and environment-friendly options to manage this pest. Several germplasm accessions in chickpea have been screened for resistance to pod borer in this locality (Rajput *et al.,* 2003). A number of sources with low to moderate level of resistance have been identified. Some of these lines were used as sources of resistance to breed high yielding lines with less susceptibility to *H. armigera*. The present finding of resistance may be helpful to draw out a great deal of curiosity of scientists to spotlight their consideration to recognize chickpea germplasm that have resistance to pod borers and other natal and corporal stresses to develop high yielding varieties having acceptable grain quality.

Table 1. Screening of different chickpea genotypes against pod borers during 2002-2003 and 2003-2004 growing seasons.

Genotypes	Larval density/ 10 plant	Pods damage (%)	Yield/plot (3 m^2) (gm)	Larval density/ 10 plant	Pods damage (%)	Yield/plot (3 m^2) (gm)
CM-72	4.33 ab	23.66 b	81.67 e	1.94 bc	34.62 b	180.0 f
CM-88	6.33 a	26.01 a	68.33 e	2.52 a	40.08 a	165.0 f
CM-98	1.66 cde	10.17 fg	343.30 b	1.09 e	21.59 e	290.0 ab
Dokri-92	3.66 bc	16.11 d	188.70 d	1.80 cd	32.27 c	200.0 e
C-727	1.00 e	9.20 g	530.00 a	0.71 f	16.06 f	300.0 a
CM-1918	1.33 de	11.77 ef	333.30 b	1.23 e	24.67 d	280.0 ab
JUBIHA-1	4.66 ab	13.24 e	261.70 c	1.75 cd	31.38 c	250.0 c
NIFA-88	3.33 bcd	15.33 d	201.70 d	1.66 cd	31.15 c	220.0 d
NIFA-95	1.66 cde	12.37 e	285.00 c	1.47 de	25.23	270.0 b
HASSAN-2K	4.66 ab	20.35 c	90.00 e	2.23 ab	36.31 b	180.0 f
LSD value	2.09	1.67	27.02	0.38	1.90	19.46

Means sharing common letters within rows of a column are non-significantly different at 0.05.

Table 2. Pooled data indicating screening of different chickpea genotypes against pod borers (Winter 2003 & 2004).

S. No.	Genotypes	Larval population/ 10 plant	Pods infestation (%)	Yield/plot (3 m^2) (gm)	Yield Kg/ hectare (pooled)
1.	CM-72	3.140 b	29.15 b	130.8 gh	436.0
2.	CM-88	4.427 a	33.05 a	116.7 h	389
3.	CM-98	1.380 d	15.88 f	316.7 b	1055.6
4.	Dokri-92	2.737 b	24.19 c	194.3 f	647.6
5.	C-727	0.8550 d	12.63 g	415.0 a	1383.3
6.	CM-1918	1.283 d	18.22 e	306.7 b	1022.3
7.	JUBIHA-1	3.212 b	22.31 d	255.8 d	852.6
8.	NIFA-88	2.498 bc	23.24 cd	210.8 e	702.6
9.	NIFA-95	1.568 cd	18.80 e	277.5 c	925.0
10.	HASSAN-2 K	3.450 ab	28.33 b	135.0 g	450.0
	LSD value	1.014	1.224	16.05	

Means sharing common letters within rows of a column are non-significantly different at 0.05.

Feeding pattern of gram pod borer *Helicoverpa armigera*: A preliminary study was furthermore undertaken to determine the *Helicoverpa* feeding behaviour on chickpea under field conditions. Larval feeding behaviour showed that first and second instars larvae almost exclusively preferred the flowers. The larvae were occasionally found on the pods, but no first or second instars were found on leaves. The third instar larvae did not prefer leaves, but were found in almost equal numbers on the pods and flowers. The fourth and fifth instars larvae were found almost exclusively on the pods. These experiments showed that there is a marked food preference of larvae according to their age and this information may help considerably in shaping the components that would interfere the larval feeding behaviour on chickpea.

Discussion

Results on varietal rankings of chickpea genotypes tested evidenced that all the genotypes showed variable response to the susceptibility trait under surveillance. Similar to our results, Weigand *et al*., (1992) and Yelshetty *et al*., (1996) recorded chickpea genotypes presenting the lowest and highest susceptibility to *H. armigera*, but Sanap *et al*., (2005) reported that the mean pod damage ranged from 20.37% to 34.27% in chickpea genotypes. Their results showed that some chickpea genotypes were more attractive to *Helicoverpa* moths than the others. The preference or non-preference for oviposition on chickpea by female moth may be due to its varying behavioural response possibly due to different canopy structure of the plants. One more possible explanation for these variations may be the variability in oviposition response of adult females due to chickpea foliar secretions containing high concentrations of malic acid (Rembold, 1981). The amount of foliar exudate and the concentration of malic acid depend on temperature and growth stage and have been shown to increase during the reproductive stages of the plant (Koundal & Sinha, 1981). When moths were drawn to chickpea in all growth stages, there was relatively less oviposition activity and damage in resistant cultivars that secreted high concentrations of malic acid (Rembold, 1981; Lateef, 1985; Reed *et al*., 1987). Moths could, therefore, be assessing weeds in post-flowering chickpea as oasis in an increasingly hostile oviposition environment. The aggregative oviposition response of *Helicoverpa* spp., in weedy chickpea has been documented in experimental as well as commercial crops with results similar to those reported here (Sequeira *et al*., 2001). However, much work needs to be done to fully understand the processes underlying observed patterns of host plant selection in the field and their relevance to insect pest management. Volatiles from plants are considered likely to play an important role in host location. Laboratory evidence had demonstrated that *H. armigera* (Rembold *et al*., 1991; Hartlieb & Rembold, 1996) and other moths of the genus *Helicoverpa* (Tingle & Mitchell, 1992) showed upwind flight towards certain host volatiles. The use of host volatiles has been proposed as a potential lure for both male and female insects and as means of monitoring and forecasting populations (Udayagiri & Mason, 1995). Hence, the pest can be effectively controlled by selection and use of high yielding and tolerant varieties to *Helicoverpa* and short duration chickpea that comes to harvest in 110 days to escape pest's infestation.

As a part of integrated pest management, installing pheromone traps @ 10/ha can monitor pest build up to take decision on timely control measures. Spraying can control early instar larvae but sensible use of pesticides can be used to control this pest as a last resort depending upon the need. The development of new chickpea varieties is being advised to enhance crop protection that is possible. Plant breeding in combination with biotechnology tools can provide new materials for better plant management. Acharjee *et al*., (2004) studied genetic transformation of resistance to pod borers and Polymerase chain reaction, dot blot and western blot analyses confirmed the expression and transmission of transgenes in transgenic and in their progenies plants. Hence, such pest management tools like host plant resistance, if extensively deployed may have positive impact on the environment by reducing the amount of chemical pesticide uses in chickpea crop.

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