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Full Length Research Paper

Survey on screening resistance resources in some chickpea (*Cicer arietinum* L.) genotypes against gram pod borer *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) pest

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These efforts examined sources of resistance in some chickpea (*Cicer arietinum* L.) genotypes to its foremost insect pest gram pod borer *Helicoverpa armigera* (Hubner). The susceptibility of 23 chickpea genotypes was checked at the farm conditions. Overall, pod borers infestation throughout cropping season remained variable on different genotypes. A peak pest population density and its damage, and reduction in grain yield and its quality occurred in CM-1594/01 genotype. At the same environmental conditions, decreased pest population and peak yield were observed in genotype CH-31/99. This was definitely due to occurrence of variable genetic potential of resistant or susceptible genotypes towards pest tolerance and yield enhancement. For that reason, genotype CH-31/99 may be used as resistant donor in the genetically crossing program to evolve pod borer resistant/ tolerant varieties of chickpea. Hence, host plant resistance could be considered as the most sustainable approach to reduce losses due to insect pests.

Key words: Resistance, *Helicoverpa,* pod borer, chickpea, *Cicer arietinum.*

INTRODUCTION

Pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae), is a highly polyphagous pest which infests many host plants (Attique et al., 2000; Sarwar, 2012). The *H. armigera*, commonly known as cotton bollworm or American bollworm, is a major polyphagous noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops (Talekar et al., 2006). Patanker et al. (2001) reported that *H. armigera* is the most serious pest of chickpea and other crop plants all over the world. In severe cases it causes about 75 to 90% losses in seed yield, and it was pointed out that gram pod borer damaged leaves, tender shoots, apical tips, floral buds and pods. The gram pod borer *H. armigera* is a key pest of chickpea (*C. arietinum* L.) (Sarwar et al., 2009, 2011). The damage caused by this pest on chickpea ranged up to 84.4% with an average of 7% in different farming systems (Lateef, 1992). Its high pest status arises from the preference of larvae for plant structures such as flower buds, flowers and pods (Fitt, 1989). In Pakistan Sarwar et al. (2009, 2011) reported 26.01 to 40.08% and 10.53 to 39.14% crop losses on susceptible and tolerant genotypes, respectively, due to *H. armigera* from early vegetative to podding stage in chickpea. However, the yield levels of this crop are not very encouraging. Among the factors responsible for low yield, the damage caused by this insect pest is one of the major factors in chickpea production. The major reasons for the reluctance of farmers to use insecticides against this crop appeared to be the non-availability of proper insecticides, their high cost and development of pest resistance against certain chemicals.

Although considerable efforts have been made to develop pest management strategies over the past many years, we are still unable to manage several insect pests in an environmentally benign manner. The difficulties experienced in controlling insect pests have largely been due to development of insect resistance to insecticides and overuse of insecticides. The emergence of resistant insect populations, high cost of protection, and harmful effects on the environment obviate the need for alternate strategies, which are environmentally sustainable and economically viable such as the identification of genotypes with resistance to *H. armigera* (Rajput et al., 2003).

Concerted efforts to transfer insect resistance into improved cultivars with acceptable yield and quality has not been very successful (Naser et al., 2009). Knowledge of the extent of susceptibility or resistance of crop varieties and pest status on that crop is a fundamental component of integrated pest management (IPM) programs for many crops. Such information can help to detect and monitor pest infestation, variety selection and crop breeding. Growing a resistant variety is an ideal component of integrated pest management strategy and use of less susceptible or tolerant cultivars may offer as one of the suitable components of eco-friendly pod borer management approach. Since chickpea growers have to spend much of inputs like pesticides to control *H. armigera*, it was considered viable to search the available germplasm for sources of resistance to such pest for use in breeding insect resistant cultivars. The present studies were undertaken to evaluate the performance of different chickpea genotypes against *H. armigera.*

MATERIALS AND METHODS

Experimental site and crop growing

Twenty three promising chickpea genotypes were screened for resistance against *H. armigera* under pesticide-free field conditions during 2005 to 2006 season. The experiments were laid in a randomized complete block design (RCBD) in three replications at Nuclear Institute of Agriculture, Tandojam, Sindh, Pakistan. Seeds of all genotypes viz., CM-1463/94, CM-2100/96, CM-3821/97, CM-3837/97, CM-4068/97, CM-1223/98, CH-17/99, CH-31/99, CH-53/99, CH-58/99, CH-65/99, CH-38/00, CH-42/00, CC-94/99, CC-98/99, CM-2983/00, CM-3632/00, CM-1589/01, CM-1594/01, CM-210/01, CM-633/01, CM-1616/01 and CM-98 were obtained from Nuclear Institute for Agriculture and Biology, Faisalabad.

A rough seedbed was prepared to avoid packing of the cloddy surface due to winter rains, and to facilitate soil aeration and easy seedling emergence. Each genotype was sown in November 2005, in two-row plots of 3 m length with plant spacing of 30 cm row-to-row and 10 cm plant-to-plant with one meter as gap in each replication. The seeds were drilled into the furrows with a 5 cm soil layer over them. All the recommended agronomic practices were adopted for raising the chickpea crop. No irrigations and fertilizers were applied to all the genotypes as per local circumstance and recommendations. The test material was kept free from any insecticidal spray throughout the crop season to put more pest pressure on test material.

Experimental methodology

The level of resistance/ susceptibility on each of the test entries was assessed under field conditions by recording larval number and percent pod damage on plants selected from each test line. For each observation, the incidence of pod borer was recorded from the time of crop at seedling stage to maturity wherein random samples of five plants per genotype per replication were taken to observe the numbers of borer. The observation on pod damage was recorded from one meter row of randomly sampled plants at maturity by counting the total number of healthy and damaged pods, from which percent pod damage of each entry was calculated. The percentage pod damage was recorded one week before harvesting, and the crop was used for ranking pest damage. The crop was harvested when leaves started senescence and shedding. The plants were harvested at the base by manual labor, using a sickle. After harvest, the crop was allowed to dry in the sun for a few days. Threshing was done by beating the plants with sticks and grain yield (gm) per replicate was recorded. The data obtained from the trials were pooled and subjected to statistical analysis with Statistix 8.1 software. The mean values were separated by using LSD test at alpha= 0.05. The level of resistance or susceptibility of each test entry was determined by using the observations recorded on pest resistance/ susceptibility incidence.

RESULTS AND DISCUSSION

The pest was active throughout the crop season, but damage to crop was caused by the larvae which fed on the leaves and destroyed the seedlings in the early stages. At the time of pod formation it was found feeding on the developing grain after making a hole in the pod and thrusting its head therein. The response of 23 genotypes of chickpea to the incidence of pod borer *H. armigera* was studied without any plant protection chemical used.

Gram pod borer population

It is evident from the data presented in Table 1 that depending on the palatability of the test lines, the larval population of *H. armigera* and pod damage varied from 0.60 to 3.93 larvae and 12.18 to 23.12% pod damage, respectively. The most susceptible/ palatable genotypes for the pest were found to be CM-1594/01 and CM-1616/01 because there were 3.93 and 2.22 larvae per m plant row and 23.12 and 21.23% pod damage, respectively. These genotypes were statistically different with other and rated as susceptible. The least susceptible/ palatable genotypes were CH-31/99, CM-210/01, CM-3837/97 and CM-2983/00 which supported

Table 1. Field screening of different chickpea genotypes against gram pod borer.

S. No.	Name of genotypes	Larval population	Pod infestation (%)	Yield (per 3 m^2 area)
1	CM-1463/94	1.13^{cde}	15.64^{abc}	988.3^{bcd}
2	CM-2100/96	1.33^{bcde}	18.13^{abc}	816.3^{bcde}
3	CM-3821/97	1.86^{bc}	18.88^{abc}	660.0^{de}
4	CM-3837/97	0.66^{e}	12.63^{bc}	1123.0^{abc}
5	CM-4068/97	1.00^{cde}	15.38^{abc}	990.0^{bcd}
6	CM-1223/98	0.93^{cde}	14.80^{abc}	1028.0^{bcd}
7	CH-17/99	1.00^{cde}	15.06^{abc}	993.3^{bcd}
8	CH-31/99	0.60^{e}	12.18^{c}	1441.0^{a}
9	CH-53/99	1.33^{bcde}	17.95^{abc}	846.7^{bcde}
10	CH-58/99	0.86^{cde}	13.77^{bc}	1037.0^{bcd}
11	CH-65/99	0.80^{de}	13.65^{bc}	1043.0^{bcd}
12	CH-38/00	1.13^{cde}	16.34^{abc}	895.0^{bcde}
13	CH-42/00	1.60^{bcde}	18.15^{abc}	775.0^{bcde}
14	CC-94/99	1.33^{bcde}	17.63^{abc}	862.0^{bcde}
15	CC-98/99	0.73^{de}	13.29^{bc}	1080.0^{abc}
16	CM-2983/00	0.66^{e}	13.16^{bc}	1109.0^{abc}
17	CM-3632/00	1.13^{cde}	16.31^{abc}	928.3^{bcde}
18	CM-1589/01	1.26^{bcde}	17.42^{abc}	868.3^{bcde}
19	CM-1594/01	3.93^{a}	23.12^{a}	585.0^{e}
20	CM-210/01	0.60^{e}	12.49^{bc}	1145.0^{ab}
21	CM-633/01	1.20^{cde}	16.42^{abc}	871.7^{bcde}
22	CM-1616/01	2.22^{b}	21.23^{ab}	643.3^{de}
23	CM-98	1.73^{bcd}	18.79^{abc}	731.3^{cde}
	LSD value	0.859	7.405	335.2

The means not sharing a common letter differ significantly at 5% level of significance.

0.60, 0.60, 0.66 and 0.66 larvae and 12.18, 12.49, 12.63 and 13.16% pod damage, respectively and rated as resistant. The remaining genotypes CM-1463/94, CM-2100/96, CM-3821/97, CM-4068/97, CM-1223/98, CH-17/99, CH-53/99, CH-58/99, CH-65/99, CH-38/00, CH-42/00, CC-94/99, CC-98/99, CM-3632/00, CM-1589/01, CM-633/01 and CM-98 were rated as moderately resistant or moderately susceptible. From the results, it was noticed that the genotypes CH-31/99, CM-210/01, CM-3837/97 and CM-2983/00 were promising for resistance to *H*. *armigera*. The other genotypes viz., CM-1594/01 and CM-1616/01 were significantly highly susceptible. The lower pest damage indicates the lower level of pod borer attack on genotypes, indicating better tolerance to pod borer.

Plant yield

The mean grain yield among the test genotypes ranged from 1441 gm in CH-31/99 to 585 per 3 m^2 in CM-1594/01. The highest mean grain yield of 1441 gm recorded in CH-31/99 was significantly higher than that of the other genotypes. The genotype CH-31/99 showed good resistance/ tolerance against *H. armigera* and ultimately gave good yield, so, these could be used for cultivation by the farmers.

In total, 23 chickpea genotypes were screened; four genotypes, viz., CH-31/99, CM-210/01, CM-3837/97 and CM-2983/00 recorded less pod damage compared to the rest of entries. The mean pod damage among the test entries ranged from 12.18 to 23.12%. These results were highly significant and in agreement with those of early workers, but the range of damage recorded by them varied greatly that is, 12.63 to 33.05% (Sarwar et al., 2009); 11.55 to 48.11% (Khan et al., 2009), and 13.24 to 38.0% (Sarwar et al., 2011). These variations in pod damage may be due to difference in regional climatic conditions and the type of tested genotypes. It is evident from the data presented on the incidence of pod borer studied on genotypes of chickpea to *H. armigera* that the least attacked entries gave the highest yield at the end of the season. On the other hand, those which suffered maximum pod damage showed minimum yield. The high yielding reaction was possibly due to ability of genotype to survive damage and exhibit high yielding potential. Bhalani et al. (1987) also reported that in the screening of chickpea genotypes for resistance to *H. armigera* in pesticide free field, some genotypes gave good mean yield, despite of considerable damage. These findings are also in line with those of Sehgal (1990) who reported significant positive correlations between yield reduction and percent pod damage.

Several other workers have reported differential response of chickpea genotypes to pod borers. Earlier, Parvez et al. (1996) reported that a number of chickpea lines had shown to possess resistance to pod borers that may be used as resistant donors in resistance breeding against insect pests of chickpea. This was because of podding potentiality, pod size, seed size, and seed weight which varied widely among the genotypes. According to Shahzad et al. (2005), the resistant genotypes caused high antibiotic as well high antixenotic effects (resistance mechanism employed by a plant to deter or prevent pest colonization) for the larvae of *H. armigera* at vegetative stage and flowering stage of plant. Therefore, it discouraged the pest invasion to tolerate the attack of *H. armigera* by plant host (Hossain, 2009). Yoshida et al., (1995) investigated mechanisms of resistance to *H. armigera* in chickpea; oxalic acid and malic acid were detected as major components in all genotypes that were analyzed by high-performance liquid chromatography. Genotypes resistant to *H. armigera* accumulated more oxalic acid on the leaves than susceptible genotypes. Oxalic acid showed significant growth inhibition on *H. armigera* larvae when included in a semi-artificial diet. The accumulation of oxalic acid was considered to be one of the mechanisms of *H. armigera* resistance in chickpea. Inhibition of larval growth by oxalic acid was not caused by anti-feedant effects but more likely attributable to antibiosis. Similarly, Rembold and Winter (1982) found that the level of malic acid could be used as an index of susceptibility of a cultivar to attack by *H. armigera.* Thus, in future the level of malic acid and other biochemical factors must be analyzed to check the variations among these tested genotypes to ascertain the major components involved and understand the specific basis for the resistance. In accordance with Cotter and Edwards (2006) plants use a number of resistance mechanisms that can affect insect feeding, including physical factors such as leaf toughness or trichome density, or chemical factors such as toxic allelochemicals and proteinase inhibitors. As stated by Yadav et al**.,** (2006), it appeared that the extent of pod borer damage varied between the chickpea types. Spreading types were more susceptible to *Helicoverpa* damage than erect types. Yield losses due to *Helicoverpa* infestation were always greater in the irrigated than in the rainfed materials. These characteristics should be informative for the resistance improvement of chickpea for environments in which *Helicoverpa* damage occurs frequently.

CONCLUSIONS

In a nutshell, in spite of the high variations among the genotypes in present study, results support that the pod infestation, larval population and grain yield could be used as a selection criterion of a resistant genotype as the integral part of management program against *H. armigera*. It also provides useful information on antibiosis mechanism of resistance to *H. armigera*. On the basis of percent pod damage and pest susceptibility rating, entries CH-31/99, CM-210/01, CM-3837/97 and CM-2983/00 were found promising with minimum mean pod damage and consistently showed resistant reaction for the entire season of crop testing as compared to CM-1594/01 and CM-1616/01 genotypes. Therefore, these genotypes may be used in hybridization program to evolve high yielding pod borer resistant/ tolerant varieties of chickpea that may be used as one of the components of integrated pest management.

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