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Evaluation of Resistance in Different Chickpea Strains to *Callosobruchus chinensis* Linnaeus (Coleoptera:Bruchidae) under Laboratory Conditions

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Abstract: To evaluate resistance of seven strains of chickpea against *Callosobruchus chinensis*, three tests (confinement, free choice and antixenosis) were conducted in the postgraduate laboratory of the Department of Entomology, University of Arid Agriculture Rawalpindi during the years 1997-1999. Randomised Complete Block Design with four replications was used in all the tests. The cotton strains of chickpea namely NCS 96002, NCS 950004, NCS 950012, 92CC-076, 92CC-079, NCS 950183 NCS 960003 and one variety, Paidar-91 were collected from Pulses Section of National Agricultural Research Centre Islamabad. In all the tests, the variety Paidar-91 was used as check/standard, being commercial variety in Potohar region. It was concluded that the chickpea strain NCS-960003 was found to be partially resistant in all the three tests when compared with the standard and NCS-950012 and 92CC-079 were turned out to be be partially resistant to susceptible. NCS-96002 was turned out to be partially susceptible to susceptible. NCS-960183, NCS-950004 and 92CC-076 did not differ much from the standard (Paidar-91).

Key words: Resistance *Callosobruchus chinensis* Linnaeus Chickpea Strains Antixenosis Confinement Test Susceptible Check Free Choice Test

Introduction

Chickpea (*Cicer arietinum* L.) is the third most important pulse crop after dry beans (*Phaseolus vulgaris* L.) and dry peas (*Pisum sativum* L.) on global basis (Ali *et al.,* 1998). It is one of the most important leguminous crops, extensively cultivated in dry and rain-fed areas of the world (Khattak *et al.,* 1991). Chickpea in the world is grown over an area of 12009 thousand hectares, having the average yield of 742 kg/ha and total production of 8908 thousand metric tons (FAO, 1996).In Pakistan gram alone contributes about three fourth of the pulses grown (Ali *et al.,* 1991).

According to Ahmed (1995), grain is a living entity and is affected by biotic and abiotic factors. Every year more than 20,000 species of field and storage pests destroy approximately one third of the worlds food production and this loss amounts to dollars worth millions annually (Aslam and Suleman, 1999). Chickpea grains are stored in godowns and warehouses in large and small quantities and are attacked by various insect pests. *Callosobruchus chinensis* L. (Coleoptera; Bruchidae) the pulse beetle (PB) is a destructive pest of chickpea in storage (Aslam and Suleman, 1999). In Syria infestation ranged from 0-79 percent, screening did not reveal any acceptable degree of resistance but some wild accessions were resistant (Weigand and Tahhano, 1990).

Ahmed *et al*. (1993) discovered that varieties with hard, rough, wrinkled and thick seed coat showed less seed damage and number of holes were therefore more resistant than varieties with smooth, soft and thin seed coat.

Based on Sharvale and Borikar (1995), seeds of 11 chickpea (*Cicer arietinum*) were infested with freshly emerged pairs of *Callosobruchus chinensis* in test tubes. On the basis of oviposition, adult emergence, growth index, grain damage and weight loss gram varieties as Sel-436, Phule G-5, Chaffa and Annegiri were classed to be least susceptible while L-550 and Phule-G1 were highly susceptible to pest damage. According to Singh *et al*. (1997), two Turkish germplasm lines PI-594331 and PI-594332 were released in 1994 because of their resistance to *Callosobruchus chinensis*, which has not been identified to date in cultivated chickpea. Both lines are prostrate in growth habit and late maturing and low yielding.

The best plant protection for future should be based on host plant resistance and this method is particularly relevant to subsistence farming system of the semi-arid tropics (Lal and Kishore, 1996).

In the past some work on genetic resistance in chickpea to PB was studied by Ahmed *et al.* (1991). Some studies on comparative susceptibility and resistance on morphological basis of various legumes including chickpea attacked by bruchid beetle have been done. The present investigations were therefore, undertaken to definitely delineate the quantitative damage caused by PB to grains under experimental conditions and further to screen the relevant chickpea cultivars for their resistance against PB under laboratory conditions, keeping into view, Dahms (1972), Miller and Miller (1986) and Kogan (1994) criteria of evaluating resistance in host plants (the chickpea grains in this case).

Materials and Methods

For screening of chickpea strains against *Callosobruchus chinensis* (L.), the pulse beetle (PB) under laboratory conditions in the Department of Entomology, University of Arid Agriculture, Rawalpindi; seven lines namely NCS 96002, NCS 950004, NCS 950012, 92CC-076, 92CC-079, NCS 950183 NCS 960003 and one variety, Paidar-91 were collected from Pulses Section of National Agricultural Research Centre Islamabad. Varieties were subjected to fumigation using Agtoxin, following Iqbal *et al*. (1993), Mahmood *et al*. (1991) and AGP (1992) for two weeks so as to kill any pests already existing.

After fumigation, the strains were subjected to different types of tests, including free choice, confinement, and Antixenosis test. In all the experiments four replications of each and every strain were used. Paidar-91 was used as check/standard, being commercial variety in Potohar region. The data were collected on regular basis and results were analysed statistically to reach certain conclusions. Adults of the PB were collected from the Insects culture and rearing cell maintained in the Department of Entomology and were used in conducting different tests, such as confinement test and antixenosis test.

In Free choice test all strains of chickpea were subjected to the attack of PB freely, following Dahms (1972). Ten grams of each strain were placed in earthen cups of size 1×4.5 cm. The cups were placed at random in wooden boxes of (43×30 cm) size in all the four replications. The boxes were left open. They were left free to be attacked by PB in the laboratory. The cultivars were examined on weekly basis to record (1) the number of PB attracted to different strains and (2) the number of emergence holes. The method of visual observation was followed. The

observations regarding number of PB attracted to different strains were continued for three weeks. The observations for the number of adult emergence holes for the each treatment were also recorded for five weeks.

In confinement test plastic jars of the size 11 × 9.5 cm were used as experimental units. In all jars fifty grams of the chickpea strains were placed. Twenty adults of PB were collected from the maintained culture and released in each jar, following Dahms (1972), Miller and Miller (1986) and Kogan (1994). The treatments representing seven lines and one variety were each replicated four times. The jars were covered with muslin cloth, the rim of the lid was held tightly on the jar so as to avoid the escape of PB, and provide sufficient air. The insects were allowed to remain there for the purpose of egg laying till they died. The new adults emerged and continued their next generation. The observations regarding weight loss, percent grain damage etc. were recorded after a period of ninety days of release of PB. The percent weight loss and percent grain damage were calculated. following Khattak *et al.* (1987) after ninety days of the release of the PB.

In Antixenosis test preference and non-preference responses of PB to eight different strains of chickpea were observed, following Kogan (1994). Tests were carried out using four replications of each strain keeping Paidar-91 as check/standard. Ten grams of all chickpea strains were placed in the earthen cups of 1 × 4.5cm. These cups were placed in the glass boxes of 45 × 38.5 cm at an equal distance. Forty adult PB were released in each replication. The boxes were closed immediately after the release to avoid the escape of PB from the boxes. Then the number of PB attracted to each strain was recorded after 48 hours. Experiment was continued up to eight days.

The data recorded in all the tests were subjected to statistical analysis as Randomised Complete Block Design using MSTATC (version 1.3) program. When significant F ratio was obtained, t-Tests (Least significant difference) were applied to the means. Based on the grouping of the t-tests the strains were assigned different levels of resistance/susceptibility. The resistance of an experimental strain is usually measured by comparing the strain with a cultivar known to be susceptible (Painter 1951; Dahms 1972). Levels of resistance used, were described by Aslam *et al.* (1999). According to which the strains which showed significantly higher infestation/damage, when compared with a susceptible cultivar were classified as highly susceptible. The strains which did not differ from susceptible cultivar in showing the infestation/damage were classified as susceptible, while the strains showing significantly less infestation or damage than the susceptible cultivar were classified as intermediately susceptible, partially susceptible, partially resistant, intermediately resistant, resistant and highly resistant depending upon nature of grouping of the t-test.

Results and Discussion

Under free choice test two parameters were used to determine the preference and non preference response of PB towards eight different chickpea strains (1) number of PB attracted to different chickpea strains (2) number of emergence holes. The results drawn are given below.

According to the grouping of t-test, comparison of the means indicates that preference of *C. chinensis* for different chickpea strains was proved to be highly significant. When all the strains of chickpea were compared with susceptible standard (Paidar 91), the strains of chickpea NCS-96003, NCS-950012 and 92CC-079 were found to be partially resistant. Whereas NCS-96002 was found to be partially susceptible. NCS-950183 turned out to be intermediate between partially susceptible (NCS-96002) and partially resistant (NCS-96003, 92CC-079, NCS-950012) strains. As far as strain 92CC-076 is concerned it was found to be intermediately susceptible. The strain NCS-95004 was statistically not much different from 92CC-076 and NCS-96002 (Table 1). Yadav and Pant (1978), also found similar results and they concluded that black gram is preferred by *C. chinensis* when free choice was given among black gram, bangal gram, green gram, pigeon pea, cluster bean, pea, grass pea, and lentil. Brewer and Horber (1984) also concluded that one chickpea variety was found susceptible, while comparing 16 legume varieties for resistance to

Table 1: Average No. of pulse beetle attracted to different chickpea strains under Free Choice and and Antixenosis tests and average number of Emergence Holes in different strains under Free Choice Test

Strains	Av. No. of Beetless attrected under Free Choice Test	Av. No. of Emergence holes under free Choice Test	Av. No. of Pulse Beetles attracted under antixenosis Test
92CC-076	14.25b	39.50a	5.125a
92CC-079	5.250e	30.70c	4.250abc
NCS-950004	12.00bc	36.10ab	5.063a
NCS-950012	5.500e	20.15d	3.00bc
NCS-950183	7.00de	22.20d	4.438ab
NCS-960003	6.250e	19.65d	2.313c
NCS-96002	9.500cd	29.65c	3.375abc
Paider 91	18.17a	34.00bc	3.313abc

Means followed by the same letters are not significantly different from one another at alpha = 0.05

Table 2: Percent weight loss and per cent weight damage of different chickpea strains by pulse beetle under confinement test

Strains	Percent Weight Loss	Percent Damage
92CC-076	44.65a	59.70a
92CC-079	25.60b	39.20cd
NCS-950004	42.47a	56.30ab
NCS-950012	18.20c	36.60d
NCS-950183	39.72a	52.60b
NCS-960003	16.80c	27.40e
NCS-96002	28.20b	44.20c
Paidar 91	27.10b	41.40cd

Means followed by the same letters are not significantly different from one another at alpha = 0.05

C. chinensis. Sharvale and Borikar (1995) also concluded on the basis of oviposition, adult emergence and weight loss, that some gram varieties were classed to be least susceptible and some were highly susceptible.

Results of Table 1 indicate that when all the seven lines were compared with Paidar 91 (susceptible check), 92CC-079 and NCS-96002 were found to be partially susceptible. Whereas NCS-950183, NCS-950012 and NCS-960003 were found to be partially resistant. When compared with Paidar 91 (standard/control), 92CC-076 turned out to be highly susceptible as maximum number of emergence holes were observed on it.

As far as the chickpea strain NCS-950004 is concerned it was intermediate between susceptible (Paidar 91) and highly susceptible strain (92CC-076), and it contained the number of emergence holes closer to the susceptible standard Paidar 91. Jakhmola and Singh (1971) also observed that adult female showed preference for oviposition in large seeds of gram. Ahmed *et al.* (1993) evaluated 39 varieties of chickpea for number of holes and described that some varieties with hard, rough, wrinkled and thick seed coat showed less number of holes

and were more resistant. Ahmed *et al.* (1991) using free choice test concluded that significant correlation exist between number of damaged seeds and number of emergence holes.

Preference and non preference response of PB towards different chickpea strains was also observed in antixenosis test. Least Significance Difference test was applied to the data recorded and analyzed. The results of comparison of means are shown in the Table 1. According to this table chickpea strains NCS-96002 and 92CC-079, when compared with Paidar 91 (susceptible standard) were found in the same category as susceptible. Chickpea strain NCS-960003 turned out to be partially resistant, whereas NCS-950012 was statistically very close to NCS-960003.

As far as NCS-950183 is concerned, statistically it was not much different from susceptible (Paidar 91, 92CC-079 and NCS-96002) strains, hence can be classified into susceptible cultivars. When chickpea strains 92CC-076 and NCS-95004 were compared with susceptible standard, these two strains were found to be highly susceptible, which means that these two strains attracted the highest number of PB and were highly preferred. Raina (1971), while studying resistance among 14 different chickpea varieties to bruchids in the laboratory by means of selective preference and no choice test also reported that some strains are more preferred and others are least preferred.

Under confinement test on the basis of percent weight loss of grains, NCS-96002 and 92CC-079 were found to be susceptible in addition to Paidar 91. Whereas NCS-96003 and NCS-950012 proved to be partially resistant when compared with standard Paidar 91 (susceptible). The chickpea strain 92CC-076, NCS-950004 and NCS-950183 were found to be highly susceptible and were the most damaged cultivars (Table 2).

From these results it can be concluded that chickpea strains vary in their resistance and they can be grouped into different categories of resistance. These results are similar to one presented by Sharvale and Borikar (1995). Gujar (1976) while studying the weight loss of gram, concluded that *C. chinensis* was more injurious to the seeds than *C. maculatus*. Gujar and Yadav (1978) also concluded same results.

Percent damage was recorded after 90 days of the release of PB in each treatment sample. Results show that damage done by PB to different lines of chickpea was significantly different from one another. Table 2 indicates that chickpea strain 92CC-079 was also found to be susceptible when compared with check/standard (Paidar 91), whereas NCS-96002 was statistically not much different from Paidar 91 and 92CC-079 (susceptible strains). When 92CC-076 was taken into consideration it was found to be the highest damaged strain, whereas NCS-95004 was also severely damaged. As far as NCS-950183 is concerned, significant damage was also observed in this case. The chickpea strain NCS-950012 was statistically closer to susceptible strains (Paidar 91 and 92CC-079). According to Table 2, NCS-96003 was proved to be partially resistant. Sharma and Dwivedi (1996) also concluded that on the basis of ovipositional preference, growth and damage caused out of nine varieties of chickpeas, two were highly resistant. Khattak *et al.* (1995) evaluating six chickpea cultivars also reported that two varieties were more susceptible and one variety was significantly resistant.

When the results of free choice, antixenosis and confinement (percent damage and percent weight loss) tests were compared, it was concluded that the chickpea strains NCS-960003 was found to be partially resistant in all the three tests. NCS-950012 when compared with Paidar-91 also turned out to be partially resistant in free choice test (number of pulse beetle attracted and number of emergence holes) and confinement test when percent loss was calculated. As far as antixenosis test is concerned, it was statistically very close to partially resistant, NCS-960003, but it was found to be closer to susceptible standard (Paidar-91) when percent damage was calculated under confinement test.

The chickpea strain NCS-96002 turned out to be susceptible in antixenosis test and confinement test when percent loss was calculated. However, it was closer to susceptible strain Paidar-91 when percent damage was calculated in confinement test. In free choice test, it was found to be partially susceptible (on the basis of the number of pulse beetles attracted and the number of emergence holes), when compared with standard. Comparison of the results of all the tests reveals that, chickpea strain-92CC-079 was found to be susceptible in antixenosis and confinement tests i.e, on the basis of percent damage and percent loss . As far as free choice test is concerned, when compared with Paidar-91, this cultivar was found to be partially resistant in case of number of pulse beetle attracted and was partially susceptible when emergence holes were calculated.

Khattak *et al*. (1991) conducted studies on the response of 6 chickpea cultivars to the infestation of pulse beetle and evaluated on the basis of per cent weight loss, that none of the cultivars were completely resistant to the infestation of PB. However, their response varied significantly.

The chickpea strain NCS-960183 was found to be highly susceptible under confinement test when percent loss was calculated, and was also significantly damaged when percent damage was taken into consideration. Under antixenosis test it was statistically very close to susceptible standard Paidar-91, whereas in free choice test, it was found to be intermediate between partially susceptible and partially resistant strain (in case of number of pulse beetle attracted to different strains) and was least susceptible or partially resistant according to the number of emergence holes in free choice test.

When compared with standard/check paidar-91, NCS-950004 was turned out to be highly susceptible in antixenosis test and confinement test, when percent loss was calculated. It was found to be severely damaged when percent damage was recorded under confinement test. Under free choice test (number of pulse beetle attracted), it was not much different from intermediately susceptible and partially susceptible strains which means it holds intermediate position between these two strains (92CC-076 and NCS-96002). The chickpea strain 92CC-076 was proved to be highly susceptible in confinement (percent loss and percent damage) and antixenosis tests whereas in free choice test it was found to be intermediately susceptible for the number of pulse beetle attracted to different strains recorded. It was most preferred strain when the number of emergence holes under free choice test were recorded. Katiyar and Khare (1985) conducted the trials of 20 germplasm of gram in the laboratory and reported that some were least susceptible, some were most susceptible while others were moderately susceptible. From the results drawn it can be concluded that none of the experimental strain proved to be completely resistant and some may show more resistance than the others. The results are similar to the one reported by Gupta and Kashyap (1971).

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