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Evaluation of Resistance in Some Wheat Cultivars to *Sitophilus oryzae* Linnaeus. (Coleoptera: Curculionidae) under Laboratory Conditions

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Abstract: To evaluate the resistance of nine wheat cultivars (Rawal 87, Chakwal 86, Inqilab 91, Khyber 87, Sariab 92, Bakhtawar, Faisalabad 85, C 591 and Pak 81) against *Sitophilus oryzae* Linnaeus, three tests (Free choice, Confinement and Antixenosis) were conducted in the Department of Entomology, University of Arid Agriculture, Rawalpindi, during 1997-99, using Randomized Complete Block Design with four replications in each test. When compared with Chakwal 86 (the susceptible check/standard), C 591 was proved to be partially resistant under all three tests. Khyber 87 was found to be susceptible to highly susceptible. Pak 81 was found susceptible to partially resistant, while Rawal 87, Inqilab 91, Sariab 92, Bakhtawar and Faisalabad 85 were not significantly different from the standard (Chakwal 86). The results revealed that there was variability in different wheat cultivars against *Sitophilus oryzae* and this variability could be incorporated in evolving wheat varieties resistant to insects so as to minimize the dependence on insecticides/fumigants for the control of insects in godowns/warehouses.

Key words: Resistance, *Sitophilus oryzae Linnaeus,* Wheat Cultivars, Antixenosis, Confinement Test, Susceptible Check, Free Choice Test

Introduction

Wheat occupies an eminent place in the economy of our country (Chowdhry *et al*., 1998). It constitutes about 80 percent of total intake (Baloch and Irshad, 1986). Almost all the agricultural commodities including cereals are stored in godowns/stores on large or small scales because storage of food grain is inevitable both in times of deficit and surplus production (Lal, 1996). Different insect pests attack different commodities and cause heavy losses. Every year about 25-30 percent crop yields are damaged in fields and stores by different insect pests (Lal and Srivastava, 1996).

Grain storage loss is a serious problem confronting the world today. In Pakistan different loss estimates viz., 5% (Ahmed, 1983) and 10-15 percent (Jillani, 1981), at farm level wheat storage have been reported. Wheat is attacked by several stored grain pests including *Sitophilus oryzae* Linnaeus (Coleoptera: Curculionidae), the rice weevil (RW) as its principal stored grain pest. It is a dominant pest of wheat in Pakistan. When it breeds and feeds in the stores, it causes grain heating and also moulds appear on the grains (Aslam and Suleman, 1999). About 10-15% of wheat is lost annually due to ravages of stored grain pests during storage (Department of Plant Protection, 1986). Hasaballa *et al*. (1994) reported that RW preferred wheat diet the most from RW amongst three natural product diets (wheat, maize and rice) in the laboratory. According to Ahmed (1995), grain is a living entity, which is affected by biotic and a-biotic factors resulting in qualitative and quantitative losses. Barnardo (1972) concluded that in different varieties antibiosis and preference are both involved to *Sitophilus oryzae.*

Ram and Singh (1996) evaluated 64 wheat varieties for resistance to RW, using no-choice progeny tests, which revealed considerable varietal variability. The varieties found most resistant were Raj-911, Kalyan Sona, A-9-30-1 and PV-18; while HW-517, Shailaja, DL 20-9 and HD-2307 were the most susceptible.

Jayakumar and Jeyaraj (1995) stored samples (100, 200, 300 g) of grains of 6 varieties in bottles infested with 10 pairs of freshly emerged *Sitophilus oryzae* adults. Loss in grain weight was assessed 90 days later. Infestation was highest for Kuruvi (11 g weight loss) in 300 g sample and for IR-50 (10.9 g) in the 200 g and (6.3 g) 100 g samples. Lowest infestation was recorded for IR-20 (1.02 g) in the 100 g and (1.9 g) 300 g samples and for Bhavani (2.2 g) in the 200 g sample. IR-50 was classed as the most susceptible variety and IR-20 as the least susceptible.

The differences in resistance of varieties to stored grain pests has been known much earlier and there has been an increasing interest in developing grain varieties resistant to stored grain insects (Seifelnasr and Mills, 1985). However, much research on these lines has not been done in developing countries to exploit it for control purposes. The best plant protection for future should be based on host plant resistance. This method is particularly relevant to subsistence farming system of the semi-arid tropics (Lal and Kishore, 1996). The use of resistant varieties of wheat against insect pests is a major control measure (Everson and Gallun, 1980). Systematic research on wheat resistance to insects is of great significance from both breeder's and entomologist's point of view (Hamed and Khattak, 1997), therefore, screening of different cultivars against RW was done in the laboratory to evaluate their resistance against this insect pest.

Materials and Methods

Experiments were conducted during 1997-99 at University of Arid Agriculture, Rawalpindi, to evaluate the resistance in different wheat cultivars against *Sitophilus oryzae*. The 9 cultivars of wheat (Inqilab 91, Sariab 92, Pak 81, Bakhtawar, Chakwal 86, Khyber 87, Faisalabad 85, Rawal 87 and C 591) were collected from National Agricultural Research Center, Islamabad. Using Agtoxin these cultivars were subjected to phosphine fumigation following Iqbal *et al*. (1993), Mahmood *et al*. (1991), AGP (1992), Brown (1994) and MSU (1998), for at least two weeks so as to kill any pests already present. Polyethylene sheets were used for this purpose.

After successful accomplishment of fumigation these cultivars were subjected to following tests i.e., (i) free choice (ii) confinement and (iii) antixenosis tests. Culture of RW used in these tests was three weeks of age and it was maintained in the insect culture and rearing cell, Department of Entomology, University of Arid Agriculture, Rawalpindi. Chakwal 86 was used as standard (being the commercial variety of this region) in all the tests. The cultivars were placed in the experimental units at random using four replications in all the tests.

In Free choice test all the wheat cultivars were subjected to attack of RW freely following Dahms (1972). Earthen cups (2×2.5 cm) were used for this purpose. Ten grams of all the cultivars were placed in the cups using four replications. These

cups were placed in wooden boxes of size 43 × 30 cm. The boxes were left open to be attacked by RW freely from the surrounding environment. The test continued for ten weeks and the cups were examined on weekly basis. Data were collected for the number of RW attracted to different wheat cultivars.

In confinement test 50 grams each of all the wheat cultivars were placed in plastic jars of size 11x9.5 cm, following Dahms (1972), Miller and Miller (1986) and Kogan (1994). In each jar 20 adults of RW taken from the maintained culture, were released using earthen weevil collection vase with narrow neck. Muslin cloth was used with the help of lid rings to cover these jars for sufficient aeration. Observations on the number of insects (progeny), percentage grains damaged and percentage weight loss were recorded as described below.

The number of adult rice weevil in all the cultivars of each replication were counted separately after the interval of thirty days from the start of the confinement test. These counted numbers of rice weevil were again released and the second reading was taken 30 days after the first reading. The same procedure was followed and the last (the 3rd) progeny was recorded 30 days after the 2nd reading. Percent Damage of Grains was calculated from confinement test after 90 days interval. The grains were sieved using a 60-mesh sieve. Then all the samples were weighed with damaged and sound grains collectively.

During next step damaged grains of each cultivar were separated from the undamaged ones and then weighed. Following Khattak *et al*. (1987) the percent damage and weight loss of all the wheat cultivars in four replications was calculated.

Antixenosis test was also conducted to observe the preference and non-preference response of RW to different cultivars of wheat following Kogan (1994). Fifty grams of all the wheat cultivars in small earthen cups (1x4.5 cm) were placed at random in four wooden boxes (43x30 cm). One hundred and fifty adult RW collected from the culture maintained under laboratory conditions, were released with the help of earthen weevil collection vase in the center of each box and the boxes were closed. The observations were taken after 24 hours of release. Three such tests were performed at an interval of 24 hours so as to confirm the results. Numbers of rice weevil attracted to each treatment were counted to observe their response towards nine different test samples. The method of visual observation was followed for this purpose.

The data recorded for free choice, confinement (progeny, percent weight loss and percent damage) and antixenosis tests were subjected to statistical analysis as a randomized complete block design using MSTATC.

T tests (Least Significant Difference Test) were applied to see the means and based on grouping of T tests, the varieties were categorized into different levels of resistance and susceptibility following Aslam *et al*. (1999).

Results and Discussion

Table 1 shows that when other cultivars of wheat were compared with susceptible check (Chakwal 86), C 591 was found to be partially resistant. Pak 81 was statistically not much different from C 591. Whereas Inqilab 91 and Sariab 92 were found to be partially susceptible. As far as Faisalabad 85 and Bakhtawar are concerned, they were found to be intermediately susceptible. Rawal 87 turned out to be intermediate between partially and intermediately susceptible cultivars and was statistically less different from Inqilab 91, Sariab 92, Faisalabad 85 and Bakhtawar. Chakwal 86 was susceptible and Khyber 87 although attracted the highest number of insects but was not significantly different from the standard one. Sharma and Chahal (1977) had also reported differences in preferences of RW to different wheat varieties under free choice conditions.

Under confinement test different parameters were calculated such as progeny of rice weevil, percent weight loss and per cent damage of wheat grains. The progeny of RW was observed on all the 9 cultivars keeping Chakwal 86 as standard (susceptible). Table 1 reveals that C 591 is partially resistant and least number of rice weevil were found on it. Whereas Khyber 87 and Bakhtawar were statistically not much different from C 591. Number of rice weevils present on these two cultivars were slightly higher than C 591. When Inqilab 91 was compared with check/control (Chakwal 86), it was found to be partially susceptible. Faisalabad 85 was also statistically not much different from Chakwal 86. Whereas Pak 81 turned out to be intermediately susceptible (Table 1). Sariab 92 attracted the highest number of rice weevil and presence of RW was also very significant on Rawal 87. So these two cultivars were found to be highly susceptible. Ram and Singh (1996) evaluated 64 wheat varieties for resistance to RW using no choice progeny tests and had revealed considerable varietal variability. He reported some of the wheat varieties as most resistant and some as most susceptible.

Preference and non-preference response of rice weevil was also observed under antixenosis test. According to Table 1 wheat cultivars Bakhtawar and Rawal 87 were also found susceptible, when compared with the susceptible check/standard (Chakwal 86). Whereas C591 and Pak 81 turned out to be partially resistant. Khyber 87 was the cultivar that attracted the highest number of rice weevil, therefore, ranking highly susceptible. As far as Faisalabad 85, Sariab 92 and Inqilab 91 are concerned, when compared with Chakwal 86 (susceptible check), these cultivars attracted slightly higher number of rice weevil. Statistically these were not much different from the highly susceptible Khyber 87 and the susceptible cultivars, hence, categorized as intermediate between susceptible and highly susceptible cultivars. Barnardo (1972) concluded that in different wheat varieties preference was involved to *Sitophilus oryzae*.

At the end of confinement test pre cent damage of all the nine cultivars of wheat was calculated. Table 2 shows that when all the eight cultivars of wheat were compared with the standard Chakwal 86 (susceptible), Bakhtawar and Inqilab 91 were also found to be susceptible. C 591 turned out to be partially resistant, whereas Khyber 87 was intermediate between C 591 and all the three susceptible cultivars (Chakwal 86, Inqilab 91 and Bakhtawar). Table 2 also reveals that Sariab 92 showed the highest percentage of damage by RW, so it turned out to be the highly susceptible one. Also a significant number of RW were attracted to Rawal 87. As far as Faisalabad 85 and Pak 81 are concerned, they fall in between the susceptible check (Chakwal 86) and the highly susceptible cultivars (Sariab 92 and Rawal 87). Singh *et al*. (1972, 1973, 1974) on the basis of grain damage and weight loss by RW had also shown variability in five wheat varieties against the attack of this pest.

In addition to percent damage, percent weight loss was also calculated from the confinement test. All the wheat cultivars were compared to Chakwal 86 (susceptible ceck) and it is evident from Table 2 that Bakhtawar, Faisalabad 85 and Pak 81 were also found to be susceptible. C 591 was proved out to be partially resistant, whereas Khyber 87 and Inqilab 91 were intermediate in position between the susceptible cultivars (Chakwal 86, Bakhtawar, Faisalabad 85 and Pak 81) and the partially resistant C 591.

Highest number of rice weevil were found present in Sariab 92, which proves it to be the highly susceptible cultivar. Rawal 87 also followed it, ranking second in position as far as the number of rice weevil are concerned. Both of these cultivars turned out to be highly susceptible ones, when compared with Chakwal 86 (susceptible check).

Table 1: Average number of rice weevils attracted to different wheat cultivars under Free Choice, Confinement and Antixenosis tests

Cultivars	Free Choice Test	Confinement Test	Antixenosis Test	Percent damage
Bakhtawar	1.275 abc	156.5 ef	3.417 bc	49.17c
C 591	0.4500 d	124.1 f	1.833 c	26.67c
Chakwal 86	1.425 ab	198.2 cd	3.167 bc	48.80c
Faisalabad 85	1.325 abc	199.8 c	4.583 ab	53.18bc
Inqilab 91	0.9000 bcd	162.3 de	4.5000 ab	48.47c
Khyber 87	1.850 a	148.3 ef	5.833 a	42.22cd
Pak 81	0.8000 cd	174.8 cde	1.917 c	52.44bc
Rawal 87	1.250 bc	260.2 b	2.750 bc	66.38b
Sariab 92	0.8750 bcd	306.5 a	4.083 ab	84.28a

Means followed by the same letters are not significantly different from one another based on LSD = 0.5872 and Alpha = 0.05

Table 2: Percent weight loss of different wheat cultivars by rice weevil under confinement test

Cultivars	Percent wt. loss
Bakhtawar	27.83 b
C591	16.67 c
Chakwal 86	27.97 b
Faisalabad 85	29.87 b
Inqilab 91	22.81 bc
Khyber 87	24.76 bc
Pak 81	30.95 b
Rawal 87	42.64 a
Sariab 92	49.97 a

Means followed by the same letters are not significantly different from one another based on LSD = 15.86 and Alpha = 0.05

Jayakumar and Jeyaraj (1995), had also reported some varieties of wheat most susceptible and some as the least susceptible against *Sitophilus oryzae* on the basis of loss in grain weight and pest infestation. Iqbal *et al*. (1993) tested 10 wheat varieties for resistance/susceptibility in the laboratory against the attack of *Sitophilus oryzae* and reported significant differences in those varieties on the basis of weight loss of the grains.

When the results of all the tests were compared keeping Chakwal 86 (susceptible) as control/check, C 591 proved to be partially resistant under all the three (free choice, confinement and antixenosis) tests. Wheat cultivar Khyber 87 was found highly susceptible in free choice and antixenosis test, whereas under confinement test statistically it was very close to susceptible ones. Inqilab 91 turned out to be partially susceptible when compared with susceptible check (Chakwal 86), under free choice test and also in confinement test when progeny of rice weevil was compared, it was found partially susceptible. When percent damage was calculated under confinement test it was found susceptible and statistically not much different from susceptible in per cent weight loss. Also it turned out to be very close to susceptible ones, under antixenosis test. By comparing with susceptible Chakwal 86 (standard/control), Rawal 87 was also found to be susceptible under antixenosis test, and statistically intermediately susceptible in free choice test. As far as confinement test is concerned, it turned out to be highly susceptible when per cent damage, percent weight loss of grains and progeny was compared.

When wheat cultivar Sariab 92 was compared with standard/check (Chakwal 86) it was found highly susceptible under confinement test (percent damage percent weight loss of grains and progeny of rice weevil). Whereas in antixenosis test it was also more susceptible than Chakwal 86 (control/check). When free choice test is taken under consideration, it turned out to be partially susceptible. Bakhtawar was found to be statistically in the same category, as Chakwal 86 (control) i.e. susceptible under antixenosis test and under confinement test when percent damage and percent weight loss were calculated.

Whereas in free choice test this cultivar proved to be intermediately susceptible. When progeny of rice weevil was considered statistically it turned out to be very close to partially susceptible cultivar Inqilab 91.

Faisalabad 85 was found to be slightly more susceptible, when compared with susceptible Chakwal 86 (check), under antixenosis test and in confinement test when progeny of rice weevil and percent damage of grains were considered. Whereas it turned out to be susceptible when per cent weight loss of grains was calculated. Under free choice test, this cultivar was found to be intermediately susceptible.

Wheat cultivar Pak 81, when considered under antixenosis test, turned out to be partially resistant as C 591 and very close to it under free choice test. When it was compared with Chakwal 86 (susceptible check) in confinement test, this cultivar was found to be intermediately susceptible, susceptible and close to susceptible, considering progeny, per cent weight loss and per cent damage of grains, respectively. Chahal and Singh (1974) had also shown some varieties of wheat as relatively resistant and some as susceptible against RW out of the 15 varieties screened. Sinha (1969, 1971) reported some wheat varieties as most and some as least resistant against RW.

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