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Screening of Different Wheat CuRivers (Flour) Against the Attack of *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae) Under Laboratory Conditions

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Abstract: Nine wheat cultivars (Rawal 87, Inqilab 91, Khyber 87, Sariab 92, Bakhtawar, Chakwal 86, Faislabad 85, C591 and Pak 81) were screened against *Tribolium castaneum* using 3 tests (free choice, confinement and antixenosis) in the Department of Entomology, University of Arid Agriculture, Rawalpindi during 1999-2000. It was concluded that keeping Chakwal 86 as (susceptible/ check), Sariab 92 and Bakhtawar were found to be highly susceptible. Inqilab 91, Khyber 87, Faisalabad 85 were not significantly different from the standard Chakwal 86. Rawal 87 and Pak 81 turned out to be partially resistant. C591 turned out to be susceptible to partially resistant against Red FlourBeetle (RFB). The results showed that there was variability in different wheat cultivars and none of them found to be completely resistant. Although complete immunity was not possible, yet some of the genetic traits could be incorporated for evolving varieties which possess resistant characters. The present results also show that as susceptible variety is highly preferable, so it can be used as a quick and mass laboratory culture of RFB, which may be needed in other scientific experiments.

Key words: Host plant resistance, wheat cultivars flour, *Tribalium castaneum,* herbst, antixenosis test, confinement test, free choice test

Introduction

Wheat (*Triticum aestivurn*) meets the major dietary requirements of people in Pakistan. It is described as king of cereals for centuries and it continues to retain this pride even today. It provides about 60% of the calories and about 50 percent of the proteins to the human race (Wittwer, 1980). The production of wheat in 1998-1999 was estimated at 18054.5 thousand tons as compared to 18694 thousand tans of last year showing a decline of 3.4% (Government of Pakistan, 1998). Therefore, a dire need is being felt to increase the yield of this cereal crop. The bulk of harvested cereal grains are stored in the godowns on large or small scales as storage of food grain is inevitable both in times of deficit and surplus production (Lal, 1996). According to Singh *et al*. (1997), food grains under storage condition are damaged by several biotic and abiotic processes. Among the biotic processes the insect pests are major agents which cause considerable loss in terms of quality of food grains. Different commodities are attacked by different insect pests. They cause heavy losses each year due to which about 25-30% crop yields are damaged in fields and stores by different insect pests (Lal and Srivastava, 1996). Wheat is attacked by several stored grain pests including *Tribolium castaneum* Herbst., the red flour beetle (RFB) as its major secondary stored grain pest. It is pest of cosmopolitan nature especially of tropical regions and has great impact on the economy of Pakistan, which could not be under estimated (Hamed and Khattak, 1985). A single pair of this pest can accelerate its progeny to one million in 150 days (Gray, 1948). The stored wheat suffers losses to a varying degree on account of insect pests (Zafar *et al*., 1987). During storage, the secondary pest nibbled away the germ point of wheat rendering it unfit for germination, in addition they mix up their excreta, create offensive smell in products reducing their nutritive value (Anisa, 1971). Growing crop varieties resistant to insect pests is one of the primary methods of avoiding or reducing losses which they cause (Bhatia, 1976). Resistant cultivars provide the corner stone for successful pest management system. Use of resistant lines is a vital component in the management of any pest (Bhatti and Paruthi, 1998). Wheat varieties show different levels of attack of insect during storage (Irshad and Gillani, 1988). Khattak *et al*. (1994) observed losses caused by *Tribolium castaneum* to flour from ten wheat cultivars in laboratory conditions on the basis of developmental period, total progeny production and percentage of weight loss. 5-186 emerged as significantly resistant while WN 30-6-1 was highly susceptible. The other cultivars were in order: WS-91-3 < Pirsabak-85 = Sarsab 2 < WM-89-1 = Pak 81 < Barani-83 < WM-23-1-1 < WM-79-7. Suleman *et al*. (2000) reported wheat cultivars to be susceptible, highly susceptible and partially resistant. The different behavior in 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). Varietal resistance is one of the safest approach of eradicating stored grain pests but in Pakistan work done on the susceptibility of different varieties of wheat flour to *Tribolium castaneurn* is scanty and needs exploration. Different wheat cultivars flours had subjected to check resistance to *T. castaneum* and variation was found to the attack (Nehra *et al*., 1985; Khattak *et al*., 1994).

According to Khattak *et al*. (1994) both entomologists and plant breeders can join hands for evolving resistant varieties against the insects. For evolving pest resistant varieties cooperative efforts of breeders and entomologists are required (Chesnokov, 1962). For raising healthy crop correct choice of seed is essential and pest resistance of that seed has to be evaluated together with its economic properties. Host plant resistance has been identified as thrust area for the suppression of pests (Tondon, 1998). As the best plant protection for future should be one based on host plant resistance and this method is particularly relevant to subsistence farming system of the semi-arid tropics (Lal and Kishore, 1996), also the use of wheat resistant to insect pests is a major control measure or is compatible with other control measures (Everson and Gallun, 1980), and also a 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). The present project therefore, deals with screening of wheat cultivars (flour) against the attack of RFB under laboratory conditions. The percent weight loss, progeny, number of RFB attracted to different varieties were taken as the index of level of resistance.

Materials and Methods

Different cultivars of wheat (Inqilab 91, Sariab 92, Pak 81, Bakhtawar, Chakwal 86, Khyber 87, Faisalabad 85, Rawal 87, and C591) were collected from National Agricultural Research Centre, Islamabad. Using Agtoxin, these cultivars were subjected to fumigation following Brown (1994) for at least two weeks so as to kill any pests already present. Then all the cultivars were ground into flour by an electric grinder. After fumigation the flour of these cultivars was subjected to antixenosis, free choice and confinement tests using culture of RFB maintained in Insect Culture and Rearing Cell, Department of Entomology University of Arid Agriculture, Rawalpindi. Chakwal 86 was kept as standard/check in all the tests. The cultivars were placed in the experimental units at random using four replications, with complete randomized block design. The experimental material was kept at $28+2°C$ and $60+5$ percent R.H.

Antixenosis Test: Antixenosis test was conducted to observe the response of RFS to different varieties of wheat following Kogan (1994). Ten grams of flour of all the wheat cultivars were placed in the earthen cups of (1×4.5 cm) at equal distance from the center at random in four wooden boxes. Hundred adults of RFB collected from the culture maintained in the insect culture and rearing were released with the help of vials in the center. The boxes were immediately closed after the release to avoid the escape of RFB from them. The observations on the number of insects attracted to each cultivar were recorded 24 hours after the release of RFB so as to find out the response of this pest to the flour of different cultivars. Experiment was continued up to five days.

Confinement Test: In confinement test, 30 grams of wheat flour of all the cultivars were placed in plastic jars following Kogan (1994). Ten pairs of 10-day old adults of RFB taken from the maintained culture, were released in each jar. Pairing was done following Halstead (1963). Muslin cloth was used tightly with the help of lid rings to cover these jars for sufficient aeration and to avoid the escape of RFB.

Progeny: The insects were allowed to remain there for purpose of egg laying till they died. Observations on the progeny (adults, larvae, and pupae) were recorded at intervals of thirty days. The new adults emerged and continued there next generation. The same procedure was followed for second and third generations.

Percent weight loss: Following Khattak *et al*. (1994), the weight loss was determined after ninety days from start of confinement test using formula:

$$\text{Wt Loss (\%)} = \frac{\text{Wt of control sample-Wt of treated sample}}{\text{Wt of control sample}} \times 100$$

Free Choice Test: In free choice test, the flour of all the wheat cultivars was subjected to attack of RFB freely following Dahms (1972). Small earthen cups of size (1×4.5 cm) were used for this purpose. Ten grams of flour of all the cultivars were placed in the cups. The cups were placed at random in wooden boxes of (43×30 cm) size using four replications. The boxes were left open without any condition or restriction in the laboratory. The cultivars were examined on weekly basis so as to record the number of RFB attracted to flour of each cultivar. The method of visual observations was followed. The observations regarding number of RFB attracted to different cultivars were continued for three weeks.

Statistical Analysis: The data recorded for free choice, antixenosis, confinement (progeny, percent weight loss) were subjected to statistical analysis as complete randomized block design using MSTATC. The resistance and susceptibility of cultivars were measured by comparing the strains with a cultivar known to be susceptible following Dahms (1972). Least Significant Difference Test was applied to see the differences in means and the varieties were categorized into different levels of resistance and susceptibility following Suleman *et al*. (2000). The cultivars, which showed significantly higher infestation by RFB when compared with the standard/susceptible cultivar, were classified as highly susceptible. The cultivars which did not differ from standard in showing the infestation by RFB were classified as susceptible, while the cultivars which showed significantly less infestation by red flour beetle than the susceptible cultivar were classified as intermedialy susceptible, partially susceptible, partially resistant, intermediately resistant and highly resistant depending upon the nature of grouping of LSD test.

Results and Discussion

Antixenosis Test: According to Table 1 Bakhtawar attracted the highest number of RFB when compared with susceptible check (Chakwal 86). As far as Khyber 87, Faislabad 85, Sariab 92, Inqilab 91 were concerned when compared with Chakwal 86, these wheat cultivars attracted slightly higher number of RFB, but these were not statistically different from it. On comparing check Chakwal 86 with Pak 81 and Rawal 87 it was concluded that they attracted least number of RFB. It could also be seen that Chakwal 86 and C591 were not statistically different from each other (Table 1).
According to Sattigi *et al*. (1996) RFB preferred wheat flour the most among the cereals including rice, maize, sorghum flour under laboratory conditions.

Confinement Test: In confinement test, progeny of RFB on monthly basis and percent weight loss of wheat cultivars at the conclusion of the experiment were recorded.

Progeny: Table. 1 shows that a significantly higher progeny was recorded in cultivars Sariab 92 and Bakhtawar over a period of three months. Following Bakhtawar was Faislabad 85 and Khyber 87 which showed slightly higher number of RFB on comparing with susceptible check Chakwal 86. The cultivars Ingilab 91, 0591, Faislabad 85, Rawal 87 were found to be statistically not much different from Chakwal 88, where as lowest progeny trend was found in Pak 81.
In the first month, the number of RFB was maximum in Bakhtawar and Sariab 92. In the second and third months Sariab 92 showed higher progeny. Least progeny was recorded in Pak 81 in three months. The cumulative progeny of RFB increased in second and third months. Higher level of infestation was recorded at optimum conditions by Khokhar and Gupta (1974). Saxena and Sarin (1978) also showed variations in the progeny of confined adults of RFB. Khokhar and Gupta (1974) assessed the susceptibility of ten wheat cultivar to RFB on the basis of mean progeny under laboratory conditions and reported varietal variability.

Table 1: Number of red flour beetles attracted to different wheat cultivars under antixenosis, confinement, free choice tests and % weight loss of the cultivars flour under confinement test

Cultivars	Antixenosis test	Confinement test Test (Progeny)	% Weight Loss	Free choice test
Bakhtawar	15.90a	291.3a	11.58a	15.67ab
Khyber 87	12.75b	199.3b	8.925b	8.667c
Faisalabad 85	11.55b	200.6b	9.035b	8.500c
Sariab 92	11.25b	303.3a	13.05a	17.67a
Inqilab 91	10.75b	199.0bc	9.137b	8.583c
Chakwal 86	10.40bc	195.3bc	8.962b	13.25b
C591	8.0500	185.7bc	8.289bc	6.583cd
Pak 81	3.600d	148.3c	3.080d	3.833d
Rawal 87	3.00d	170.2bc	6.528c	7.083cd

Mean followed by same letters are not significantly different from one another based on alpha = 0.05

Table 2: Categories of different wheat cultivars on the basis of free choice, antixenosis and confine ment tests

Category	Wheat Cultivars
Highly susceptible	Sariab 92, Bakhtawar
Susceptible	Faisalabad 85, Inqilab 91, Khyber 87, Chakwal 86
Susceptible to partially resistance	C591
Partially resistant	Pak 81, Rawal 87

Percent weight loss: The results of the mean weight loss of cultivars showed that higher weight loss of 13.05 percent was recorded in Sariab 92 followed by Bakhtawar having weight loss 11.58% on comparing with susceptible check. Pak 81 showed lower weight loss of 3.08% whereas the cultivars Ingilab 91, Faislabad 85, C591 were not statistically different from Chakwal 86 (Table 1). The difference was nonsignificant between C591 and Rawal 87. Alamzeb and Khattak (1986) reported that% weight loss caused by *Tribolium castaneum* in wheat: maize flour combination varied from 8.923.7 percent. Similarly Khattak and Shafique (1986) studied losses in wheat flour cultivars ranging from 3.6-14.9%. Khattak *et al*. (1994) evaluated ten wheat cultivars flour against RFB in laboratory conditions on the basis of % weight loss and found significant variations.

Free choice test: Sariab 92 and Bakhtawar when compared with susceptible check Chakwal 86, attracted the highest number of RFB (Table 1). Khyber 87,Ingilab 91, Rawal 87, and C591 attracted intermediate number of RFB.Similarly cultivars Rawal 87 and C591 were not statistically different from each other. Pak 81 attracted the lowest number of RFB. Oosthuizen (1945) reported that RFB preferred the finer milling products of wheat. Saxena and Sarin (1978) found that number of RFB varied in different wheat cultivars and there was some food preference. Week wise comparison of nine wheat cultivars showed that Sariab 92 attracted the highest number of RFB and least population trend was found in Pak 81 throughout the duration. Suleman *et al*. (2000) found variability in different wheat cultivars against *Sitophilus oryzae* under free choice test.

Comparison of Resistance of Different Wheat Cultivars on the Basis of Free Choice, Confinement and Antixenosis Tests: When the results of all the tests were compared keeping Chakwal 86, Pak 81 proved to be partially resistant under all the three (confinement, free choice, and antixenosis) tests. Whereas wheat cultivar Bakhtawar was found to be highly susceptible in antixenosis, progeny, percent weight loss and free choice test. Sariab 92 turned out to be highly susceptible in progeny, percent weight loss and free choice, when compared with susceptible Chakwal 86. In antixenosis test it was found to be susceptible. Inqilab 91, Khyber 87, Faislabad 85 turned out to statistically not much different from Chakwal 86 in antixenosis, progeny and weight loss test. In free choice test, they were significantly different from Chakwal 86 and found to be partially resistant. Wheat cultivar C591 emerged as susceptible in progeny, percent weight loss test and partially resistant in free choice and antixenosis test when compared with Chakwal 86. Rawal 87 was found to be susceptible in progeny test while under antixenosis, % weight loss and free choice it was found to be partially resistant. Over all conclusion drawn from three tests are shown in Table 2. Girish *et al*. (1976) reported differences in susceptibility to damage in different wheat varieties against RFB. Nehra *et al*. (1985) screened 13 wheat flour varieties to RFB and reported them as resistant, highly susceptible and intermediate. Khattak *et al*. (1994) evaluated ten wheat cultivars against RFB and found some wheat varieties as most resistant and some as highly susceptible.

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