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Reaction of Certain Wheat Varieties to the Action of Red Flour Beetle, *Tribolium castaneum* (Herbst) (Coleoptera) Under Insectary Conditions

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Abstract.- Flour beetle, *Tribolium castaneum* (Herbst) is the foremost limiting factor for profitable storage of wheat in many geographical regions of Pakistan. At this instantaneous, the performance of the 10 wheat varieties was tested for their resistance to red flour beetle under laboratory circumstances. This study had the objective to determine the extent of variations for resistance in local and regional wheat varieties to this nefarious biotic constraint. Three diagnostic techniques such as percentage infestation, frass weight and total number of adults emerged were to be assessed lucratively for the detection of varietals resistance. Scrutiny revealed that out of all tested varieties; only Marvi-2000 was significantly segregated as relatively tolerant with a good level of presentation to be included in future breeding programme. Pest population was typically higher in G.A-2002 that was statically susceptible variety than the tolerant ones and others, and found to be a sensitive indicator. Entomologists and plant breeders should place more emphasis to exploit Marvi-2000 as host grain resistance to insects for their management purposes.

Key words: Red flour beetle, *Tribolium castaneum,* Wheat, insect resistance, *Triticum.*

INTRODUCTION

The most important food crops that are the chief source of carbohydrates are cereals, which supply more than two-third of edible dry matter of world's food and more than half of protein need. Wheat *Triticum aestivum* L. (Family: Gramineae) and other cereals provide a nutritious food containing the important elements for an adequate diet. Wheat crop possesses great genetic diversity and is grown across varied agro-ecological zones. This cereal is subjected to injury from the time it matures in the field until actually consumed by man. Mishandling during storage, poor storage structures and other physical factors are also responsible for losses. During storage wheat grains are attacked by more or less than 23 insects species in Pakistan, and out of these, 10 species are known to be very serious. Attacked grains have contamination from feces, living and dead insects, egg shells, pupal cases, cocoons, noxious odors and webbing. Estimates of losses of stored grains caused by insect pests range from 5-10% of the world production. In some tropical countries these losses are as high as

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30% (Lohar, 2001). The principal stored grain pest of wheat is red flour beetle *Tribolium castaneum* (Herbst) that is a cosmopolitan and most serious pest. It also feeds upon dry fruits, pulses and prepared cereal foods such as cornflakes. Both the larva and the adult cause damage to stored grains (Hamed and Khattak, 1985). EI-Mofty *et al.* (1989) showed that beetle secretes certain kind of liquid in the flour, which spoils it and has also been reported to be carcinogenic, producing cancerous growth. Due to severity of the damage by this insect, its pest status cannot be over looked.

Lohar (1997) conducted the laboratory experiment on different varieties of stored grains, for feeding *T. castaneum.* None of the cereal variety was immune to insect infestation. The percent weight losses and the mean progeny produced were significantly higher in wheat than other cereals. Fogliazza and Pagani (2003) carried out studies with stored product pests including *Tribolium* spp., the results showed that insects infesting kernels, negatively affected the rheological properties more than other flour pests. Both kernel and flour pests showed negative effects on baking quality. Wakil *et al.* (2003) conducted studies to compare the

nutritional losses of wheat attacked by *T. castaneum.* A positive correlation was observed among damaged wheat, and protein and fat contents, whereas, negative correlation was found in carbohydrate contents and insect damage. Kumawat (2007) surveyed *T. castaneum* among major insect pests infesting stored wheat.

Control of insects by the use of insecticides has always appealed to agriculturists. Chemicals are quite harmful to the environment, human beings and animals. The availability of many effective synthetic insecticides has made it possible for farmers to control most insects of agricultural importance. At the same time, however, the extensive use of the insecticides, most of which have broad-spectrum activity, has created many complex environmental problems. Residues of the chemicals in or on agricultural products pose potential hazards to people and animals. Due to environmental pollution and hazards of these chemicals, it is essential to explore controlling means other than chemicals. Studies have shown that these methods can play an important role in the reduction of pest populations. Keeping in view the importance of the problem, the present studies were therefore, undertaken as an attempt to find out the inherent resistance in wheat genotypes against red flour beetle, which could be utilize in developing wheat varieties resistant against this pest in expectations. It is thought that this venture will be a good choice because stored grain insects and methods to exterminate them is becoming a big issue today. This method will verify a more cost effective and secure way of controlling pests in stored grains.

MATERIALS AND METHODS

The offered line of investigation on the population development of red flour beetle *Tribolium castaneum* (Herbst) on wheat grains was accomplished in the laboratory at the Department of Entomology, Sindh Agriculture University, Tandojam, from 20 August 2004 to 20 January 2005. A total of 10 varieties of wheat samples were used to study their resistance against Red flour beetle. The varieties used were: G.A-2002, Bakhtawar, M.H-97, Iqbal-2000, Soghat-90, Chakwal-86, Uqab-2000, A.S-2003, SD-66 and Marvi-2000 collected from Plant Genetic resources, Tandojam. Grains of every single one variety were mechanically prepared dust and straw free, and afterward the healthy and in good physical shape grains were selected. All treatments were replicated three times. Experiment was conducted in the laboratory at 29±2°C and 65±5% R. H. The standard weight of the samples of each variety used in the experiment was fifty (50) gram, kept in plastic jars (15 x 6 cm). Ten pairs of just now emerged adult flour beetles (both sexes in counterpart figures) of identical age from laboratory stocked culture were released in each jar containing the grains. Red flour beetles were obtained from a laboratory colony maintained at 26±1°C, 70 to 80% R.H., and a photoperiod of 10:14 (L:D). The colony was revitalized periodically with storage collected adults to overcome adverse selection effects of laboratory rearing. The mouth of each jar was roofed with muslin scarf, made tighter with rubber band.

The experiment was started from 20-08-2004 in the morning hours and the observations were taken from 04-09-2004 and lasted up to 20-01-2005. The weights were first calculated before releasing the insects in the plastic jars that was approximately 50 grams of each variety. The observations were taken regularly from the start of experiment at the intervals of 15 days and adult beetle populations fluctuations were recorded at each interval by counting their numbers. After the termination of the experimental period, the following parameters were studied to guesstimate the relative susceptibility of wheat varieties to insect attack: (a) Percentage grain damage, (b) Frass weight, and (c) Adult population.

Data recorded was subjected to statistical analysis to check the variability among different varieties by bringing into play Duncan's Multiple Range Test at alpha= 0.050.

RESULTS AND DISCUSSION

Results obtained on the varietals assessment of different wheat varieties against the population of red flour beetle indicated that all the trialed varieties suffered significantly different losses. But their scale of susceptibility was greatly differed from minimum to maximum extent (Table I). All the tested varieties varied in their total number of grains

present in 50 gm of the sample. Least numbers of grains were counted in variety Marvi-2000, where 1136 grains were recorded. Varieties S.D-66 and AS-2003 were second and third in grain numbers having 1247 and 1355 grains per samples, respectively. The leading grain numbers were observed in Bakhtawar variety, where 2036 grains were counted in 50 gm of sample. Among other varieties, total number of grains varied from 1447 to 1974. As the different varieties exhibited variable number of grain size in each sample, naturally there existed miscellany in number of healthy grains. In this respect, the highest healthy grains 1737 and 16191 occurred in the varieties G.A-2002 and Bakhtawar, respectively, on the other hand, at the bottom was variety Marvi-2000 with 1032 grains. Number of healthy grains in other varieties varied from 1068 to 1423. For the parameter on the number of damaged grains, varieties also varied bearing 463 to 103.3 grains spoiled by flour beetle, and data was significantly different.

The results on % infestation presented in Table clearly indicated that statically least % damage was noted in Marvi-2000 showing 9.06% infestation and the prevalent recorded in case of M.H-97 showing 25.10% mean losses, hence, both these varieties behaved relatively tolerant and relatively susceptible responses, respectively. Varieties Iqbal-2000 and G.A-2002 gave moderately resistant responses as 10.44 and 12.10% damage, respectively. Most of varieties, S.D-66, Chakwal-86, AS-2003, Uqab-2000, Soghat-90 and Bakhtawar were categorized as moderately susceptible that displayed non-significant 14.18, 17.04, 17.42, 17.77, 19.84 and 20.50% infestation, correspondingly.

Frass weight followed almost similar pattern as was observed in case of % infestation levels. Statistically, significantly maximum frass material was recorded in variety M.H-97 with 0.8133 gm followed by Bakhtawar (0.6940) and Soghat-90 (0.6583). The smallest amount of frass material was found in variety Marvi2000 having 0.4073 gm output tracked by Iqbal-2000 with 0.4310 gm weight attained. These observations recorded clearly proved that Marvi-2000 and M.H-97 behaved most tolerance and susceptibility behavior, correspondingly surrounded by all the varieties tested. The entire left behind varieties showed that frass weight was in the order starting 0.4570 in the direction of 0.5490 gm. Depending upon the varietals behaviors all the trialed varieties significantly differed in their ability to harbour the total number of adult red flour beetle. The peak population build up was recorded in variety M.H-97 that harboured 82.67 adults, while, Bakhtawar and Soghat-90 were graded at second and third position harbouring 75.33 and 69.33 insects, in that order. The lowest population emergence were counted in Marvi-2000 holding 39.33 adults, which was approached by Iqbal-2000 and G.A-2002 varieties where 41.67 and 50.33 adults were counted, respectively. All the left behind varieties showed 56.33 toward 65.00 level of adult emergence. Pedestal upon this parameter, it is transparent that variety Marvi-2000 was resistant, whereas, M.H-97 was susceptible in sharing the adult population and percent infestation in that order.

Presented study is in accordance to the finding of previous workers where it was concluded that each wheat variety or genetic line behaved differently to the stored grain insect pests (White and Loschiavo, 1988). In progress results on % infestation precised that the % damage was distinguished from 9.060% to 25.10% infestation. This study is in harmony to the findings of Ahmad (1980) where the losses of stored wheat grain during storage were estimated to be about 10-15%. Whereas, Banerjee and Nazimuddin (1985) concluded that the maximum weight loss caused to single kernel by individual larvae was 19 to 16% for wheat. The figures for adults were 16.2 to 8.8% for wheat grain. Simultaneous feeding by the adult's species caused a maximum weight loss of 26.2% on wheat. What's more, at present maximum frass material was recorded range beginning 0.4073 gm toward 0.8133 gm. Nevertheless, Bekon and Fleurat (1992) assessed dry matter loss and frass production in 200 gm wheat samples by *T. castaneum.* The average frass production for *T. castaneum* varied from 27 to 44 mg per pair. Irshad and Talpur (1993) investigated 2.25% loss in the weight of the wheat grains. Bandyopadhyay and Ghosh (1999) investigated the loss of stored wheat ranging from 4.3 to 25.5% damage. Syed *et al.* (2001) studied the relative susceptibility of commercial wheat cultivars

to *T. castaneum.* On the basis of percent weight loss and population build up, it was found that cultivars were categorized as the most susceptible and the least susceptible. The correlation of weight loss with population increase and moisture contents was highly positive. Sharma (2002) studied the response of sixty wheat genotypes (*Triticum aestivum* and *Triticum durum*) on the growth and development of three major stored grain insect pests. The extent of damage caused by all three insect species was significantly different and the genotypes differed significantly in their susceptibility to the same insect. Various studies concerning relative resistance of wheat undertaken in Pakistan were by Khattak and Shafique (1986), Khan and Khattak (1988), Ali *et al.* (1989), Irshad *et al.* (1991), Abro (1996), Ahmad *et al.* (1998) and Sartaj *et al.* (2001). These researchers concluded that each wheat variety or genetic line acted differently when aligned with red flour beetle.

Table I.- Multiple comparisons of different parameters due to infestation by red flour beetle on different wheat varieties.

Sr.No.	Varieties	Total number of grains	No. of healthy grains	No. of damaged grains	Percent infestation	Frass weight	Adult population
1	M.H-97	1886 a	1423 b	463.0 a	25.10 a	0.8133 a	82.67 a
2	Bakhtawar	2036 a	1619 a	417.0 ab	20.50 ab	0.6940 b	75.33 ab
3	Soghat-90	1552 bc	1245 bcde	307.7 abc	19.84 abc	0.6583 b	69.33 abc
4	AS-2003	1355 cde	1118 de	237.3 bc	17.42 abc	0.5473 c	65.00 abc
5	Marvi-2000	1136 e	1 032 e	103.3 c	9.060 c	0.4073 e	39.33 d
6	Uqab-2000	1447 bcd	1190 cde	257.3 bc	17.77 abc	0.5490 c	65.67 abc
7	S.D-66	1247 de	1 068 de	178.3 c	14. 18 bc	0.5007 d	56.33 bcd
8	Iqbal-2000	1520 b	1361 bc	158.7 c	10.44 bc	0.4310 e	41.67 d
9	Chakwal-86	1527 bc	1265 bcd	262.7 bc	17.04 abc	0.5050 d	64.00 abc
10	G.A-2002	1974 a	1737 a	237.0 bc	12.10 bc	0.4570 de	50.33 cd
LSD Value		238.1	195.9	184.3	9.475	0.0767	18.53

Current study showed that probably resistance could not be attributed due to size of grain. The varieties having smaller or larger size of grains harboured least or highest numbers of insect towards their selves. It was evident that all the varieties of wheat could not express their resistance to flour beetles injury under laboratory conditions. The significant differences observed among the wheat varieties for different parameters are corroborate with the practical finding of Simwat and Chahal (1982) where the extent of damage in different wheat varieties have been reported to differ very much and some of wheat varieties have been reported resistant to *T. castaneum.* Warchalewski and Nawrot (1993) studied the population parameters of *Tribolium,* feeding on nine wheat varieties whose physicochemical properties were analyzed. Some properties such as kernel hardness, falling number, non-protein nitrogen content and protein quality (rather than quantity) appeared to contribute towards increased wheat grain resistance as assessed from the population indices studies. Similarly, Khattak *et al.* (2000) revealed that varieties high in fat, fiber, ash and protein contents be bred to reduce the possibilities on insect attack during storage. Laszczak *et al.* (2002) determined the feeding preferences and development of the *Tribolium* on kernels of wheat cultivars. The results revealed that the development of the pest was influenced by the wheat cultivar, kernel size and kernel granulation fraction. Possibly, a combination of more than one or all the factors, play their part in making a variety resistant or susceptible to insect attack and necessarily, not one single factor. Likewise, Wakil *et al.* (2003) studied and compared the nutritional losses of wheat attacked by *Tribolium,* the results showed that a correlation was developed among insect damage, protein, fat, fiber, ash and carbohydrate contents of the grains. Randolph *et al.* (2005) conducted experiment in laboratory to categorize resistance in the wheat cultivars. This study confirmed that some cultivars containing Dn4 gene might express antibiosis and tolerance, whereas, others may not show the same categories. Thus, resistance expression is affected

by genetic background. According to Sayed *et al.* (2006), the moisture content played a significant ($p<0.01$) role in population growth, percent weight loss and percent grain damage. The relation between the characteristics of the grains of wheat genotypes and the level of infestation of grains by *T. castaneum* may be due to the hardness of the grain. This corroborates the findings of Singh *et al.* (2008), indicating that increased hardness resulted in reduced growth and development of pest.

On the basis of results achieved, it was possible to categorize test varieties into 4 assemblages, relatively resistant (Marvi-2000), moderately resistant (lqbal-2000, G.A-2002, S.D-66), moderately susceptible (Bakhtawar, Soghat-90, Uqab-2000, A.S-2003, Chakwal-86) and relatively susceptible (M.H-97). Study showed that amongst the accessible storage method, one potentially prolific approach involves the disclosure of host grain resistance to insect invasions. Use of resistant genetic stock can be the most effective measure to minimize the damage, provided that proper management practices are followed. Our current studies specified that among different wheat varieties trialed, 'M.H-97' was found significantly susceptible to the invasion of red flour beetle. In the light of such conclusions, prolonged storage of such most sensitive variety should be discouraged. Whenever, such situation prevails then there is a dire demand to adopt adequate remedy measures against the storage insects. Through the systems of hybridization and genetic recombination, hard works are needed to enhance for evolution of insects resistance and high yielding cultivars like 'Marvi-2000'. Transfer of pest resistance traits from such resistant sources to agronomically equipped standard genotype can contribute an imperative task in the repulsion of whichever insect to grain.

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