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Evaluation of Resistance in Some Wheat Cultivars to *Tribolium castaneum* (Herbst) under Laboratory Conditions

[1]Nazish Bostan and [2]Muhammad Naeem
[1]Department of Zoology, [2]Department of Entomology, University of Arid Agriculture, Rawalpindi, Pakistan

Abstract: Two tests i.e., confinement and antixenosis were performed to evaluate the six wheat cultivars (MH-97, Sariab-92, Rawal-87, Margala-99, Chakwal-86 and Chakwal-97) against *Tribolium Castaneum*, during March-June 2001, using Randomized Complete Block Design. Data were collected daily for antixenosis test and by an interval of one week for confinement test. After applying statistical results, it was found that for antixenosis test all verities have shown highly significant results. For confinement test, it was found that Chakwal-97 was the most susceptible and Rawal-87 was most resistant. The result showed that there was variability in different wheat cultivars resistance and none of them found to be totally resistant. Although complete resistance was not possible, but some of wheat varieties could be used with specific genetic traits to develop resistant characters. These results also showed that the susceptible variety is most preferable by the pest, so it can be used as a quick and mass laboratory culture of RFB, which may be used in other scientific experiments.

Key words: Resistance, *Tribolium castaneum*, wheat cultivars flour, antixenosis test, confinement test

Introduction

Wheat (*Triticum aestivum)* is the most widely cultivated of all cereals. It is principal food of man, in most areas of the world. It is grown in all temperature countries, and in the most of subtropical countries of the world. In Pakistan it is the basic dietary requirement. It provides proteins and calories of 50 and 60%, respectively (Wittwer, 1980). Wheat is the major cereal crop occupying on eminent place in economy of our country (Chowdhry *et al.*, 1998). Wheat constitutes about 80% of total dietary intake (Baloch and Irshad, 1986). The estimated production of wheat was 18, 054.5 thousands tons, which shows a decline of 3.4% (Gop, 1998-99). In our country almost all the agricultural commodities including cereals are stored in godowns /stores on large and small scale, because storage of food grains is inevitable both in time, deficit and surplus production (Lal, 1996).

Different insect pests attack different commodities and cause heavy economic losses. Every year about 25 - 30% crop yields are damaged in the crop fields and stores by different insects, pests(Lal and Srivastava ,1996). According to Singh *et al.* (1997), in stores /godowns the grains are damaged by several biotic and abiotic processes. In biotic factors the insect pests are major agents which cause great loss in terms of quality and quantity of food grains. Grain storage loss is a serious problem confronting the world today. In Pakistan different storage loss ranging from 1.4, 5 and 10-15% at farm level wheat storage have been reported (Ahmed *et al.*, 1976; Ahmed, 1983; Jilani, 1981). About 10-15% wheat is lost annually due to ravages of stored grain pests during storage (Department of Plant Protection, 1986).

Red flour beetle(*Tribolium castaneum*) is the major secondary store grain pest(Hameed and Khattak, 1985). Under optimum conditions a single pair of red flour beetle (RFB) can multiply its progeny to one million in 150 days (Gray, 1948 and Barnardo, 1972). Below 10 degree centigrade *Tribolium castaneum* does not survive (Gray, 1948). During storage *Tribolium castaneum* nibbles away the grain points of wheat and other cereals, rendering them unfit for germination, also it mixes up its excreta, creating an offensive smell in products, thus reducing their nutritive value (Anisa, 1971). Growing those crop varieties which are resistant to insect pests is one of the primary methods of avoiding/reducing losses which they cause (Bhatia, 1976). Resistant cultivars provide cornerstone for successful pest. management system. Resistant varieties are the essential components in the management of any pest. Use of resistant varieties and development has great impact of agricultural production at world level (Bhatti and Parathi, 1998). Attack of stored wheat by insect pests is at various levels depending upon their susceptibility (Irshad and Gillani, 1988). Suleman *et al.* (2000) stated wheat cultivars to be partially resistant, highly susceptible and susceptible. Wheat verities behave differently to stored grain pests, resulting in the increase of research to develop grain varieties resistant to stored grain insects (Seifelnasr and Mills, 1985). For eradicating stored grain pest the safest approach is varietal resistance, but in Pakistan work done on resistance of different varieties of wheat flour to *Tribolium castaneum* is scanty and it requires more explorations (Nehra, 1985 and Khattak *et al.*, 1994). Plant breeders and entomologists should cooperate to produce resistant varieties against the insects. The cooperative efforts of breeders and entomologists are required for evolving pest resistant varieties (Chesnokov, 1962).

The main objectives of the research is to evaluate the population dynamics and resistance of *Tribolium Castaneum* against different wheat cultivars.

Materials and Methods

For assessment of resistance in some wheat cultivars to *Tribolium Castaneum* experiments were conducted at the University of Arid Agriculture, Rawalpindi during the year 2001. The six cultivars of wheat, MH-97, Sariab-92, Rawal-87, Margala-99, Chakwal-86 and Chakwal-97 were collected from National Agriculture Research Council, Islamabad. These cultivars were subjected to following tests i.e.,Antixenosis test and confinement test.

Antixenosis Test: To observe preference, non-preference of RFB antixenosis test was conducted following Kogan (1994). 30 grams of all wheat cultivars were placed at equal distances, in a wooden box containing plane white sheet, in circular fashion. The tests were conducted at random in three wooden boxes. 12 adult RFB collected from maintained culture under laboratory conditions were introduced with the help of camel hair brush. RFB were introduced in the middle of 3 boxes and boxes were immediately closed to prevent the escape of RFB. The observations were taken after 24 hours of release. The method of visual observation was followed for this purpose. Experiment was continued up-to 3 months.

Confinement Test: In this test 30 grams of all the 6 wheat cultivars were placed in plastic jars of size 11 multiplied 9.5 cm, following Dahms (1972), Miller and Miller (1986) and Kogen (1994). In each jar 10 adults of *Tribolium castaneum* were introduced taken from maintained culture with the help of camel hair brush. Muslin cloth was used with the help of lid rings in order to cover these jars for preventing the escape of RFB and for sufficient aeration.

Results

Antixenosis Test: The population of the *Tribolium Castaneum* was recorded on six wheat varieties. The daily population differed significantly on all six wheat varieties (Table 1 and Fig. 1). In case of MH-97 the population build up was significantly higher by each day. In case of Sariab-92 the statistical analysis showed significant population on daily basis. As for as the statistical results of Rawal-87 were concerned they were significantly different for the entire period of observations. On daily basis in case of Margalla-99, the population started building up by every passing day and it was highly significant. For Chakwal-86 the statistical analysis also showed significant results. Which means the daily population of *Tribolium Castaneum* differed as it grew in number over the period of 77 days. In case of Chakwal-97 the statistical data when analyzed gave significant results regarding the population fluctuations of daily basis. Fig.1 and Table 1. As for as the replications are concerned they had the following effects on wheat varieties namely MH-97, Sariab-92, Rawal-87, Margalla-99, Chakwal-86 and Chakwal-97. On the basis of statistical analysis obtained, generally all replications had a non significant effect on the population of *Tribolium castaneum*.

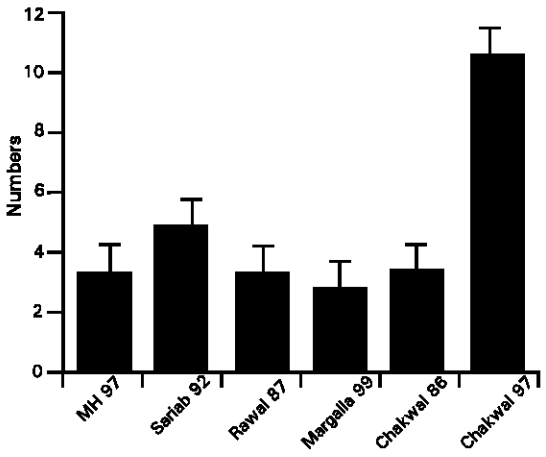

Fig.1: Number of *Tribolium castaneum* (Mean ± 1 standard error) on different varieties of wheat inantixenosis test.

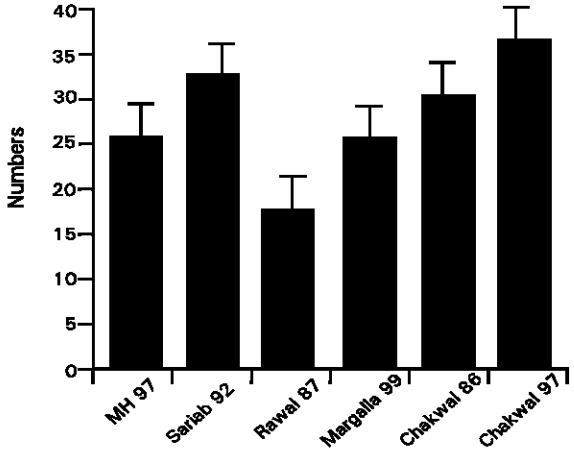

Fig. 2: Number of *Tribolium castaneum* (Mean ± 1 standard error) on different varieties of wheat in confinement test.

Table 1: Wheat 2001, Anova comparing the daily data total numbers of *Tribolium castaneum* classified by antixenosis test (N = 2808)

Varieties	S.O.V	Sum of squares	df	Mean square	F	Sig.
	Between					
MH-97	groups	2159.14	76	28.41	2.739	0.000***
	Within groups	1597.25	154	10.372		
	Total	3756.39	230			
	Between					
Sariab -92	groups	4072.461	76	53.585	4.484	0.000***
	Within groups	1840.5	154	11.951		
	Total	5912.961	230			
	Between					
Rawal -87	groups	2199.074	76	28.935	5.087	0.000***
	Within groups	876	154	5.688		
	Total	3075.074	230			
	Between					
Margalla-99	groups	1460.412	76	19.216	2.243	0.000***
	Within groups	1319.25	154	8.567		
	Total	2779.662	230			
	Between					
Chakwal - 86	groups	1856.89	76	24.433	2.961	0.000***
	Within groups	1270.833	154	8.252		
	Total	3127.723	230			
	Between					
Chakwal - 97	groups	14394.756	76	189.405	4.49	0.000***
	Within groups	6496.75	154	42.187		
	Total	20891.506	230			

***significant (P < 0.001)

Table 2: Wheat 2001, Anova comparing the weekly data total numbers of *Tribolium castaneum* classified by confinement test (N = 2808)

Varieties	S.O.V	Sum of squares	df	Mean square	F	Sig.
	Between					
MH-97	groups	4698.972	11	427.179	33.359	0.000***
	Within groups	307.333	24	12.806		
	Total	5006.306	35			
	Between					
Sariab -92	groups	11443.369	11	1040.331	5.686	0.000***
	Within groups	4391.333	24	182.972		
	Total	15834.972	35			
	Between					
Rawal -87	groups	2937	11	267	11.125	0.000***
	Within groups	576	24	24		
	Total	3513	35			
	Between					
Margalla-99B	groups	6417.417	11	583.402	8.418	0.000***
	Within groups	1663.333	24	69.306		
	Total	8080.75	35			
	Between					
Chakwal - 86	groups	11607.417	11	1055.22	1.366	0.251
	Within groups	18539.333	24	772.472		
	Total	30146.75	35			
	Between					
Chakwal - 97	groups	17265.222	11	1569.566	13.199	0.000***
	Within groups	2854	24	118.917		
	Total	20119.222	35			

*** significant at (p < 0.001)

Confinement Test: Six wheat varieties were used for the evaluation of their relative susceptibility regarding the feeding trends of *Tribolium castaneum*. A total of thirty individuals were released by random selection on each varieties. The population of the pest differed on each variety in a given week upto fifth week the population although fluctuated but was not significantly different for each variety as shown in Table 2 and Fig. 2. But in sixth week it started taking a differential trend. Chakwal-97 sustained the highest number of individuals in the successive weeks and maximum number was recorded on Chakwal-97 in twelfth week that was 206. Rawal-87 was the variety, which sustained the lowest number; maximum number that was found on Rawal-87 was 106 in the twelfth weeks. Above results show that Chakwal-97 was the most susceptible and Rawal-87 was most resistant wheat variety. Weekly data of *Tribolium castaneum* was significantly different on all the varieties except Chakwal-86. MH-97 was significantly influenced by the pest. Results regarding Sariab-92 were also significant. In case of Rawal-87 the population dynamics of the pest showed significant variation. Statistical analysis regarding the attack of the above-19 mentioned pest was significant in case of Margalla-99. Chakwal-86 was the only variety which showed non significant effect on the weekly dynamics of the pest. However, the statistical analysis showed significant effect on weekly population of pest in Chakwal-97.

These results showed that all the varieties except Chakwal-86 were significantly different in terms of pest population. Statistical analysis showed that there was no effect of the replications of all the varieties on the population dynamics of the pest. Statistical results regarding the effect of replication on MH-97 were non significant. Same were the results for Sariab-92. In case of Rawal-87, also there were non-significant results for replication effect on population. For Margalla-99 the statistical results were not significantly different for the replications. Statistical results showed no significant effect of the replications of the varietal population regarding pest in case of Chawal-86. In case of Chakwal-97 same non significant results were obtained.

Discussion

As for as the results of our antixenosis test which were based on our daily data are concerned are highly significant for all varieties of wheat namely MH-97, Sariab-92, Rawal-87, Margalla-99, Chakwal-86 and Chakwal-97. In weekly data recorded Chakwal-97 is highly susceptible and Rawal-87 is highly resistant as compared to other varieties.

Nehra *et al.* (1985) screened wheat flours of 13 different varieties to *Tribolium castaneum* and found them as highly susceptible, intermediate and resistant. Kundu and Gupta (1969) reported that there is a wide variability in wheat grains in insect pests infestation and possibilities have been opened up for incorporating resistance to storage pests in to wheat breeding programs. Dahms (1972) identified sixteen possible criteria for revolution of insect resistance in crop plants, including number of insects attracted to cultivars when given a free choice, measurements of food insects consume, visual evaluation, observation of (confinement) comparative effects of forced insect feeding, number of eggs oviposited, weighing insects after definite feeding period on different cultivars, some most important ones. Gupta (1974), Saxena and Sarin (1978) stated that there is a variation in the progeny of confined adults of RFB. Gerish *et al.* (1976) evaluated differences in susceptibility to damage in various wheat cultivars against *Tribolium castaneum*. Saxena and Sarin (1978) studied that RFB have food preferences and their number differs in different wheat cultivars. The infestation might be confirmed by the appearance of adults on the surface of grains. Main damage occurs in previously hold or broken grains or the grains damaged by other pests. Larvae and adults both cause damage. RFB is a serious secondary pest throughout the world in warmer areas, in food stores and godowns (Hill, 1983). The eggs of RFB are small, cylindrical, white and scattered in the product. The larvae are yellowish white and 6mm long in fully grown state. The larvae do the damage to the stored grains. Pupa is yellowish white, which turns brown with the passage of time. The adults are flat, oblong, rust brown and about 3-4mm long under some conditions living for an year or more. Life period from the egg stage to the adult stage is 35 days at 30 degree centigrade. In late afternoon adults fly in large number (Hill, 1983). According to Miller and Miller (1986) and Kogen (1994), is resistance usually measured through the effect of exposure of plants or plant parts to insects evaluating of yield reduction and reduction of stand. We can also measure it in terms of insects, as number of eggs oviposted, food preferences, aggregation, intake of food, utilization, rate of growth longevity, death/morality. In the mass screening of large population it is usually enough to rate plant usually on a scale of 1-5 from resistant to susceptible. The parentage weight loss caused by RFB in wheat maize flour combination varied from 6.9-23.7% (Alamzeb and Khattak, 1986) Khattak and Sjafiq (1976) studied losses in wheat flour cultivars from 3.6-14.9%. The RFB is a serious pest of stored grain of various crops even when there is low humidity (Zakladnoi and Ratanova, 1987). RFBs start eating the grain first in few cases; while in other cases it start eating the germs first. This species is resistant to high temperature and sensitive to low temperature. At 42 °C all stages of RFB die in 114 hours . At 52 °C adults die after 15 minutes, eggs after 30 minutes, larvae after 45 minutes and pupae after 3 hours. Khattak *et al.* (1994) found that varieties of wheat were significantly different on the basis of %age of weight loss under laboratory conditions. Some wheat varieties were highly resistant and some were highly susceptible.

Significantly high population is found in Chakwal-97 variety of wheat and least population is found in Rawal-87 and it might be due to the reason that the grains of Chakwal-97 are soft as compared to Rawal-87 whose grains are hard. The grains of Chakwal-97 have more moisture contents and their nutritional value is high as compared to Rawal-87, that's why it was more easily affected by *Tribolium Castaneum*. Margalla-99 is also quite resistant and this character might be due to the hardness of its grains. According to Khattak *et al.* (1996) studied the development of progeny and losses caused by *Tribolium Castaneum* to flour from ten wheat cultivars were conducted under controlled laboratory conditions. As a result S-186 emerged as significantly resistant while MW-30-6-1 was highly susceptible. The variation in the results of antixenosis test and confinement test might be due to the fact that the RFB prefers the dark environment as compared to light. antixenosis test was performed in dark while confinement test was performed in light. The results showed significant and non-significant outcomes because it might be that the temperature fluctuates during March-June and it might be that light effect the RFBs because in boxes they are in dark as compared to bottle where they are all the time in light. Sartaj (2001), stated that significantly high population is found in C-591 and this might be due to the reason that the grains of C- 591 are soft as compare to Margala-99, whose grain are hard. The grains of C-591 have more moisture contents and their nutritional value is high as compare to margala-99, that's why it was more easily affected by *Tribolium Castaneum*.

References

Ahmed, H., 1983. Losses incurred in stored food grains by Insect pests. A review. Pak. J. Agric. Res., 4: 198- 207.

Ahmed, M., H. A. Qayyum, and M. I. Azeem, 1976. Evaluation of losses in different varieties of wheat due to insect pests during storage in Lyallpur district. Proc. Seminar ECCO Pak. Fert., Co: 201-228.

Alamzeb and khattak, 1986. Influence of wheat maize flour combination on progeny development of red flour beetle *Tribolium Castaneum herbst*. Sarhad J. Agric., 2:517-521.

Anisa, B., 1971. destructive role of secondary grain pest, Proc. 23, Pakistan. Sci. Conf., 111. pp:56.

Balouch, U. K. and M. Irshad, 1986. post harvested research on food grains in Pakistan. A Review, Pakistan Agriculture Research Council, pp:45.

Barnardo, B. N., 1972. varietal resistance of corn to the rice weevil, *Sitophilus oryzae* L., Philippine. Entomol., 2: 195-203.

Bhatia, S. K., 1976. Resistance of insects in stored grains. Trop. Stor. Prod, inf., 31:21-35.

Bhatti, D. S. and I. J. Paruthi, 1998. Nematode problem of wheat, barley and their management. In Upadhyay, R. K., Mukerji, K. G., Chambola B. P. and Dubey, O. P. (eds.), Integrated pest and diseases management. APH Publishing cooperation, New Delhi, pp: 132-144.

Chesnokv, P. G., 1962. Methods of investigating plant resistance to pests. Published for NSF Washington, D.C. and Dept. Agric. by the Israel program of scientific translation Jerusalem, pp: 107.

Chowdhry, M. A., A. Maqbool, N. Mahmood,. and I. Khaliq, 1998. Performance of pure and mixed stands for bio-mass and grains yield in Hexaploid wheat. Pak. J. Biol. Sci.,1: 145-147.

Dahms, R. G., 1972. Techniques in the evaluation and development of host plant resistance. J. Environ. Quality, 1:254-259.

Department of Plant Protection, 1986. Food storage, pests, present and future activities. Karachi, Pakistan, pp: 35.

Everson, E. H. and R. L. Gallan, 1980. Breeding plants resistance to insects. John Wiley and sons. New-York, pp:683. Gray, H.E. 1948. The biology of flour beetle. Milling porc.12, pp:18-22.

Government of Pakistan, 1998-99. Economic survey of Pakistan. Finance division, Islamabad, pp: 9-11.

Girish, G. K., B. P. Tripathi, R. P. S. Tomer, and K. Krishnamurithy, 1976. Studies on assessment of losses of four conventional grain storage practices and losses in rural areas in Uttar Pradesh. Bull grain. Technol., 12: 99-210.

Hamed, M. and S. U. Khattak, 1997. Evaluation of resistance in wheat genotypes, to angiomas grain moth *Sitotroga cerealella* Oliv. The nucleus, 34: 165-168.

Hamed, M. and S. U. Khattak, 1985. Red flour beetle stuffs. Sarhad J. Agric., 1: 97-101.

Hill, D. S., 1983. Agricultural insect Pests of tropic and their control. Cambridge university press. Cambridge. London., pp: 440.

Hill, D. S., 1990. pests of stored products and their control. CBS publishers and distributors, Delhi, pp:18-101.

Irshad, M. and W. A. Gillani, 1988. Resistance of some wheat varieties to the attack of *Sitotroga cerealella* during storage. Pak. J. Ent. 3: 85-94.

Jilani, G., 1981. post harvested protection of food grains with natural insect repellents. Prog. Farm., 1: 26-29.

Khattak, S. U. K., M. M.,Khattak, N.H. Farmanullah and N. Hussain, 1994. Evaluation of ten wheat cultivars flour against *Tribolium Castaneum herbest*. Bangladesh J. Zool., 22: 217-222.

Khokhar, D. S. and D. S. Gupta, 1974.Relative resistance of some varieties of wheat to *Sitophilus oryzae* L and *Rhizopertha dominica* F at differentemperatures. Bull. Grain. Technol., 12: 117-123.

Kogan, M., 1994. plant resistance in pest management. In: Metcalf, R. L. and Luckman, W. H. (eds.), John Wiley and sons, Inc. New York. pp: 73-128.

Kundu, G. G. and M. Gupta, 1969. Resistance to stored grain pests in world collection of wheat further studies on relative resistance of some varieties of wheat to *Sitophilus oryzae* L. Indian J. Ent., 31: 333-335.

Lal, S., 1996. National activities in safe storage of grains in India. In editor Lal, O.P. Recent advances in Indian entomology. APC publications. Pvt. Ltd. New Delhi, pp: 185-192.

Lal, O. P. and Y. N. Srivastava, 1996. Host plant resistance against insect pests in India. In: Lad, O. P. (edt.), Recent advances in Indian entomology. APC publications. Pvt. Ltd. New Delhi, pp: 216-127.

Miller, J. R. and T. A. Miller, 1986. Insect plant interactions. Springer, New York.

Nehra, P., K. Sarin, and K. Sharma, 1985. Evaluation of certain parameters associated with categorization wheat varieties with regard to resistance to *Tribolium Castaneum Herbst*. Bull. Grain. Technol., 21: 211-216.

Sattigi, H. N., K.A Kulkarni, and S. Lingappa, 1996. Biology of red flour beetle *Tribolium Castaneum Herbst* on different cereal flour under laboratory conditions. Koranataka. J. Agric. Sci., 8: 86-89.

Sexana, A. K. and K. Sarin, 1978. Studied on the food preference of *Tribolium Castaneum Herbst*, to wheat varieties of Rajistan (Coleoptera: Tenebrionidae) Bull. Grain. Technol., 14: 233-234.

Seifelnasr, Y. E. and R. B. Mills, 1985. Resistance of pearl millet cultivars to *Sitophilus oryzae*, Sitotroga cerealella and *Rhyzopertha dominica*. J. Econ. Entomol., 78: 81-84.

Sartaj, A., 2001. Evaluation of resistance of wheat and maize cultivars to *Tribolium Castaneum* (herbst) and rice cultivars to sitotroga cerealella (oliver) under laboratory conditions. M.Sc. Biology. University of Arid Agriculture, Rawalpindi, Pakistan, pp: 15.

Singh, H., V. Kumar., R. Kumon and H. R. Rohilla, 1997. Neem is sustainable agriculture. Scientific publishers, Jodhpur. pp: 147-161.

Suleman, N., M. Aslam, and A. Riaz, 2000. Evaluation of resistance in some wheat cultivars to *Sitophilus oryzae* L., (Coleoptera: curculionidae) under laboratory conditions. Pak. J. Biol. Sci., 3: 1029-1032.

Tondon, J. P., 1998. Research development and management for production of wheat. In: Upadhay, R. K., Mukerji, K.G., Chambola, B.P. and Dubey, O.P. (eds.), Integrated pest and disease management. APH publishing coporation. New Delhi., pp: 32-144.

Wittwer, S. H., 1980. The shape of things to come. In: Carlson, P.S. (ed.), The biology of crop productivity. Academic press, San Francisco, pp: 414.

Zakladnoi, G. A. and V. F. Ratanova, 1987. Stored grain pests and their control. Oxonian press pvt. Ltd. New Delhi. Calcutta, pp: 49-50.