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Feeding preference and biology of *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae) in different wheat varieties

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Abstract
Experiment was conducted in Stored Grain Laboratory, Entomological Research Institute, Faisalabad during 2015-16. Under laboratory conditions, five wheat varieties viz., Pasban-90, Shafaq-06, Sehar-06, Faisalabad-08 and Lasani-08 were tested against *Tribolium castaneum* to evaluate the feeding preference and biology of *T. castaneum*. Maximum no. of eggs was observed in Sehar-06 i.e. 250.67 followed by Pasban-90, Shafaq-06, Lasani-08 and Faisalabad-08 i.e. 211, 201.67, 199 and 190.33 respectively. As for as development time was concerned maximum development time was observed in Faisalabad-08. Development time of *T. castaneum* in different wheat varieties was Faisalabad-08 (53.01 days), Lasani-08 (45.32 days), Pasban-90 (42.34 days), Shafaq-06 (37.54 days) and Sehar-06 (33.70 days). Biotic potential of *T. castaneum* in different wheat varieties were Sehar-06(0.0712), Shafaq-06(0.0614), Pasban-90(0.0549), Lasani-08 (0.0507) and Faisalabad-08(0.0430). Intrinsic rate of Increase of *T. castaneum* in different wheat varieties were Sehar-06 (0.1070), Shafaq-06(0.1032), Pasban-90(0.0989), Lasani-08 (0.08656) and Faisalabad-08(0.07952). was observed.

Keywords: *Tribolium castaneum*, wheat, feeding preference, biology

1. Introduction
Wheat, *Triticum aestivum* L. (Family: Gramineae) and other cereals give a nutritious food containing the important elements for an adequate diet [22]. Wheat crop acquires 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 [4]. Red flour beetle, *Tribolium castaneum* (Herbst) is a broad-based and serious pest of cereal grains and their products [16]. *T. castaneum* (Herbst) is the primary limiting factor for gainful storage of wheat in many geographical regions of Pakistan [4]. Adult beetle and larva feed on stored food stuffs viz. dry fruits, pulses, bran, coat, germ, grain dust and prepared cereal foods. [5, 12, 15, 8]. This insect is unable to feed on intact grains, however, it does considerable loss to grains damaged by other insects and other products [18]. In case of serious infestation, the flour turns yellowish and mouldy, has a pungent, nasty odour and becomes unfit for human use [5]. 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 [19].
The broad use of the insecticides, most of which have broad-spectrum activity, has created many diverse environmental problems. Residues of the chemicals in or on agricultural products cause potential hazards to people and animals [28] Due to environmental pollution and hazards of these chemicals, it is important to look at controlling means other than chemicals. Studies have shown that these methods can play an important role in the decrease of pest populations. The varieties of wheat show different level of infestation of *T. castaneum*. (Herbst). The infestation levels have been studied on the whole grain or flour made from these grains. Mostly these studies included whole grain. Population buildup of pest insects was index of infestation and resistance in these varieties. The infestation levels were also associated with biochemical characters of varieties [10]. The resistance of cultivars to *R. dominica* infestation might be attributed to the low content of protein and high content of carbohydrate compared to susceptible cultivars. Kernel hardness, gluten/amylose content,

larval and adult preference and emergence showed difference between resistant and susceptible cultivars [24, 20, 6, 7].

2. Material and Methods

Wheat flour of Pasban-90, Shafaq-06, Seher-06, Lasani-08 and Faisalabad-08 were tested for antixenosis (non-preference), development time, generation time, Biotic Potential and intrinsic rate of increase of red flour beetle, *T. castaneum* (Herbst.) under laboratory conditions (28±2 °C and 60±5% RH). Uniform population of *T. castaneum* were maintained in laboratory. Wheat varieties were put separately in s glass chamber and covered on top with a lid. Feeding preference of *T. castaneum* for different varieties was determined by releasing 50 beetles into the glass chamber. After 24 hours the beetles in each variety were counted and recorded. This feeding preference test was replicated three times using fresh samples of wheat varieties and adult beetles from laboratory culture each time. The beetles feeding preference was assessed on the basis of mean number of beetles attracted to various varieties. Biological parameters were found out d by releasing 20 adults of *T. castaneum* in each variety in separate plastic jars. The adult females were examined regularly at gap of twenty four hours for their oviposition. On the following day for collecting eggs, a 50 mesh sieve was used to separate the adults and eggs from the flour. Collected eggs were taken in petri dish and observed hatching of eggs. Then the newly hatched first instar grubs were carefully collected with the help of soft camel hair brush and were individually transferred in glass vials containing 3 mg of wheat flour supplied as food in each vial. Duration of each stage, grub stage and pupal period were recorded.

Formulas for

Development time= Larval Duration + Pupal Duration

$$\text{Biotic Potential} = \frac{\text{Log Fecundity}}{\text{Log Development time}}$$

$$\text{Intrinsic Rate of Increase} = \frac{\text{Log}_{ne}\, R^{o}\ (\text{Net Replacement Rate})}{\text{Generation Time}}$$

Data regarding biology of Tribolium was analysed by using state software Statistix 8.1.

3. Results and Discussion

It is evident from this study that there are variabilities among different wheat varieties tested with respect to the number of larvae, pupae and adults that emerged, feeding preference, development time, biotic potential and intrinsic rate of increase of *T. castaneum*. The results on feeding preference (antixenosis), Fecundity, no. of larvae, no. of pupae, larval duration, pupal duration, development time, generation time, biotic Potential and intrinsic rate of increase of red flour beetle, *T. castaneum* in different wheat varieties are presented in Table 1 and 2.

Results on feeding preference in wheat varieties by adult *T. castaneum* varied significantly in five different wheat varieties. The free choice antixenosis tests revealed that higher number of beetles were attracted toward Seher-06 (16.36), followed by Pasban-90 [13], Shafaq-06 [9] and Lasani-08 (8) for feeding. Feeding preference of beetles for Faisalabad-08 (3.67) was the lowest. The feeding preferences and development of the *Tribolium* on kernels of wheat cultivars revealed that the development of the pest was influenced by the wheat cultivar, kernel size and kernel granulation fraction [17]. 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.

The presented study is in accordance to the finding of previous workers where it was found that each wheat variety or genetic line behaved differently to the stored grain insect pests [15, 8, 25].

Table 1: Feeding preference and life history of *Tribolium castaneum* in different wheat varieties.

Wheat Varieties	Beetles attracted out of 50	Fecundity (eggs)	No. of larvae	No. of Pupae	Larval Duration	Pupal Duration
Pasban-90	13.33± 0.33AB	211±5.77AB	144±11.54AB	127 ±4.04A	32.67± 1.73 ABC	9.67 ±1.73A
Shafaq-06	9 ± 1.15BC	201.67 ±5.77B	128 ±6.93 BC	88 ±5.77B	29.68 ± 2.31BC	7.86 ±1.73 A
Seher-06	16.36± 1.15 A	250.67±11.54 A	167 ±8.66 A	141± 4.04 A	25.37± 2.30C	8.33 ±1.73 A
Lasani-08	8 ± 1.73BC	199 ± 11.54 B	104 ±4.62 CD	79 ±4.62B	36.75± 2.30 AB	8.57 ±1.15A
Faisalabad-08	3.67± 1.15 C	190.33 ± 5.77 B	85± 5.78 D	53±2.31 C	41.00 ±2.89A	12.01 ±2.30 A
LSD	5.55	39.87	36.71	20.04	10.88	8.24

Among all varieties, Sehar-06 was more vulnerable to oviposition as compared to other varieties as total number of eggs laid *by T. castaneum* was maximum in Sehar-06 (250.67) followed by pasban-90 (211), Shafaq-06 (201.67) and Lasani-08 (199) and lowest number of eggs were observed in Faisalabad-08 (190.33). Population counts showed more population of larvae was in Seher-06 (167) significantly greater than in other varieties. It was followed by Pasban-90 (144), Shafaq-06 (128) and Lasani-08 (104) in descending order. The development time of *T. castaneum* was rapid in Sehar-06 (33.70 days) followed by shafaq-06 (37.54 days), Pasban-90 (42.34 days) and lasani-08 (45.32 days). The peak population builds up recorded in variety Sehar-06, while pasban-90 and Shafaq-06 were graded at second and third position. The lowest population emergence was counted in variety Faisalabad-08. For a better approach of pest control, this study revealed that all the stored wheat grain of different varieties exhibited the phenomenon of preference/ non-preference to T. castaneum. This phenomenon is due in the structure and composition of wheat such as, starches, carbohydrates, and enzymes [9]; and proteins [11]. Some physical and biochemical properties of the cultivars have been assessed by researchers to determine their respective level of resistance to the stored grain insects. The resistance of these cultivars to grain insect's infestation might be attributed to the low content of protein and high content of carbohydrate compared to susceptible cultivars. Kernel hardness, gluten/ amylose content, larval and adult preference and emergence showed difference between resistant and susceptible cultivars [24, 20].

Development time was delayed in Faisalabad-08 (53.01 days) as compared to other varieties as biotic potential and intrinsic rate of increase of *T. castaneum* varied in different varieties as highest in Sehar-06 i.e. 0.0712 and 0.1070 respectively as compared to that in other varieties.

Table 2: Development time, biotech potential and intrinsic rate of increase of *T. castaneum* in different wheat varieties.

Wheat Varieties	Development time (Days)	Biotech potential	Intrinsic rate of increase
Pasban-90	42.34 AB	0.0549 BC	0.0989 A
Shafaq-06	37.54 AB	0.0614 AB	0.1032 A
Seher-06	33.70 B	0.0712 A	0.1070 A
Lasani-08	45.32 AB	0.0507 BC	0.08656 B
Faisalabad-08	53.01 A	0.0430 C	0.07952 B
LSD	17.622	0.0120	0.0121

Presented study is in harmony to the finding of previous workers where it was concluded that each wheat variety act in a different way to the stored grain insect pests [27]. The response of sixty wheat genotypes (*Triticum aestivum* and *Triticum durum*) on the growth and development of three major stored grain insect pests studied by [26]. 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 [15, 1, 2, 3, 13, 14, 23]. These researchers concluded that each wheat variety or genetic line acted differently when aligned with red flour beetle.

4. Conclusion

On the basis of results, it was concluded 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 susceptible variety is highly preferable, so it can be used as a quick and mass laboratory culture of *T. Castaneum*, which may be needed in other scientific experiments.

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