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Feeding Preference and Development of *Tribolium castaneum* (Herbst.) in Wheat Products

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Abstract.- Studies on free choice feeding preference of *Tribolium castaneum* beetle and larval development in wheat products were conducted under laboratory conditions (28±2°C and 60±5% RH). The results revealed that significantly higher number of beetles preferred flour grade-2 (30.00) followed by flour grade-1 (15.14), maida (9.71) and bran (9.43) for feeding. Feeding preference of beetle was the lowest for dry and tempered wheat. (2.14 and 2.43 respectively). After release, the neonate larvae developed rapidly in all treatments. However, all 50 larvae took 24 days to become imago in flour grade 1, 2 and bran; 25 days in maida and fine and 28 days in suji. The larval development was delayed in wheat grains and only 23.33 and 37.00 larvae matured to adult stage in dry and tempered wheat respectively in a period of 70 days. The developing larvae caused the highest weight loss to flour grade-l (3.41%) and the lowest to dry wheat (0.41%). The correlations (r) between different parameters of *T. castaneum* and wheat products were positive and significant. Factors affecting storage losses in wheat products are discussed.

Key words: Antixenosis, red flour beetle, development, wheat products.

INTRODUCTION

Wheat is the most important staple food in Pakistan. It is stored and consumed as flour, suji, maida and grains. During storage wheat grain and its products are vulnerable to various insect pests. It is estimated that 5-10% of world's grain production is lost due to ravages of insects. These losses reach to 50% in tropical countries where temperature and humidity run high during summer season (Maqsood *et al*., 1988; Adams, 1998; Ahmad and Ahmad, 2002). Red flour beetle, *Tribolium castaneum* (Herbst) is a cosmopolitan and serious pest of cereal grains and their products. Adult beetle and larva feed on stored food stuffs *viz.* dry fruits, pulses, bran, coat, germ, grain dust and prepared cereal foods. (Atwal, 1976; Hamed and Khattak, 1985; Khattak *et al*., 1999; Dars *et al.,* 2001). This insect is unable to feed on intact grains, however, it does considerable loss to grains damaged by other insects and flour and other products (Li and Arbogast, 1991). In case of serious infestation, the flour turns yellowish and mouldy, has a pungent, disagreeable odour and becomes unfit for human consumption (Atwal, 1976). Wheat products including maida. fine and suji are part of endosperm, but have different particle size with minimum bran (around 0.05%). Flour grade 1 and 2 contain 5 and 10 per cent bran respectively. In tempered wheat moisture is raised upto 14.5 per cent, however, milling process reduces the moisture to 13.5 per cent in all milled products (unpublished information from Usman Flour Mills, Faisalabad) The response of wheat and its products vary for infestation to storage insects. Therefore, studies on feeding/hiding preference of *T. castaneum,* larval development and weight loss caused in wheat and its products were conducted under controlled laboratory conditions.

MATERIAL AND METHODS

The studies were conducted at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad during 2003. Wheat grains of Inqlab-91 (dry and tempered) and its products (bran, suji, fine, maida, flour grade 1 and 2) supplied by Usman Flour Mills, Faisalabad were tested for antixenosis (non-preference), development of red flour beetle, *Tribolium castaneum* (Herbst.) and weight loss caused by the insect larvae to various products under laboratory conditions (28±2°C and 60±5% RH). The samples were preconditioned at 5°C for two weeks. The moisture content of wheat products was determined at pre-treatment following standard AACC (1980) method.

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Table I: Beetles preference for feeding adult progeny development from *Tribolium castaneum* (Herbst) larvae and weight loss in wheat products.

Wheat products	Beetles attracted out of 80 beetles	Adult progeny developed out of 50 larvae	Weight loss (%)	Moisture content (%)
Dry wheat	2.14 d	23.33 c	0.40 e	8.82 f
Tempered wheat	2.43 d	37.00 b	2.00 d	11.74 d
Bran	9.43 c	50.00 a	3.18 b	11.50 d
Suji	5.43 cd	50.00 a	2.84 c	12.52 b
Fine	5.71 cd	50.00 a	2.88 c	12.38 bc
Maida	9.71 c	50.00 a	3.14 b	12.15 c
Flour grade-1	15.14 b	50.00 a	3.10 b	12.90 a
Flour grade-2	30.00 a	50.00 a	3.10 b	13.05 a

Values sharing similar letters in each column do not differ significantly at 5% level according to DMR test.

Antixenosis tests

Wheat and its products (10g each), on glazed papers, were put separately in octagonal perspex chamber and covered on top with a lid. Feeding preference of *T. castaneum* for different products was determined by releasing newly emerged 80 beetles into the chamber from top hole with the help of glass funnel. The chamber was also covered with black cloth and the test insects were allowed to settle in various products. After 24 hours the beetles in each product were counted and recorded. This feeding preference experiment was replicated seven times using fresh samples of wheat products 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 products.

Larval development

Fresh samples of wheat grains and its products (10 g each) were kept in 150 g capacity glass jars. Fifty neonate *T. castaneum* larvae from laboratory reared culture were released in each jar and covered on top with finely perforated lid. The experiment was replicated 3 times along with an untreated control. The larvae were allowed to feed and develop in different products. Soon after adult emergence, beetles were recorded twice a week in various products. Per cent grain weight loss in infested samples was determined using control samples.

The data on beetles feeding preference to wheat and its products, larval development to adult stage, sample weight loss due to larval feeding and moisture content were subjected to analysis of variance and means were compared using Duncan's multiple range test at 5% level of significance. Correlations (r) between various parameters of *T. castaneum* and wheat products were computed. (Steel and Torrie, 1980). Data on number of *T. castaneum* adults developed in various products over 70 days period were also presented graphically.

RESULTS

The results on feeding preference of red flour beetle (*Tribolium castaneum* Herbst.) to wheat grain and its products, larval development, percent weight loss and moisture content (Table I) varied significantly ($P \leq 0.05$). The free choice antixenosis tests revealed that significantly higher number of beetles attracted toward flour grade 2 (30.00) followed by flour grade 1 (15.14), maida (9.71) and bran (9.43) for feeding. Feeding preference of beetles for dry wheat (2.14) was the lowest followed by tempered wheat (2.43), fine (5.71) and suji (5.43). The development of *T. castaneum* neonate larvae to adult beetles was rapid and all 50 larvae took 24 days to become imago in flour grade 1, 2 and bran; 25 days in fine and maida and 28 days in suji. However, larval development was delayed in wheat grain and only 23.33 and 37.00 larvae reached adult stage in dry and tempered wheat respectively in a period of 70 days (Fig. 1). The percent weight loss caused by feeding of *T. castaneum* larvae was maximum in flour grade 1 (3.41), followed by bran (3.18), maida (3.14), flour grade 2 (3.10), fine (2.88) and suji (2.84). The larvae

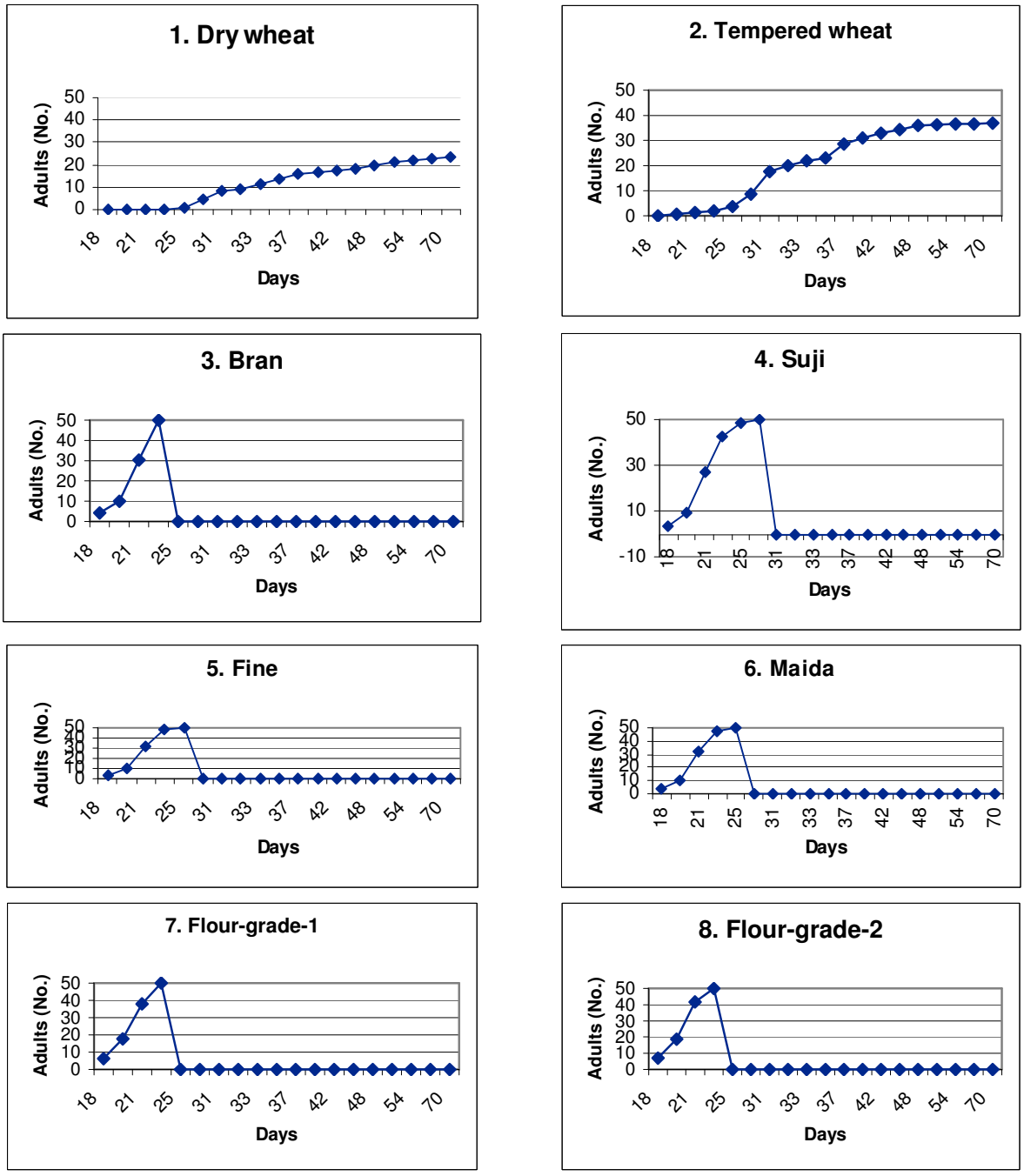

Fig. 1. Number of *Tribolium castaneum* adults developed in different wheat products.

inflicted the lowest weight loss to dry wheat (0.40) followed by tempered wheat (2.00%) The correlations (r) between adult progeny developed and grain weight loss (0.981); adult progeny developed and moisture content of wheat products (0.897); and grain weight loss and moisture content (0.906) were positive and significant (Table II).

Table II.- Correlation (r) between different parameters of *Tribolium castaneum* and wheat products.

Parameters	Grain weight loss (%)	Moisture content (%)
Adult progeny developed	0.981**	0.897**
Grain weight loss	-	0.906**

**Significant at 1% level.

DISCUSSION

This study shows that preference of red flour beetle, *T. castaneum* for feeding varied in wheat and its products. Khattak *et al.* (1986) found that reproductive potential and adult eclosion of *T. castaneum* was significantly high in whole wheat flour with 5 percent yeast followed by 10, 15, 2 and 1% yeast and whole wheat flour alone. Dars *et al.* (2001) reported that wheat variety TJ-83 harboured the highest population in storage (243.02 beetles/ fortnight) followed by Pavon (214.30 beetles/ fortnight) and IqbaI-91 (158.27 beetles/ fortnight). Similarly adult progeny developed and weight loss of flour of 10 different wheat cultivars varied significantly (Khattak and Shafique, 1986). In our study, number of *Tribolium* larvae developed to adult stage was 23.33 to 50 and development period was 24 to 70 days causing weight loss of 0.40 to 3.41% in various wheat products. The adult progeny development was rapid, high in number (50) inflicting higher weight loss in preferred wheat products. Among the products flour grade 1, 2, bran and maida emerged as the most preferred food while dry and tempered wheat was liked the lowest by the beetle. The physico-chemical nature of food has positive impact on minimum development period of insect pest and extent of losses of food products (Hamed and Khattak, 1985; Khattak *et al.,* 1999). Development, survival and population increase of *T. castaneum* depends on food content, temperature of the environment and moisture. Lhaloni *et a1*. (1988) reported that the reproduction of *T. castaneum* increased with increasing temperature (20 - 30°C) and moisture content (10 - 16%); to peak at 27°C and 16% moisture.

In our studies development rate and survival of *T. castaneum* was significantly higher in wheat flour followed by bran, fine, maida, suji, tempered wheat and dry wheat. It indicates that an intact grain showed better storage than ground grain against this insect. Li and Arbogast (1991) reported that fecundity, development, survival, and population increase of *T. castaneum* was significantly higher in maize flour followed by cracked grain, commercial maize and undamaged maize. Furthermore, survival of young larvae was low and development was delayed in undamaged grain. The positive and significant correlations (r) between different parameters of *T. castaneum* and wheat products manifest that high and rapid population development of beetles inflicted high weight loss of more preferred wheat products having high moisture content. These results are in close conformity to findings of previous workers (Hamed and Khattak 1985; Lhaloni *et al*., 1988; Khattak *et al*., 1999; Shafique and Ahmad, 2003).

CONCLUSIONS

It is inferred from the results that intact wheat grain with low moisture content reduces *T. castaneum* population. Therefore, undamaged and dry grains of insect resistant wheat varieties should be preferred for prolonged post-harvest storage to minimize losses by this insect pest. Wheat flour and other products are prone to *T. castanum* damage, should be consumed afresh and their prolonged storage should be discouraged. Furthermore, insect proof packages need to be developed to check insect infestation and product losses.

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