



## Quantitative losses in some advanced genotypes of barley incurred by *Tribolium castaneum* L. (Herbst.)

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### Abstract

The present study was performed to estimate the quantitative losses in different barley varieties against *Tribolium castaneum* (Herbst) which is commonly known as red flour beetle. Quantitative parameters like damaged grain percentage, frass weight (broken grains debris and insect exuviae), number of adult emergence and percentage weight loss were determined at three different incubation temperatures i.e., 28°C, 32°C and 35°C. Data was compiled through Factorial under Completely Randomized Design (CRD). Results revealed that maximum damaged grains percentage and frass weight production with maximum number of adult emergence occurred in Jou-87 at 32°C, while minimum in the B-09006 at 35°C and 28°C. Maximum percentage weight loss was recorded in susceptible variety Jou-87 and minimum percentage weight loss in resistant variety B-09006 while Jou-83, H-93 and B-09008 showed nearly same response. Present study suggested that barley variety, B-09006 showed comparatively resistance against red flour beetle during storage conditions and should be considered by indigenous barley growers.

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## Introduction

Barley (*Hordeum vulgare* L.) is fourth cereal grown crop considered as top ten crop plants in the world. It is originated in Ethiopia and South Asia while it is domesticated in Nile River Valley of Egypt about 17,000 years ago (Reddy, 2006). Barley is being used as model crop for many disciplines like virology, pathology and genetics (Reddy, 2006).

Barley crop has achieved distinction of being the first grain crop to be cultivated. It is also very important because used as food stuff by mankind. Protein contents are very rich in barley that varies from 7.5 to 15 % of their dry weight of grain. The starch contents in barley are about 60-75% of dry weight. Due to these nutritional values barley is considered about 80-90% as valuable as the same weight of maize grain for livestock feeding (Pourkheirandish and Komatsuda, 2007).

Comprehensive studies were carried out to examine the losses in cereal crops like wheat, rice, maize, sorghum and barley caused by stored grain insects *Tribolium castaneum*, *Rhyzopertha dominica* and *Trogoderma granarium* (Udo, 2005). It is further investigated that different stored grain insects (*Tribolium castaneum*, *Rhyzopertha dominica* and *Trogoderma granarium*) caused 15 % losses during storage conditions (Giga *et al.*, 1991). It is recorded that in every year millions of dollars loss occurs due to the stored grain insect pests in United States (Flinn, *et al.*, 2003).

There are so many insect pests which attack on stored grains like *Tribolium castaneum*, *Rhyzopertha dominica*, *Trogoderma granarium* and *Sitotroga cerealella* etc. Due to the attack of these stored grains insect pests about 2- 6 % food grains of Pakistan are lost during storage in every year (Avesi, 1983; Haritos *et al.*, 2006).

Quantitative losses by *Tribolium castaneum* in barley by their secondary mode of action, its adult and larvae both damage the stored grains (Atwal, 1976; Hamed and Khattak, 1985; Khattak *et al.*, 1999; Dars *et al.*,

2001). Due to stored grain insect pests not only quantity of grains but their quality is also affected. Storage losses due to different insect pests are ranged from 0.45 to 0.72 % (Hassan, *et al.*, 1994).

The aims of this study were;

1. To estimate the quantitative losses in advanced barley genotypes against *Tribolium castaneum*.
2. To screen out susceptible and resistant barley variety against *Tribolium castaneum*.

## Materials and methods

The current study was carried out in the Grain Research, Training and Storage Management Cell, Department of Agri. Entomology, University of Agriculture, Faisalabad.

### Collection of insects

Adults of Red Flour Beetle, *Tribolium castaneum* (Herbst) were taken from grain markets, godowns and flour mills which are located in Faisalabad.

### Rearing of insects

Insect culture was reared on wheat flour in sterilized jar which should be kept in the incubator at temperature 30°C and 60% relative humidity.

### Collection of barley varieties

Total five barley varieties, including Jou-83, Jou-87, H-93, B-09006 and B-09008 were used. They were collected from AARI (Ayub Agricultural Research Institute, Faisalabad). First three varieties of Barley are currently under production in different parts of Pakistan while seed of later, two varieties are of advance lines. Varieties were cleaned and disinfested for two weeks prior to starting experiment.

### Screening of barley varieties

About 100 g seed from each variety of barley was placed in bin plastic jar covered with muslin cloth allowing ventilation and preventing the escape of beetle. Thirty adult beetles were introduced to jar to infest the 100 g seed of each variety. Each treatment was replicated three times and their data were

analyzed by Factorial under Completely Randomized Design (CRD).

*Quantitative analysis*

100 g of Barley grains were weighed by weighing balance in each jar to monitor the change in weight of grain as a result of moisture loss or grain. The infestation was checked after 90 days. After checking the infestation, the following data were taken.

*Percentage weight loss*

Percentage weight loss was calculated by using count and weight method of Gwinner formula (Gwinner *et al.*, 1996) which is

$$\text{Weight loss (\%)} = \frac{(Wu.Nd) - (Wd.Nu)}{Wu (Nd+Nu)} \times 100$$

Wu = Weight of undamaged seed Wd = Weight of damage seed

Nu = Number of undamaged seed Nd = Number of damage seed

*Number of damaged grains*

Number of damaged grains was counted manually and find out the percentage damaged grains by using formula.

$$\% \text{ of damaged grains} = \frac{\text{Damaged Grains}}{\text{Total Grains}} \times 100$$

*Frass weight*

At the time of each data, frass was weighed of each sample by weighing balance.

**Results**

*Number of adult emergence in barley genotypes after 90 days*

The data regarding the number of adult emergence of *Tribolium castaneum* in different barley genotypes after 90 days of experiment have a highly significant relation at various temperatures. It was recorded that number of adult emergence at 28°C (90.133) were minimum while at 32°C (97.533) and 35°C (96.800) almost equal number of red flour beetle were

recorded. Data regarding the analysis of variance showed that number of adult emergence of *Tribolium castaneum* in the different varieties of barley were highly significant. Maximum number of adult emergence was counted in Jou-87 (119.11) while Jou-83 (93.78), H-93 (92.44) and B-09008 (91.89) showed nearly equal number of adult emergence. Minimum number of adult emergence of red flour beetles were observed in B-09006 (76.89). The data regarding the analysis of variance showed that there is a significant relation in case of temperature and varieties interaction regarding number of red flour beetle emergence. Almost equal number of adults emergence were recorded at 35°C (95.67) in Jou-83, 32°C (94.00) in B-09008, 35°C (93.67) in H-93 and 35°C (93.33) in B-09008 while maximum adults were noted at 32°C (126.67) in Jou-87 and 35°C (118.00) in Jou-87 while minimum at 32°C (72.33) in B-09006 followed by 28°C (75.00) in B-09006 and 35°C (83.33) in B-09006.

**Table 1.** Comparison of mean values for No. of adult emergence of red flour beetle, *Tribolium castaneum* L. (Herbst) against different genotypes of barley at selected temperatures.

Treatments	No. of adult emergence			Treatment means
	28°C	32°C	35°C	
Jou-83	87.33EF	98.33C	95.67CDE	93.78B
Jou-87	112.67B	126.67A	118.00AB	119.11A
H-93	87.33EF	96.33CD	93.67CDE	92.44B
B-09006	75.00GH	72.33H	83.33FG	76.89C
B-09008	88.33DEF	94.00CDE	93.33CDE	91.89B
Temperature means	90.133B	97.533A	96.800A	

Tukey HSD test was performed for comparison of treatment and temperature means

*Frass weight production in barley genotypes after 90 days*

The data regarding frass weight production showed a highly significant relation at various temperatures. It was observed that frass weight was maximum at 32°C (2.0563) followed by 35°C (1.7064) and 28°C (1.5675). There is a highly significant relation in case of varieties regarding production of frass weight. It was recorded that B-09008, Jou-83 and H-93 having the frass weight due to feeding of red flour beetle were 1.6937, 1.6717 and 1.6586, respectively. B-09006 (1.3077) having the minimum frass while Jou-87

(2.5518) showed the maximum frass weight. The data regarding the analysis of variance showed that there is a highly significant relation in case of interaction. Almost equal frass weight were counted at 28°C (1.4633) in Jou-83, 28°C (1.4613) in B-09008 and 28°C (1.4547) in H-93 while minimum frass weight observed at 28°C (1.1603) in B-09006 and 35°C (1.2418) in B-09006. Maximum frass weight was noted at 32°C (3.1234) in Jou-87.

**Table 2.** Comparison of mean values for frass weight of red flour beetle, *Tribolium castaneum* L. (Herbst) against different genotypes of barley at selected temperatures.

Treatments	Frass weight			Treatment means
	28°C	32°C	35°C	
Jou-83	1.4633F	1.8733CD	1.6786DE	1.6717B
Jou-87	2.2977B	3.1234A	2.2343B	2.5518A
H-93	1.4547F	1.8435CD	1.6777DE	1.6586B
B-09006	1.1603G	1.5210EF	1.2418G	1.3077C
B-09008	1.4613F	1.9203C	1.6994DE	1.6937B
Temperature means	1.5675C	2.0563A	1.7064B	

Tukey HSD test was performed for comparison of treatment and temperature means

*Number of damaged grain percentage in barely genotypes after 90 days*

Data regarding barley damaged grain due to red flour beetle showed a highly significant relation at various temperatures. It was observed that damaged grain percentage in barley genotypes due to red flour beetles were 15.637 %, 8.782 % and 8.237 % at 32°C, 35°C and 28°C, respectively. According to the analysis of variance damaged grain percentage by *Tribolium castaneum* in barley genotypes was a highly significant relation. It was observed that H-93 (9.003 %) and Jou-83 (8.599 %) having almost equal number of damaged grain percentage. Jou-87 (18.618 %) showed the maximum damaged grain percentage followed by B-09008 (14.121 %) while B-09006 (4.086 %) showed the minimum damaged grain percentage by red flour beetle. The data regarding the analysis of variance showed that there is a highly significant relation in case of interaction. Maximum damaged grain percentage was noted at 32°C (26.513 %) in Jou-87 followed by 32°C (20.787 %) in B-09008 and 35°C (15.637 %) in Jou-87 while 35°C (7.228 %) in H-93, 35°C (6.739 %) in Jou-83, 28°C (6.708 %) in

H-93 showed almost equal number of damaged grain percentage but minimum number of damaged grain percentage were recorded in B-09006 at 35°C (3.591 %).

**Table 3.** Comparison of mean values for % damaged grain due to red flour beetle, *Tribolium castaneum* L. (Herbst) against different genotypes of barley at selected temperatures.

Treatments	% damaged grain			Treatment means
	28°C	32°C	35°C	
Jou-83	6.201FG	12.858DE	6.739F	8.599C
Jou-87	13.705CD	26.513A	15.637C	18.618A
H-93	6.708F	13.073CDE	7.228F	9.003C
B-09006	3.712GH	4.954FGH	3.591H	4.086D
B-09008	10.862E	20.787B	10.716E	14.121B
Temperature means	8.237B	15.637A	8.782B	

Tukey HSD test was performed for comparison of treatment and temperature means

*Percentage weight loss in barley genotypes after 90 days*

The data indicates that percentage weight loss due to *Tribolium castaneum* in different barley genotypes after 90 days of experiment, have a highly significant relation at different temperatures. It was noted that percentage weight loss by red flour beetle in barley genotypes was maximum at 32°C (5.1082 %) while almost equal at 28°C (2.5294 %) and 35°C (2.6496 %). According to the analysis of variance percentage weight loss in barley varieties was a highly significant relation. It was observed that B-09006 (1.2880 %) showed the minimum percentage weight loss and Jou-87 (5.8213 %) showed the maximum percentage weight loss while Jou-83 (2.5526 %) and H-93 (2.7711 %) having almost equal percentage weight loss. Percentage weight loss in B-09008 was 4.7124 (%). The data regarding the analysis of variance showed that there is a highly significant relation in case of interaction. Maximum percentage weight loss due to *Tribolium castaneum* was noted at 32°C (8.7056 %) in Jou-87 and 32°C (7.0193) in B-09008. Almost equal percentage weight loss was recorded at 28°C (4.3070 %) in Jou-87, 32°C (4.2416 %) in H-93 and 28°C (3.4424 %) in B-09008 but minimum at 28°C (1.0750 %) in B-09006.

**Table 4.** Comparison of mean values for % weight loss in genotypes of barley due to red flour beetle, *Tribolium castaneum* L. (Herbst) at selected temperatures.

Treatments	% weight loss			Treatment means
	28°C	32°C	35°C	
Jou-83	1.7857D	3.8800C	1.9919D	2.5526C
Jou-87	4.3070C	8.7056A	4.4514C	5.8213A
H-93	2.0370D	4.2416C	2.0348D	2.7711C
B-09006	1.0750D	1.6943D	1.0946D	1.2880D
B-09008	3.4424C	7.0193B	3.6754C	4.7124B
Temperature means	2.5294B	5.108A	2.6496B	

Tukey HSD test was performed for comparison of treatment and temperature means

### Discussion

The present study of quantitative losses in different genotypes of barley against red flour beetle showed that different varieties of barley were resistant and susceptible against the red flour beetle. The susceptibility of these varieties were due to the higher moisture content than the other varieties while different cultivars showed resistance against red flour beetle due to their low moisture content. The susceptibility of different varieties may be due to the some volatile substances which released from these varieties, which attract to the red flour beetle for infestation. Susceptibility of different varieties may be due to the potential of stored grain insect pests for infestation to the stored grain products. It was reported that different stored grain insect pests caused significant quantitative and nutritive losses in cereals like wheat, rice, maize, sorghum and barley during storage conditions (Upadhyay and Ahmad, 2011).

(Reddy *et al.*, 2002) evaluated an experiment on egg laying and adult emergence of *Sitophilus oryzae* on 35 varieties of sorghum and concluded that adult emergence was maximum in susceptible varieties (Nizamabad, 2219B, M 148-138 and P 721 etc.) and minimum in resistant varieties (116B, IS 9487, IS 11758). Barbhuiya and Kar (2002) reported that adults of rice weevil were maximum in wheat followed by sorghum and minimum in rice.

Timothy (2010) reported that *Tribolium* species caused considerable percentage weight loss in susceptible varieties of cereals. Bamaiyi *et al.* (2007) evaluated that maximum percentage weight loss was recorded in susceptible varieties (SINGE 2, SK 5912, KSV 8 and ICSV 210) and minimum in resistant varieties of sorghum (BES, ICSV 111, ICSV 247 and ICSH 89009NG). Surtikanti *et al.* (1999) reported that in resistant varieties of cereals, percentage weight loss was less (Bushra *et al.*, 2012) conducted an experiment on five different genotypes of barley to check percentage weight loss due to the infestation of *Sitotroga cerelella*. They observed that damage was maximum in cultivar Soorab (99.38%) So, Susceptible variety (Soorab) have the maximum number of adult emergence whereas, damage was least in variety Sanober-96 (90.62%) having the minimum number of adult emergence.

### Conclusion

This study concluded that different barley varieties showed significant losses by stored product insect pest, *Tribolium castaneum* at various temperature ranges. It was concluded that Jou-87 is the susceptible variety with maximum quantitative losses whereas; B-09006 is the most resistant one. Temperature ranges were also played a key role on the degree of insect infestation on barley seed. It was concluded that 32°C is the most favorite temperature for the red flour beetle growth.

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