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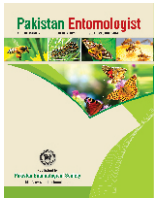

EFFECT OF TEMPERATURE ON POPULATION BUILDUP OF KHAPRA BEETLE, *TROGODERMA GRANARIUM* (EVERTS) AND ITS DAMAGE INTENSITY CAUSED TO STORED WHEAT

Akhlaq Ahmad*, Qazi Mehmood Ali, Mubarik Ahmed and Muhammad Abbas

Grain Storage Research Institute, SARC, PARC, University Campus Karachi, Pakistan.

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***Corresponding Author**:

Akhlaq Ahmad

E-mail: dr.akhlaqahmad@yahoo.com

ABSTRACT

The study was conducted in Grain Storage Research Institute of Southern-zone Agricultural Research Centre, PARC, Karachi during 2009-10, to evaluate the effect of temperature on population buildup of khapra beetle, *Trogoderma granarium* (Everts) and its damage intensity caused to stored wheat (*Triticum aestivum*). Fifteen kg wheat sample (irrespective of variety) was collected from Sindh Government godowns located in Landhi, Karachi and fumigated with Aluminium phosphide tablets to nullify the possibility of previous infestation. The insect initially reared on healthy wheat grains at 30±2°C and 70±5% relative humidity. Later on, 30 larvae of 5th instar were used in the experiment. The results reveal that, maximum population of 958 khapra was observed at room temperature (22^{0}C) followed by 747, 611 and 4 at 32^{0}C, 34^{0}C and 41^{0}C, respectively. The maximum weight loss of 19.25% caused by khapra was recorded at room temperature, followed by 16.00%, 14.23% and 0.11% at 32^{0}C, 34^{0}C and 41^{0}C, respectively. The maximum damaged grain % (22.36%) was recorded also at room temperature, followed by 18.47%, 12.035 and 0.24% at 32^{0}C, 34^{0}C and 41^{0}C, respectively. The data also reveals that, maximum healthy grain % (99.76%) was recorded at 41^{0}C, followed by 87.96, 81.52 and 77.63at 34^{0}C, 32^{0}C and at room temperature. The results show that, room temperature is ideal for khapra production and temperature 41^{0}C is not favourable for the production of khapra beetle. From the results it is also depicted that, insect population has positive correlation with weight loss% and damaged grain%. population significantly.

Keywords: Wheat, Trogoderma granarium, Storage Losses, Khapra Beetle, Population Dynamics, Temperature

INTRODUCTION

Khapra beetle (*Trogoderma granarium*) is one of the most important and destructive pest of stored grains (Burges, 2008; Mark *et al*., 2010; USDA, 1983; CABI, 1997). The population of Khapra beetle depends on biological as well as physical factors. Temperature and moisture (RH) are the two main physical factors that greatly influence the population of this beetle (Cockerel *et al*., 1971).

Khapra beetle is economic pest of Wheat, which is staple food of Pakistan (Azeem *et al*., 1976; Hamed *et al*., 1989; Szito, 2006). The pest has been given as an A2 quarantine pest for EPPO (Anonymous, 2007). The importation of wheat and similar grains as well as the flours and meals has been prohibited by the World Trade Organization (WTO) in order to protect domestic production and to prevent the introduction and spread of this notorious pest. This restriction is applicable to products transported from various countries harboring this pest. Khapra beetle larvae feed on the grain of the wheat as a result the nutritive quality of the wheat grain decreases which lead to lower the market price of the wheat (Ahmedani *et al*., 2009). Khapra beetle not only damages the grain but also contaminate the grains making them harmful to the consumers (How, 1965; Hall, 1970).

Temperature plays an important role in Khapra beetle development. At low temperature, development of the

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individual is slow and mortality is relatively high. As temperature increases to optimum level, the rate of development increases, mortality falls and as a result, the population growth becomes very high. As the conditions become relatively unfavorable the rate of population growth falls.

In case of exporting commodity, the presence of the pest (eggs, larvae or adults) may leads to an immediate quarantine of suspected goods and an expensive eradication and control effort. This beetle has never been observed to fly; therefore, its spread is probably dependent on movement of infested wheat that transported from one area to another.

Trogoderma granarium Everts. prefer grain and cereal products, particularly wheat, barley, oats, rye, maize, rice, flour, malt and noodles. It can also feed on products with as low as 2% moisture content and can develop on animal matter such as dead mice, dried blood and dried insects (CABI, 1997) The eggs of khapra beetle are milky white, turning pale yellowish with age, cylindrical, 0.7 by 0.25 mm, one end rounded, the other pointed and bearing spine-like projections (EPPO, 2004). The larvae at hatching are approximately 1.6 mm long, more than half of this length consisting of a tail made up of hairs on the last abdominal segment. Larvae are uniformly yellowish white, except head and body hairs are brown. As the larvae increase in size, their body color changes to a golden or reddish brown, more body hairs develop, and the tail becomes proportionally shorter. Mature larvae are approximately 5 mm long and 1.5 mm wide (Hadaway, 1956; Anonymous, 1981).

Larval development is not possible below 12 °C but may proceed at very low humidity e.g. at 25 °C and 2 % relative humidity. Development is most rapid in warm humid conditions, taking about 18 days at 35 °C and 73 % relative humidity, under these conditions the number of larval moults is 4 for males and 5 for female (Hadaway, 1956). The main objective of the study was to determine the most unfavourable temperature for the development of khapra. The results will enable the scientists and wholesalers to implement appropriate temperature measures to protect their stored wheat and other commodities by minimizing the storage losses.

MATERIALS AND METHODS

The study was carried out in Grain Storage Research Institute of Southern-zone Agricultural Research Centre, PARC, Karachi during 2009-10. Samples of wheat were collected from Sindh Government godowns located in Landhi, Karachi. Fifteen kg wheat sample (irrespective of variety) was collected and fumigated with Aluminium phosphide tablets to nullify the possibility of previous infestation if any (Akhlaq, 1996; Jood and Kapoor, 1992). The sample was then cleaned by sieving through sieves of different size.

The insect initially reared on healthy wheat grains at 30±2°C and 70±5% relative humidity (Solomon, 1951). The wheat grains having 10-12% moisture contents were used as rearing medium (Pingale and Girish, 1967). From the mixed age cultures collected from Sindh Government Godowns, Karachi. Khapra beetle pupae were separated and kept in an incubator at 32±2°C and 70±5% R.H for adult emergence. Fifteen pairs (15 males + 15 females) of adults of *T. granarium* were introduced in the jars containing wheat grains. The cultures were maintained in the incubator at 32±2 °C and 70±5% R.H for mass rearing. Later on, 30 larvae of 5th instar were used in the experiment.

The fumigated grains were put in glass jars of 5.5 cm diameter and 11.4 cm height each containing 250 g wheat as triplicates according to temperature treatments. The jars were covered with muslin cloth with the help of rubber band and placed in the laboratory at four different temperatures viz., 32, 34, 41°C and room temperature (control) at 70±5% R.H subjected to analyses for determination of insect population, weight loss, insect damage loss % and healthy grains%. Samples were placed in incubating chambers that were maintained at their respective temperatures and relative humidity levels. Live as well as dead insects were counted from each replication of the respective wheat sample. Total sample was drawn from the jar for assessment of percent weight loss. For this purpose number and weight of damaged and undamaged grains were recorded and put in the following equation for determination of weight loss (Gwinner *et al*., 1996).

$$\text{Percent Weight Loss} = \frac{(Wu \times Nd) - (Wd \times Nu)}{Wu \times (Nd + Nu)} \times 100$$

Wu = weight of undamaged grains
Nu = number of undamaged grains
Wd = weight of damaged grains
Nd = number of damaged grains

After sieving the 250 gm samples through 1/8, 1/12, 3/16 and 3/8 inches mesh sieves. Samples of cleaned grain (after removing the frass) weighing 50 grams were drawn from each treatment. The grains were classified and counted for percent insect damaged and healthy one by using the following equations (Ahmedani *et al*., 2011).

$$\text{Percent insect damaged grains} = \frac{\text{No. of insect damaged grains}}{\text{Total No. of grains in sample}} \times 100$$

$$\text{Percent healthy grains} = \frac{\text{No. of healthy grains}}{\text{Total No. of grains in sample}} \times 100$$

Data on the numbers of insects and weight loss were observed after every 14 days and statistically analyzed using SPSS (Statistical Package for Social Sciences) version 10.0 and the means were compared by Duncan's Multiple Range Test at 99% level of confidence (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

According to Table 1, maximum population of insects was found at room temperature showing 958 insects per 250 gm of wheat. At temperatures 32^{0}C and 34^{0}C numbers of insects found were 747 and 611 at sixth week interval respectively. The results show that, population of insects were decreased and only 4 insects were found at temperature 41^{0}C. The results indicate that, insect population was significantly increased in all the treatments except the temperature treatment of 41^{0}C. The results are quite in line with (Burges, 2008) who reported that, temperature above 40^{0}C is unfavourable for khapra and favourable temperatures are 30^{0}C to 40^{0}C. (Hochachka and

that, temperature above 40^{0}C is unfavourable for khapra and favourable temperatures are 30^{0}C to 40^{0}C. (Hochachka and Somero, 1984; Denlinger and Yocum, 1999; Neven, 2000) reported that, high temperature cause a number of adverse biochemical changes and have lethal effects in insect.

Weight loss to stored wheat caused by *T. granarium* after 6 weeks revealed that, maximum weight loss of 19.25% was recorded at room temperature, followed by 32^{0}C and 34^{0}C temperature with 16% and 14.23% weight loss respectively (Table 2). At temperature 41^{0}C minimum weight loss of 0.11% was recorded. It is depicted from Table 1 and 2 that, weight loss is directly proportional to number of insect population in the commodity. The results are in agreement with (Ahmad *et al*., 1986; Navarro *et al*., 1978 and Ahmedani *et al*., 2011), who reported that, insect population and weight loss has positive correlation with each other. Khattak *et al*. (2000) also found that, correlation between insect population, damage and weight loss was positive and highly significant (P>0.01).

The results pertaining to percent damage to wheat grains caused by *T. granarium* are presented in Table 3. The results reveal that, maximum damage % (22.36) was observed at room temperature after sixth week, followed by 18.47% and 12.03% at 32^{0}C and 34^{0}C respectively. The minimum damage % (0.24) was recorded at 41^{0}C temperature. This low damage at 41^{0}C was because of low population density in the wheat samples. The data in Table 4 reveals that, highest healthy grain% (99.76) was recorded in 41^{0}C temperature, followed by 77.63%, 81.52% and 87.96% in room temperature, 32^{0}C and 34^{0}C respectively. The results are in accordance with (Irshad *et al*., 1988; Khattak *et al*., 2000 and Syed *et al*., 2006), who reported that, grain damage (%) and weight loss (%) was directly dependent upon insect population.

Population of Khapra beetle mainly depends on the availability of food, presence of the favorable physical factors. Temperature and relative humidity are the two important physical factors that influence the population of the insects. It is concluded that the temperature and relative humidity of the wheat storages must be monitored at regular basis and the insect management measures must be applied to avoid losses.

Table 1
Population of Khapra at room temperature (22^{o}C), 32^{0}C, 34^{0}C and 41^{0}C at 70% $^+$- 5% R.H.

Weeks	Temperature			
	Room Temperature	32^{O}C	34^{O}C	41^{O}C
2nd	79c	77c	55c	12a
4th	249b	218b	200b	7a
6th	958a	747a	611a	4a

Mean values followed by different letters are significantly different at 5% probability level.

Table 2
Effect of Khapra on weight loss % of stored wheat.

Weeks	Temperature			
	Room Temperature	32^{O}C	34^{O}C	41^{O}C
2nd	3.00b	2.31b	1.99b	0.91b
4th	10.00b	9.13b	8.55b	0.32b
6th	19.25b	16.00b	14.23b	0.11b

Mean values followed by different letters are significantly different at 5% probability level.

Table 3
Effect of Khapra on damaged grain% in stored wheat.

Weeks	Temperature			
	Room Temperature	32^{O}C	34^{O}C	41^{O}C
2nd	6.28c	6.75c	5.00b	1.99b
4th	13.8c	12.88b	7.6b	0.78b
6th	22.36b	18.47b	12.03b	0.24b

Mean values followed by different letters are significantly different at 5% probability level.

Table 4
Effect of Khapra on healthy grains% in stored wheat.

Weeks	Temperature			
	Room Temperature	32°C	34°C	41°C
2nd	93.71b	93b	94.95b	98.00b
4th	86.18b	87.11b	92.39b	99.22b
6th	77.63c	81.52b	87.96b	99.76b

Mean values followed by different letters are significantly different at 5% probability level

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