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Stored Grain Pests Incidence in Wheat with Particular Reference to Khapra Beetle, *Trogoderma granarium* Everts in Southern Haryana, India

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A B S T R A C T

Post-harvest losses due to stored product insects have been estimated to be up to 9 per cent in developed countries to 20 per cent or more in developing countries (Phillips and Thorne, 2010). Beside the quantitative loss, the insect infestation in wheat grains reduce germination and produce unpleasant odour, dirty appearance and abhorrent taste due to contamination with insect fragments and excrement. The post- harvest losses of food grains in India were 7-10 per cent of the total production from farm to market level and 4-5 per cent at market and distribution levels. The khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae), is a serious pest of stored wheat in the southern part of Haryana (adjoining Rajasthan) where the environment is relatively hot and dry favouring rapid breeding of this pest. As a rule the larvae attack the germ portion but in case of heavy infestation other parts of the grain may also be damaged. Although some information on the combined damage caused by different stored grain pests in the stored wheat is available in the literature, yet little specific data are available with respect to the damage caused by *T. granarium*, a predominant species of the area, in rural storage conditions during different months.

Introduction

Post-harvest losses due to stored product insects have been estimated to be up to 9 per cent in developed countries to 20 per cent or more in developing countries (Phillips and Thorne, 2010). Beside the quantitative loss, the insect infestation in wheat grains reduce germination and produce unpleasant odour, dirty appearance and abhorrent taste due to contamination with insect fragments and excrement (Khare *et al.*, 1974). The post-harvest losses of food grains in India were 7-10 per cent of the total production from farm to market level and 4-5 per cent at market and distribution levels (Anonymous, 1999).The khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae), is a serious pest of stored wheat in the southern part of Haryana (adjoining Rajasthan) where the environment is relatively hot and dryfavouring rapid breeding of this pest. As a rule the larvae attack the germ portion but in case of heavy infestation other parts of the grain may also be damaged. Although some information on the combined damage caused by different stored grain pests in the stored wheat is available in the literature, yet little specific

data are available with respect to the damage caused by *T. granarium*, a predominant species of the area, in rural storage conditions during different months.

Materials and Methods

Investigations on incidence of *khapra*beetle, *Trogoderma granarium* Evert in wheat grain were conducted during 2013 in the Department of Entomology, CCS Haryana Agricultural University, Hisar. The pest incidence in three blocks of Mahendergarh district, namely, Mahendergarh, Kanina and Nangal Chaudhary, under rural storage conditions was recorded through monthly surveys of 15 farmers' stores per village taking two villages from each block. During each survey, a 500g wheat sample from various storage structures such as, metallic bins, gunny (jute) bags and open bulk storage (in a room) was collected separately in polyethylene bags with the help of a grain trier (i.e. sampler) from each farmer's store; thus taking 90 samples of wheat grain per survey. Sampling was done five times from the same storage structures during the study period at monthly interval starting from mid June 2013 up to mid November 2013. From each such sample, a 50 g sub-sample was drawn and examined in the laboratory for damage by *T. granarium* and other stored grain pests.

Since the studies were focused on*T. granarium*, the grain samples were examined for the presence of grains with germ portion eaten. The damage caused by other pests such as *Sitophilus oryzae, Tribolium castaneum*, and *Rhyzoperthadominica* was put intothe category of weeviled grains. Per cent damaged grains by *T. granarium*, per cent weeviled grain and per cent combined grain damage due to all the pests was worked out. Weights of counted number of healthy grains, *T. granarium* damaged grains, and weeviled grains were recorded with the help of Saptula Balance (Model 1230N22). Per cent damaged grains under different storage conditions in different Blocks of the district at various observation periods were calculated. Moisture of each sample was measured with the help of Universal Moisture Meter, Model no. S6010 (Osaw Production Pvt Ltd India). Grain-weight loss was worked out with the help of the following formula (Adams andSchulten, 1978):

$$\text{Percent weight loss} = \frac{\text{UND-DNU}}{\text{U (ND+NU)}} \times 100$$

Where, U = Weight of undamaged grain
NU = Number of undamaged grain
D = Weight of damaged grain
ND = Number of damaged grain

Since 70 per cent farmers stored wheat grain in metallic bin and 21.67 per cent in gunny bags (as revealed by the present studies), weighted means for grain damage and grain-weight loss were worked out.

Results and Discussion

Incidence of *T. granarium* under different storage conditions

The data on *T. granarium* incidence in wheat grain stored in different storage conditions, *i.e.*, storage in metallic bin (MB), gunny bag (GB) and open bulk storage (OBS) in different Blocks of Mahendergarh district at different periods of observation are presented in Table 1. Mean grain damage was 0.10, 1.59, 2.83, 4.01 and 3.91 per cent in MB, while 0.11, 6.05, 12.65, 16.97 and 15.92 per cent in GB during 15 June-15 July, 16 July-15 August, 16 August-15 September, 16 September-15 October and 16 October-15 November, respectively. Under OBS the mean grain damage was 0.57, 5.91 and 11.38 per cent during 15 June-15 July, 16 July- 15

August and 16 August-15 September, respectively. Thus, under all the storage conditions grain damage gradually increased as the duration of storage increased. Bains *et al.*, (1976) and Dass (1977) also found similar trend of increased pest damage with the increase in storage period.

Based on mean of five sampling observations, the per cent grain damage was 2.49, 2.46 and 2.52 under MB storage, and 10.28, 10.18 and 10.48 under GB storage in Mahendergarh, Kanina and Nangal Chaudhary Blocks, respectively. Highest mean grain damage was recorded when grain sampling was done between the period 16 September and 15 October 2013, being 4.01 and 16.97 per cent under MB and GB storage, respectively. Pest incidence in the subsequent period (i.e. 16 October-15 November 2013) also remained quite high (i.e. 3.91 and 15.92% in MB and GB, respectively). On the other hand minimum grain damage of 0.10, 0.11 and 0.57 per cent under MB, GB and OBS, respectively was recorded during 15 June -15 July. However, the data for OBS were not considered for calculating the district average since the number of available samples continued to decline in the following observation dates because of consumption of the grain by the farmers. Moreover, only a small percentage of farmers (8.33) in the district stored wheat as open bulk storage as compared to 70 per cent of them in MB and 21.67 per cent in GB (data not shown).

There were no appreciable differences in grain damage among different Blocks under all storage conditions. It was probably due to the fact that there were no significant differences in the environmental conditions of the three Blocks. However, information related to stored grain pest incidence in different Blocks of Mahendergarh district is lacking. Irrespective of the Blocks, maximum per cent grain damage by the pest was recorded in GB (10.34), followed by OBS (6.00) and MB (2.49), though grain damage under OBS would have been probably still higher had the farmers not utilized the stock early, as no grain was found stored under OBS after 16 September in Mahendergarh and Kanina Blocks and after 16 October in Nangal Chaudhary Block. Thus, based on weighted mean of MB and GB storage, wheat grain damage by *T. granarium* in the district was 4.35 per cent. On the other hand, percentage of germ eaten wheat grain after about eight to ten months of storage at farmers level was 2.6 (Bhardwaj *et al.*, 1977). Such differences in the per cent germ eaten grain could probably be due to variable levels of initial infestation of this pest in different areas. Damage by this pest under GB storage was 4.2 times higher than that under MB storage. Likewise, greater incidence of the pest under gunny bag storage condition as compared to metallic bin storage has been reported by other workers also (Dharam Singh and Yadav, 1995; Gehlawat *et al.*, 1993; Malik *et al.*, 1994; Nutting and Gerhardt, 1964; Srivastava *et al.*, 1973).

Moisture content in the wheat grain samples collected from different stores varied from 9.10 to 12.22 per cent during the storage period (Table 2). Mean moisture content was 10.24, 11.32 and 11.32 per cent under MB, GB and OBS, respectively, with overall value of 10.93. Minimum moisture content was observed during 15 June to15 July and maximum between 16 September and 15 October. Bhardwaj *et al.*, (1977) also reported similar level (*i.e.*, 11%) of moisture content of the wheat grain after about eight to ten months of storage at farmers' level. However, in the present studies, *T. granarium* infestation continued to increase in all the storage conditions with the increase in storage period, as also with the increase in moisture content of the grain. Bains *et al.*, (1976) suggested that *T. granarium* could breed in

wider range of moisture and temperature and, in fact, grain moisture did not seem to be a limiting factor for the multiplication of this pest.

Incidence of other stored grain pests under different storage conditions

Almost similar pattern of grain damage was noticed with respect to other pests, namely, *Sitophilus oryzae*, *Rhyzoperthadominica*, and *Tribolium castaneum* also (Table 3). Damage by these pests was very low (0-0.2%) during 15 June-15 July, while peak damage was observed during 16 September-15 October (i.e. 3.26-3.94 in MB and 9.27-9.53% in GB). Mean values for the three Blocks showed that the grain damage was 2.09 per cent under MB and 5.32 per cent under GB storage. Similarly, Bhardwaj *et al.,* (1977) concluded that after about eight to ten months of storage of wheat at farmers' level, weevilization by stored grain pests was 5.1per cent. As seen in the case of *T. granarium* there were no appreciable differences in grain damage by these pests among different Blocks, both under MB and GB storage conditions.

Combined incidence of different stored grain pests under different storage conditions

Combined mean per cent grain damage by *Sitophilus oryzae*, *Rhyzoperthadominica*, and *Tribolium castaneum* under MB was 0.07, 1.17, 2.19,3.65 and 3.38 during 15 June-15 July, 16 July- 15 August, 16 August-15 September, 16 September-15 October and 16 October-15 November, respectively (Table 4). Similarly, the damage under GB was 0.07, 2.57, 5.34, 9.38 and 9.24 per cent during 15 June-15 July, 16 July- 15 August, 16 August-15 September, 16 September-15 October and 16 October-15 November, respectively. As evident from the data, grain damage (both under MB and GB) was quite low during June- July (i.e. 0.07%) but gradually increased with the increase in storage period, with peak damage during 16 September -15 October, being 3.65 and 9.38 per cent in MB and GB, respectively.

When values for grain damage caused by *T. granarium* were added to the damage caused by other pests, the mean values for the entire storage period (i.e. 15 June-15 November) came out to be 4.58 under MB and 15.65 per cent under GB, with overall mean of 10.12 per cent. It indicated that grain damage was 3.42 times higher under gunny bag storage than that under metallic bin storage. On the other hand, Doharey *et al.,* (1975) reported 1.0 while Dhaliwal (1977) as 1.66 per cent grain damage due to stored grain pests under metallic bin storage. Such differences in the extent of grain damage between the present findings and those of these workers could probably be due to the variations in the level of pest infestations during different years and different locations. However, Dass (1977) and Gehlawat (1993) recorded 18.3 and 15.1 per cent grain damage in jute bags, respectively, which supported the present results wherein 15.65 per cent grain damage was observed.

In the present studies, the data showed that though the grain damage continued to increase with the increase in the storage period in all the storage structures/practices, yet a small decline in the per cent grain damage was noticed during the period 16 October-15 November. This was probably due to the fact that some of the grains which were initially damaged by *T. granarium* were later on attacked by other stored grain pests also. Therefore, such grains were counted under the category of weeviled grain, thereby resulting in lower figures for grain damage by *T. granarium* during this period.

Table.1 *Trogoderma granarium* incidence on different dates under different storage conditions in various Blocks of district Mahendergarh in 2013

Period of observation	Damaged wheat grains (%) by *T.* granarium under different storage conditionsin various Blocks											
	Metallic bin				Gunny bag				Open bulk storage			
	MG	K	NC	Mean	MG	K	NC	Mean	MG	K	NC	Mean
15 Jun-15 Jul	0.09	0.11	0.10	0.10	0.15	0.20	0	0.11	0.50	0.63	0.58	0.57
16 Jul-15 Aug	1.57	1.50	1.71	1.59	5.88	5.98	6.29	6.05	6.25	5.30	6.19	5.91
16 Aug-15 Sep	2.8	2.76	2.94	2.83	12.46	12.46	13.03	12.65	11.15	10.95	12.04	11.38
16 Sep-15 Oct	4.04	4.02	3.97	4.01	17.58	16.28	17.07	16.97	-	-	-	
16 Oct-15 Nov	3.93	3.92	3.88	3.91	15.31	15.97	16.50	15.92	-	-	-	
Mean	2.49	2.46	2.52	2.49	10.28	10.18	10.48	10.34	6.00	5.63	6.27	6.00

MG: Mahendergarh; K: Kanina; NC: Nangal Chaudhary; -Data not included due to small sample size, Overall mean % grain damage (weighted mean of MB and GB storage): 4.35

Table.2 Moisture level in wheat grain samples collected from rural storage conditions at different periods in 2013

Period of Observation	Mean % moisture conent in wheat grain samples under different storage conditions			
	Metallic bin	Gunny bag	Open bulk storage	Mean
15 Jun -15 Jul	9.10	9.56	9.24	9.30
16 Jul -15Aug	10.40	11.63	11.7	11.24
16 Aug -15 Sep	10.49	11.95	12.22	11.55
16 Sep-15 Oct	10.77	11.96	12.10*	11.61
16 Oct-15 Nov	10.42	11.52	-	10.97
Mean	10.24	11.32	11.32	10.93

*only one sample found

Table.3 Combined grain damage by other pests (*T. castaneum*, *R. dominica* and *S. oryzae*) in wheat under metallic bin and gunny bag storage in different Blocks in 2013

Period of observation	Damaged wheat grains (%) in metallic bins and gunny bags in different Blocks							
	Metallic bin				Gunny bag			
	MG	K	NC	Mean	MG	K	NC	Mean
15 Jun -15 Jul	0	0	0.2	0.07	0	0.2	0	0.07
16 Jul -15 Aug	1.14	1.04	1.32	1.17	2.66	2.21	2.83	2.57
16 Aug -15 Sep	2.24	1.88	2.46	2.19	5.12	5.32	5.57	5.34
16 Sep-15 Oct	3.76	3.26	3.94	3.65	9.34	9.27	9.53	9.38
16 Oct-15 Nov	3.41	2.96	3.76	3.38	9.21	9.14	9.36	9.24
Mean	2.11	1.83	2.34	2.09	5.27	5.23	5.46	5.32

MG: Mahendergarh; K: Kanina; NC: NangalChaudhary

Overall mean % grain damage (weighted mean of MB and GB storage): 2.85

Table.4 Combined damage by different stored grain pests under metallic bin and gunny bag storage during different periods in 2013

Period of observation	Damaged wheat grain (%) by different pests in different storage conditions					
	Metallic Bin			Gunny bag		
	T. granarium	Other pests*	Total	*T. granarium*	Other pests*	Total
15 Jun -15 Jul	0.1 0	0.07	0.17	0.11	0.07	0.18
16 Jul -15Aug	1.59	1.17	2.76	6.05	2.57	8.62
16 Aug -15 Sep	2.83	2.19	5.02	12.65	5.34	17.99
16 Sep-15 Oct	4.01	3.65	7.66	16.97	9.38	26.35
16 Oct-15 Nov	3.91	3.38	7.29	15.92	9.24	25.16
Mean	2.49	2.09	4.58	10.34	5.32	15.65

*Other pests included *Triboliumcastaneum, Rhyzoperthadominica and Sitophilusoryzae*
Total mean % damaged wheat grain by all stored grain pests during the entire storage period (i.e. 15 June-15 November) in district Mahendergarh (weighted mean of MB and GB storage): 7.2

Table.5 Comparative wheat grain- weight loss by *T. granarium* under different storage conditions in 2013

Period of observation	Mean % grain loss under different storage conditions	
	Metallic bin	Gunny bag
15 Jun -15 Jul	0.01	0.01
16 Jul -15 Aug	0.33	1.27
16 Aug -15 Sep	0.76	3.41
16 Sep-15 Oct	1.32	5.6
16 Oct-15 Nov	1.32	4.77
Mean	0.75	3.01

Overall mean % grain-weight loss (weighted mean of MB and GB storage):1.28

Wheat grain-weight loss by *T. granarium* under different storage conditions

Table 5 exhibits data on comparative grain-weight loss by *T. granarium* under MB and GB storage conditions. As observed in the case of grain damage, the grain-weight loss also increased with the increase in the storage period. The extent of wheat grain-weight loss was minimum (0.01%) during 15 June-15 July and maximum (1.32-4.77%) during 16 September-15 October which corresponded with the extent of grain damage during this period. Mean grain- weight loss by *T. granarium* during the storage period was 0.75 per cent in MB and 3.01 per cent in GB storage with an overall mean value of 1.28. Similar findings were reported by Bains *et al.*, (1976) who observed that where *T. granarium* dominated, there was 1.04 to 3.02 per cent loss in weight in the end of November in Punjab. Prasad *et al.*, (1977) found that loss of weight in wheat due to stored grain pests ranged from 2.2 to 5.5 percent. Girish *et al.*, (1975) reported average loss due to insect damage as 2.90, 0.85 and 0.95 per cent in western U. P., Punjab and Haryana, respectively. In the present studies, comparative grain-weight loss between the two storage conditions indicated that the loss

by *T. granarium* was 4.01 times higher under GB than that under MB storage.

The following conclusions were drawn from the studies: i)wheat grain damage by different stored grain pests increased with the increase in storage period, being minimum during June-July and maximum during September-October; though grain moisture also increased during this period; ii) *T. granarium* was the most serious pest of stored wheat in southern Haryana as it caused greater grain damage than all other pests put together; iii) grain damage by *T. granarium* under gunny bag storage was 4.2 times higher than that under metallic bin storage; iv) there were no appreciable differences in the level of grain damage among the three selected Blocks; v) the overall grain-weight loss due to *T. granarium* incidence was 0.75 under MB storage and 3.01 per cent under GB storage with a weighted mean of 1.28 per cent. vi) per cent grain damage by all the stored grain pests (*i.e., T. granarium, S. oryzae, R. dominica*, and *Tribolium castaneum*)during the entire storage period was 4.58 under metallic bin and 15.65 under gunny bag storage with a mean value of 10.12. The studies suggested that since damage by stored grain pests in the stored wheat was considerably low under metallic bin storage than in other conditions, the farmers need to be further educated and encouraged to adopt metallic bin storage.

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