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Monitoring Stored Grain Pests using Sticky Glue Traps from Warehoused Wheat of District Dadu, Sindh, Pakistan

Shamsher Ali* and Naheed Baloch

Department of Zoology, University of Sindh, Jamshoro, Sindh, Pakistan

ABSTRACT

Studies for monitoring the stored grain pests using sticky glue traps were carried out in different areas of district Dadu on Taluka level during April-June, 2021. The observations were made at different grain storage sites by using sticky glue traps which are also considered as attractants and contains mixture of extracted wheat, oat and cold-pressed pumpkin seed oils. Maximum number of *Rhyzopertha dominica* were attracted towards traps in Government Warehouses followed by private godowns, grain stocking shop and home silos (406.6±15.2, 256.3±12.8, 222.6±14.1 and 214.3±6.11), respectively at Sita road. While, in Government and private warehouses of Taluka K.N Shah (289.6±8.08 and 286.33±14.8) *Rhyzopertha dominica* were observed in abundance. Whereas, high number of the same species were recorded from Government and private warehouses of Radhan, grain stocking shop and home silos of Bali Shah and Mehar City at the first interval of 10 days during June 2021. The similar number of *Trogoderma granarium* another stored wheat grain pest were observed in traps at studied sites of selected Talukas of District Dadu. However, they were all significantly different from control. Present findings would be helpful to recognize the efficiency of stored grain pests of wheat under different storage conditions and efficacy of sticked glue traps in enticing stored pests of wheat to develop a suitable pest management strategy against stored pests of wheat.

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SA conducted an experimental study, data analyzed and wrote the paper. NB conceived, designed and supervised the investigational work.

Key words
Stored grain pests, Stored grains, Food attractant, Sticky glue trap, Extracted oils, Monitoring

INTRODUCTION

Cereal grains are the most important and principal food sources all over the world, and they account for a major root of high energetic nutrients as compared to other food integer. Among them, *Triticum aestivum* (wheat) is considered one of the most important dominant cereals and stable food than the other crops in cultivation, yields, and utilization in the Pakistan. During the year 2021, wheat production was estimated at 27 million tonnes in the Pakistan, covering a cultivated area of about 9.2 million hectares (FAO, 2021).

Most of the farmer stores large quantities of wheat grains every year for their consumption, good rate sale, and until taking new products (Chattha *et al*., 2015). Therefore, due to the long time storage of wheat grain are exposed to infestation by several insect pests which causes great loss of concerned grain (Manickavasagan *et al*., 2008). These pests are responsible for millions of dollars in grain losses in storage each year, posing a danger to any country's food security program, particularly in developing countries where agricultural produce storage is mostly managed by resource-poor farmers (Ismaila *et al*., 2010; Balami *et al*., 2011). Globally, major losses in both quantity and quality of stored products are estimated to be between 10 and 40% of the total (Rees, 2004). Nearly in India 20% -25% (Rajashekar *et al*., 2010) and 10 to 15% grain damage observed by the attack of insect pests in Pakistan (Jilani, 1981).

Furthermore, wheat grain deterioration also affects the physical attributes of the grains, such as color, test weight, and texture (Nasar-Abbas *et al*., 2009). As a result, the final product has an unpleasant taste and smell and is inappropriate for human consumption (Vassanacharoen *et al*., 2008). This leads to infested grains may become unsalable and inedible (Obeng-Ofori, 2008). However, several insects pests cause great loss of stored grains among them, lesser grain borer *Rhyzopertha dominica* (F.) and khapra beetle *Trogoderma granarium* (Evert) are common and most destructive in the world (Roy *et al*., 2005; Mahmoud *et al*., 2015), specially in Pakistan.

To prevent maximum loss of stored grain from insect

* Corresponding author: shamsherali151@yahoo.com
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pest damage is primarily dependent on synthetically chemical insecticides such as fumigated phosphine or spraying, pyrethroids, malathion, chloropyrifos, methyl bromide etc and several other pesticides have been used by people of different areas of world for many years (Price and Mills, 1988; Singh, 1990; Kiran and Prakash, 2015). However, massive and indiscriminate use of synthetic pesticides results in increased resistance of the store's grain pests along with led to the contradictory effect of toxic residues on stores grain, create human health problems, non-target animals, poses a great threat to the environmental concern (Stefanazzi *et al*., 2010). It's important to protect grains and other food items from insect pest damage by storing them properly (Haq *et al*., 2005). So, the scientists are working to develop alternative methods which would be eco-friendly, non-toxic, economically safe, effective, and easy to operate for the control of various insect pests of stored grains such as *Rhyzopertha dominica* (F.) and *Trogoderma granarium* (Evert).

For this purpose during the last two decades, several researchers have been designed an enormous application of traps to control insects pests for the storage of cereal products. In this context, one of the most promising methods to control stored product pests is the use of traps.

There are numerous examples of dermestid pheromones being successfully used to monitor *Trogoderma* and *Attagenus* species in the field (Burk holder and Ma, 1985). For monitoring and control stored grain pests, several types of pheromones were reviewed by Burkholder and Ma (1985). Also, food attractants have been used in laboratory testing and field trials, accordingly to the reports (Chambers, 1987).

In California state surveys, a food attractant trap made of a single layer of corrugated paper with flutes partially filled with a paste made of crushed Saunders (*Pectinophora gossypiella*), dried milk, and wheat germ was utilized (Okumura, 1972). Bar-Zeev (1976) and Bar-Zeev and Ben-Tamar (1979) observed the use of synthetic or natural food attractants against larvae of *Trogoderma granarium*. Moreover, wheat germ oil was found to be particularly attractive to *Trogoderma glabrum* (Herbst) by Nara *et al*. (1981). DeCoursey (1931) documented the usage of corrugated traps baited with wheat flour to catch *Tribolium confusum* Jacquelin duVal. Wilson (1940) used alcoholic fish meal extract-treated sticky traps to catch carpet beetle (Dermestidae) larvae in residences.

For the detection and monitoring of the khapra beetle under the USDA programme, Barak (1989) used flat-type traps baited with attractive material septa and fresh oils of sesame, pumpkin seed, wheat and oat.

The present study is aimed with considerable progress in the use of a sticky glue trap containing a mixture of oat, wheat germ, and cold-pressed pumpkin seed oils as food attractants for detection, monitoring, and control of common stored grain pests in different wheat storing places of District Dadu, Sindh, Pakistan. The main goal is to develop a versatile and effective food attractant sticky glue trap with certain progressive characteristics such as with higher capturing and killing efficiency of stored grain, without the use of insecticides, effective for multiple pest species.

MATERIALS AND METHODS

Study area

To examine the attractiveness and capturing efficiency of food attractants sticky (glue) traps stored grain pests of wheat the study was conducted in 6 villages of K.N. Shah and Mehar each of District Dadu. The sticky glue traps were positioned in Government and private warehouses, wheat stocking shops and home silos at each selected location where different varieties of wheat were stored. The temperature and RH% were observed and presented in data on interval of 10 days.

Collection of material

Healthy wheat grains were collected from the grain suppliers and used in the glue traps along with wheat, oat and pumpkin seed extracted oil (Barak, 1989) to attract the stored grain pests of wheat. The wheat used in the traps were sieved to avoid dust particles, kernel pieces and broken wheat before initiating the experimental work.

Experimental design

Four sticky (glue) traps previously used by Mueller *et al*. (1990) measuring 31×20.9 cm at per study site such as home silos, wheat stocking shops, private and Government Warehouses were put in and replicated thrice where each trap was considered as replicate with additional control traps (no attractant oils used). In each trap 10 mg of wheat grain for wheat stored grain pests and 3 different types of extracted oils with 2 ml dosage were significantly mixed and put in a lid of plastic box special on the center of each sticky glue trap. These traps were placed where stored grain stock was stored in plastic bags, begged grains of stocking shops, private and Government Warehouses and in home silos. Attractant and non-attractant (control) traps were placed in a very near distance of stocked grains in plastic bags, begged grains and in home silos to assure that there is no disturbances for the study site's activities and can be easily observed. The number of stored wheat grain pests were observed regularly and traps were changed on 10 day interval at each studied site.

Table I. Month-wise record (Mean±SD), Temp. (°C) and RH (%) of trapped *Rhyzopertha dominica* in different wheat storing places of Taluka K.N. Shah, District Dadu.

Month/ year/ days	Areas of taluka	Govt: warehouses	Private warehouses	Grain stocking shops	Home silos	Control	Av: temp (°C)	Av: R.H (%)
April, 2021								
1-10	K.N Shah	231±8.18d	135±5.56d	135±5.56 d	142±8.18 a	70.3±18.7 d	40.1±2.50	17.8±4.02
11-20	Sita road	329.6±8.32d	189±6.24d	159±5.29 c	128.3±10.6 d	63.3±11.5 a	40.1±2.39	20.5±7.61
21-30	Gozo	330±6.24d	182.3±4.72d	156.6±5.77d	119.6±5.13 d	51.6±24.4 b	40.7±3.30	25±5.69
May 2021								
1-10	Sindhi Butra	282±10.8b	195±12.1b	195±12.1 b	202.6±4.50 a	78.6±22.3 c	41.9±1.76	22.6±3.53
11-20	Mitho Babar	382±10.8b	237±10.5b	188.3±17.9 b	181±8.71 b	73.0±20.8 d	42.8±2.19	23.9±3.10
21-30	Rahouja	365.3±10.0b	225.3±8.38b	202.6±15.5 b	160±10.5 b	60.0±30.0 d	45.6±3.43	24.5±8.32
June, 2021								
1-10	K.N Shah	311.6±12.5a	222.6±14.1a	222.6±14.1a	214.3±6.11a	82.3±58.6 b	45 ±1.39	30.6 ±4.69
11-20	Sita road	406.6±15.2a	256.3±12.8a	216±5.29a	213.3±10.2a	80.6±52.1 b	43.8±2.33	31.5±2.06
21-30	Gozo	391±2.62a	241.6±10.6a	230.6±7.37a	185±14.5a	79.0±53.3 a	44.2±2.54	34±5.61
July, 2021								
1-10	Sindhi Butra	249.6±6.42c	162.3±10c	162.3±10c	151.6±10.4b	55.3±24.7 b	45.1±2.33	32.1±5.21
11-20	Mitho Babar	355±13.2c	212.3±8.73c	128.3±2.08d	155.6±20.5c	45.6±21.5 a	41.2±3.18	45.1±8.21
21-30	Rahouja	345±8.71c	200±6.24c	180.3±8.96c	139±7.81c	40.6±17.4 d	40.9±1.40	40.1±5.84

According to Fisher's least significant difference (LSD) test, values preceded by distinct letters differ significantly by 5%.

Table II. Month-wise record (Mean±SD) of trapped *Rhyzopertha dominica* in different wheat storing places of Taluka Mehar, District Dadu.

Month/ year/ days	Areas of taluka	Govt: warehouses	Private warehouses	Grain stocking shops	Home silos	Control	Av: temp (°C)	Av: R.H (%)
April, 2021								
1-10	Mehar city	198±4.35d	150±4.58d	146±4.58d	125.3±6.65d	66.3±19.8 a	39.5±2.72	16.4±3.62
11-20	Radhan	226.6±4.16d	220±6.0d	127±8.0d	102±4.58d	55.0±45.0 d	38.4±3.69	19±6.20
21-30	Bali Shah	190±4.58d	187.3±6.42d	149.3±6.50d	100±3.60d	48.3±36.8 d	41.4±3.91	26.1±4.93
May, 2021								
1-10	Mureed Lakhir	271±10.3a	190±8.54b	187±8.54b	180±2.64b	70.0±18.0 b	42.4±2.20	23.1±3.40
11-20	Betto	268.3±6.65b	265±12.1b	156±9.0c	153±8.54b	61.3±16.2 b	40.3±3.62	21.1±3.75
21-30	But Serai	235.6±10.6b	212.6±4.04c	199±10.5b	144±9.53b	53.3±15.2 b	44.4±3.38	25.5±7.87
June, 2021								
1-10	Mehar city	255.6±8.02b	225±10.5a	215±10.5a	196.6±4.16a	78.6±22.3 d	44.6 ±1.58	32.1 ±4.19
11-20	Radhan	289.6±8.08a	286.33±14.8a	200±11.0a	175±10.5a	71.3±22.2 a	42.1±4.37	30.1±2.28
21-30	Bali Shah	254.3±12.8a	231.3±8.08b	221±12.5a	168±12.5a	61.0±23.5 b	45.2±2.54	35±5.86
July, 2021								
1-10	Mureed Lakhir	234±6.55c	170±6.55c	166±6.55c	148.3±8.50c	50.6±21.0 d	44.6±2.67	31.8±5.09
11-20	Betto	239±2.64c	242.3±8.73c	177±10.0b	132.6±6.02c	41.0±17.3 a	40.4±3.26	42.4±6.83
21-30	But Serai	213.3±8.32c	250±10.0a	171±8.54c	123±6.55c	30.0±17.3 b	43±2.56	39.6±5.51

According to Fisher's least significant difference (LSD) test, values preceded by distinct letters differ significantly by 5%.

Statistical analysis and meteorological data

All of the analyses were carried out using Statistix ® version 8.1, which tabulated the data using the ANOVA (analysis of variance) and LSD (Fishers least significant difference) tests. Regional AGRO-MET Centre Dadu provided the meteorological data used in this analysis.

RESULTS

The results of present studies revealed that from April to June 2021, two stored grain pests, i.e., lesser grain borer, *Rhyzopertha dominica*, and khapra beetle, *Trogoderma granarium* found in majority in food attractant traps. *Rhyzopertha dominica* found as dominant in K.N Shah and Mehar. The abundance of *Rhyzopertha dominica* and *Trogoderma granarium* were observed in the month of June at all studied areas. However, minimum number of both pest species trapped in April 2021 (Tables I, II, III, IV). In addition, significantly more *Rhyzopertha dominica* and *Trogoderma granarium* were captured in traps containing attractant oils than in control traps without their oils. The statistical significant and maximum number of pests were observed from the first 10 days (1-10) interval of May to the third 10 days (21-30) interval of June in selected four wheat storage sites of two talukas K.N. Shah and Mehar. While low record were recovered from 1st to 3rd 10 days interval of month April (Figs. 1, 2).

DISCUSSION

The present studies was aimed to observe efficacy of sticked glue traps against wheat stored grain pests in different wheat storage sites of district Dadu. No work has been published previously from Sindh and Pakistan using glue sticked traps. However, other researchers used different trapping models incorporated various attractants against stored grain pests like Barak and Burkholder (1984) used corrugated paper trap baited with vegetable oils against stored- product insects for detection and monitoring. Likewise, Barak (1989) also reported that septa pheromone lure was more attractive for adult males of *Trogoderma granarium* and fresh oils of sesame, pumpkin, oat and wheat for the larvae used in a corrugated paper trap. Similarly in our trap mixture of these oils except sesame was used as an attractant in which maximum *Rhyzopertha dominica* were attracted to traps in June when compared with *Trogoderma granarium*. In addition, several other authors have used sticky glue traps as in our research work like Mueller *et al*. (1990) who utilized lasiolure-baited glue traps in a laboritical work for cigarette beetles. Buchelos and Levinson (1985) examined sticky traps with TDA (100µg) capture six-time

Table III. Month-wise record (Mean±SD of trapped *Trogoderma granarium* in different wheat storing places of Taluka K.N Shah, District Dadu.

Month/year/ days	Areas of taluka	Govt: warehouses	Private warehouses	Grain stocking shops	Home silos	Control	Av: temp (°C)	Av: R.H (%)
April, 2021								
1-10	K.N Shah	52±4.58d	72.6±3.05d	40±8.54c	45±6.08d	32.6±20.2 d	40.1±2.50	17.8±4.02
11-20	Sita Road	76.6±8.50c	51.3±4.50d	105±9.0b	29±7.0d	15.3±10.1 c	40.1±2.39	20.5±7.61
21-30	Gozo	75±4.35d	63±5.0d	68±4.0d	9.0±2.0d	4.0±2.64 d	40.7±3.30	25±5.69
May, 2021								
1-10	Sindhi Butra	108±6.55b	130±4.58b	89±12.5ab	75.6±4.16b	44.3±40.4 c	41.9±1.76	22.6±3.53
11-20	Mitho Babar	134±10.5a	107.6±8.50b	85±8.0c	73±9.0b	40.6±44.1 c	42.8±2.19	23.9±3.10
21-30	Rahouja	117.6±2.30b	101±7.0b	131.6±12.7a	60±4.0b	30.0±17.3 c	45.6±3.43	24.5±8.32
June, 2021								
1-10	K.N Shah	136±7.54a	153.6±5.50a	106±14.5a	98.3±5.68a	47.0±37.9 b	45 ±1.39	30.6 ±4.69
11-20	Sita Road	150±11.5a	134±10.5a	140±6.0a	91±10.0a	39.0±17.5 b	43.8±2.33	31.5±2.06
21-30	Gozo	137±8.18a	121±8.0a	112±2.64b	39±3.0c	16.6±10.6 c	44.2±2.54	34±5.61
July, 2021								
1-10	Sindhi Butra	73±5.56c	95±3.60c	68±10.5b	56.6±3.05c	21.3±14.7 b	45.1±2.33	32.1±5.21
11-20	Mitho Babar	106±9.53b	76±6.55c	62±7.0d	54±8.0c	23.0±14.1 a	41.2±3.18	45.1±8.21
21-30	Rahouja	88.3±10.01c	81±6.0c	89±10.0c	86±5.0a	30.0±13.2 a	40.9±1.40	40.1±5.84

According to Fisher's least significant difference (LSD) test, values preceded by distinct letters differ significantly by 5%.

Table IV. Month-wise record (Mean±SD) of trapped *Tribolium castaneum* in different wheat Storing Places of Taluka Mehar, District Dadu.

Month/year/ days	Areas of taluka	Govt: warehouses	Private warehouses	Grain stock-ing shops	Home silos	Control	Av: temp (°C)	Av: R.H (%)
April, 2021								
1-10	Mehar city	47±9.0d	55.6±5.77b	20±0.0d	11.0±2.64c	9.66±9.01 d	39.5±2.72	16.4±3.62
11-20	Radhan	80±7.54d	35±7.0d	19±6.55d	4.0±4.0c	1.0±0.0 d	38.4±3.69	19±6.20
21-30	Bali Shah	48±1.0d	67±5.0d	14±3.0d	2.0±1.73d	0.33±0.57 d	41.4±3.91	26.1±4.93
May, 2021								
1-10	Mureed Lakhir	97±13.0b	70±7.0b	75±4.58b	28.3±10.0c	10.6±9.01 b	42.4±2.20	23.1±3.40
11-20	Betto	140.3±9.50b	89±10.0b	70±10.5b	29±6.0b	8.66±6.50 b	40.3±3.62	21.1±3.75
21-30	But Serai	94±3.0b	102±7.0b	57±5.0b	55.6±10.9ab	12.0±9.16 b	44.4±3.38	25.5±7.87
June, 2021								
1-10	Mehar city	121±15.0a	100±20.0a	96±6.55a	30±3.60b	16.0±8.71 a	44.6 ±1.58	32.1 ±4.19
11-20	Radhan	165±10.5a	110.3±5.50a	91±12.5a	65±7.0a	20.3±13.0 a	42.1±4.37	30.1±2.28
21-30	Bali Shah	118±4.0a	136±8.0a	75±6.0a	74.3±10.2a	24.3±3.0.9 a	45.2±2.54	35±5.86
July, 2021								
1-10	Mureed Lakhir	71±11.0c	120.3±0.5a	54±2.64c	51±4.58a	22.3±10.2 c	44.6±2.67	31.8±5.09
11-20	Betto	105±8.54c	61.6±14.8c	46±8.54c	10±5.0c	2.0±1.73 c	40.4±3.26	42.4±6.83
21-30	But Serai	74±2.0c	81±6.0c	30±4.0c	36.6±15.1bc	4.0±2.64 c	43±2.56	39.6±5.51

According to Fisher's least significant difference (LSD) test, values preceded by distinct letters differ significantly by 5%.

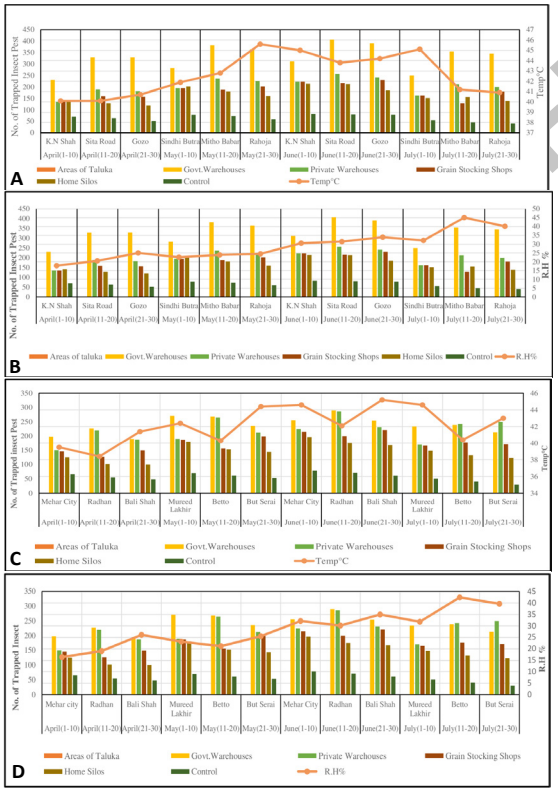

Fig. 1. Month wise record (Means) of trapped *Rhyzopertha dominica* and temperature (A, C) and RH (B, D) different wheat storing places of Taluka K.N. Shah (A, B) and Taluka Mehar (C, D) District Dadu.

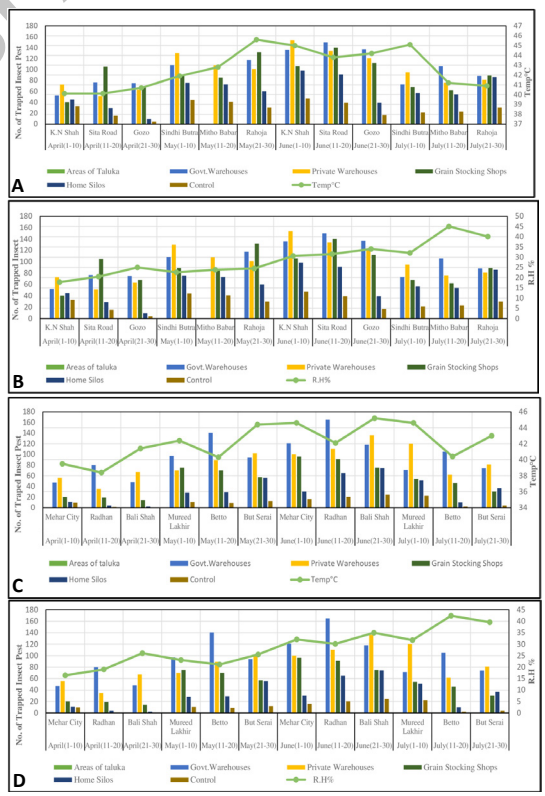

Fig. 2. Month wise record (Means) of trapped *Trogoderma granarium* along with temperature (A, C) and relative humidity (B, D) in different wheat storing places of Taluka K.N. Shah (A, B) and Taluka Mehar (C, D) District Dadu.

greater in comparison to no pheromone against *Ephestia elutella*. For Scolytid beetles, sticky traps have been practiced (Browne, 1978; Birch, 1979; McLean and Borden, 1979). Furthermore, Leos-Martinez *et al*. (1987) recorded baseball perforated traps had a significantly lower capturing efficiency than six other designated traps to lesser grain borer. Likewise in our studies minimum capture of khapra beetle observed in sticky glue traps. In addition, during the experimental work, some records of control (without the use of attractant oils) traps were taken, their capturing efficacy was 1/3 times declined observed at the food attractant traps in all sites. Most of the researchers conduct lab experiments for the installation of differently designed traps against stored grain pests at lab and warehouses with maintained temperature (22-27°C) and (60-70%) of relative humidity (Barak and Burkholder, 1984; Barak, 1989; Dowdy and Mullen, 1998; Lindgren *et al*., 1983). Our work was slightly contrary to these scientists.

CONCLUSION

The glue stick traps induced more adults of stored grain pest species *Rhyzopertha dominica* as compared to *Trogoderma granarium* larvae. Greater infestation of both species of stored grain pests were observed in Government granaries due to lack of maintenance and inappropriate storage. The glue stick traps mixed with different oil extracts proved effective in attracting *Rhyzopertha dominica* and *Trogoderma granarium*. *Rhyzopertha dominica* found as dominant in K.N Shah and Mehar Talukas of district Dadu. The abundance of *Rhyzopertha dominica* and *Trogoderma granarium* were found in traps in the month of June. It is suggested that if we use such types of traps properly during the initial infestation period in godowns it would be possible to obtain good control on stored grain pests.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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