

COMPARATIVE INSECTICIDAL EFFICACY OF PIPER GUINEENSE AND CAPSICUM FRUTESCENS (L.) ON TROGODERMA GRANARIUM (E)

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DOI: <https://doi.org/10.5281/zenodo.15752391>

Keywords**Article History**

Received on 19 May 2025

Accepted on 19 June 2025

Published on 27 June 2025

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Abstract

Wheat and other cereals sustain huge quantitative and qualitative losses each year all over the world due to the attack of storage pests. The damage caused by Khapra beetle is comparatively greater than other pests because of its ability to increase rapidly even under unfavorable environmental conditions. In developing countries like Pakistan these insect pests are managed by fumigation of highly toxic chemicals. Toxic chemicals create problems with environment and human health. Insecticidal properties of botanicals can be manipulated to get rid of these chemicals. The present study was planned to evaluate the effect of seven different plant powders against *Trogoderma granarium* in stored wheat grain under laboratory conditions. Chilli, Black pepper and Withania have insecticidal properties against wide variety of insect pests. There were seven treatments were used including untreated check. Powdery materials of Chilli, Black pepper and Withania were prepared by using two concentration that was 1 g/1000 and 5 g/1000. For mortality %, grain weight loss, larvae transformation to adults and grain damage loss was recorded at 10, 20, 30 and 40 days after insect release. For fumigation observation was noted at 24 hours, 3, 5 and 10 days after fumigation. The mortality was increased as dose and days increased. Significant differences were observed among different treatments of plant extracts in causing mortality of adults *Trogoderma granarium*. At treatments of 5 g/1000 concentration, maximum mortality was recorded in black pepper at 40 days after insect release as compared to remaining treatments. Minimum grain weight loss and grain damage loss in % were recorded at treatments of 5 g/1000 concentration in powdery materials of black pepper. The results showed for fumigation, as days increased the mortality % also increased with increasing concentration of black pepper, chilli and Withania. The results could be helpful in designing an effective management plan for the control of *Trogoderma granarium* in stored wheat grain.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is considered as the king of cereals around the globe. Worldwide production of wheat in million metric tons in different countries is ranking as European Union, China, India, Russia, United States, France, Australia, Canada, and Pakistan (FAOSTAT, 2017). In Pakistan, wheat is consumed as a staple food. Further, wheat contributes almost the 9.1 percent in value addition in agriculture and 1.7 percent in Gross Domestic Product (GDP) of Pakistan. The average total production of wheat was 27.3 million tones with an area of cultivation of 8,734 thousand hectares (Govt. of Pakistan, 2021). So, the dual-purpose wheat crop in the form of both grains and fodder fulfills the requirement of food as well as per capita demand of people and therefore, it is stated as a staple food of country (Shuja et al., 2010).

Wheat is tackled under storage by several insect pests, including khapra beetle, *Trogoderma granarium*, one of the most damaging pests in the World, including whole and ground cereal, oleaginous seeds, dry fruits, and other products. Its enormous economic importance is due to its ability to cause huge losses of stored grain due to voracious feeding and grain heating, larval hunger resistance for up to three years and its ability to live with foods that are extremely low in humidity. In addition to quantity losses, wheat grain infestations reduce germination and cause unpleasant odor, dirty appearance and abhorrent taste because of contamination with insect fragments and excrement (Khare et al., 1974). Severe khapra beetle infestations of grain can make it unpalatable or unmarketable. Grain quality may decrease as specific nutrients are depleted. A substantial reduction in crude fat, total carbs, sugars, and actual protein content is caused by 75% of the infection level in wheat, maize, and sorghum (Jood and Kapoor, 1993 and Jood et al., 1993, 1996).

The most important problems for grain storage are infested by insects and losses, particularly in villages and towns in developing countries due to wet-tropical conditions, poor sanitation and poor storage (Semple, 1985). In the current scenario, food quality and management efficiency are the most important guidelines for planning and any decision-making process, and all those responsible for storing and

preserving agricultural products must concentrate on reducing a high level of product loss.

Some insects cause serious damage to grain through indoor feeding, and others feed and hide inside cracked grains, which makes it very difficult to detect them, whereas some species are fed damaged grains or fines (Satya et al., 1996). In addition, insects may have an effect on cash reduction in their presence in grain because the damage to the quality, quantity and commercial value of the products (Santos et al., 1990), insect-related damage to the quality, quantity as well as the commercial worth of the items are influenced. The Coleoptera order includes many pests of stored product, and the red flour beetle is one of the most damaging secondary insect pests of durable product. Stored insect pests damaged our economy by infesting agricultural products stored and causing global losses of 10 to 40 per cent per year on stored grains (Mathews, 1993).

One of the most destructive pests in the World is the khapra beetle, the *Trogoderma granarium* known as the *Trogoderme du grain* (French), the *Khaprakafer* (German), the *Escarabajo Khapra* (Spanish). In fact, this is an EPPO quarantine A2 (OEPP/EPPO, 1981) classified as one of the World's 100 worst invasive species (Lowe et al., 2000). One of the most renowned insect pests of stored grains is the khapra beetle (*Trogoderma granarium*) (Sarmamy et al., 2011). It is one of the world's top 100 invasive plagues, mostly affecting Asia and Africa's tropical and subtropical regions (Lowe et al., 2005). Khapra beetle is very common in high temperature and low humidity geographical areas (Ghanem, 2007). *T. granarium* extends across the globe through cargo because it cannot fly and is an EPPO quarantine A2 (OEPP/EPPO 1981) The adult *T. granarium* does not feed, but the larvae do, and the stored product is severely polluted by mass weaving and frass (Musa et al., 2010). Secondary insect pests, particularly *Ephestia cautella* (Walker), and fungal colonization (*Aspergillus flavus* L.) is often followed by the infestation of the khapra beetle. This causes quality deterioration and loss of food grain weight (El-Nadi, 2001). Maize kernel feeds have been found to adversely affect mineral quality, available carbohydrates, protein and starch digestibility and protein bioavailability. During their development,

larvae consume an average of 3-12 mg of food and females eat about twice as much as males. In constant darkness there was more food; On the other hand, Constant light accelerated growth but slowed oviposition. Losses due to khapra beetle range from 0.2 to 2.9 percent over the 1-10.5-month period (Irshad and Iqbal, 1994 Food grain storage losses owing to insects have been estimated to be between 10% and 18%. Pakistan has a 2.32 percent weight loss rate (Khan and Cheema, 1978).

Today, the focus has been on controlling stored pests with alternative control agents, such as plant leaves, flowers and seed extracts (Halawa et al., 2009). In addition, extracts from some medicinal plants can also be used that are beneficial to humans. The need for safe and natural methods of pesticide management is a major concern for health and the environment (Kostyukovsky et al., 2002). Many investigations on black pepper fruit have shown its great power as an efficient insecticide against a wide variety of pests (Khani et al. 2012), and its valuable spicy and food savor Worldwide is also known to have significant economic importance. In this study, the importance of wheat, its insect pests and its management by means of environmentally friendly methods was evaluated with the objectives. To evaluate the mortality of the khapra beetle by insecticidal activity of the red chilli, black pepper and withania, to assess the impact of the red chilli, black pepper and withania powder on larval transformation of khapra beetle and to calculate the grain damage loss of wheat treated by different plant powder by khapra beetle Present study was aimed to assess the dose rates of the indigenous plant extracts against the khapra beetle that lead to eco-friendly management of stored grains.

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MATERIALS AND METHODS:

The research was conducted in the Department of Plant Protection, Faculty of Agricultural Sciences, Ghazi University, Dera Ghazi Khan, Punjab Pakistan.

Collection of Insects:

Heterogeneous sample of adults of *Trogoderma granarium* were collected for rearing in the laboratory from local grain market of Dera Ghazi Khan.

Rearing of Insects:

The insect culture was maintained in disinfected jars in the incubator, at $30\pm 2^{\circ}\text{C}$ and 60 percent R.H., to achieve a homogenous population. For 60-90 minutes, wheat flour decontaminated at 60°C has been used as a culture medium. In each jar of 250g wheat, thirty larvae (20F+10M) were released. These same jars have been protected with soft cloth and firmly attached with rubber bands in order to prevent the beetles from running away. Beetles have been allowed to lay eggs three days in crop media before they have been removed with sieves and fine camel's hair brush from jars. During the experiment, the pest culture has been kept in ten disinfected jars packed with 250g wheat. The egg meal was put back in the same jars.

Collection of Plant Material:

Black pepper, Red chili and *Withania* were purchased from a local market of the city. Plant materials were cleaned from all mixing and dried under shade and were grinded by electric grinder into fine powders.

Plant Material Treatment:

Wheat grains of 1000g were dried and clean then placed in 1500g capacity jar. Plant material mixed with wheat grains after weighing on electric balance. Plant material mixed with grains in jars and shacked mixture well to get uniform mixing. The experiments were carried out separately for (1) population buildup, (2) feeding deterrence and biocide toxicity and (3) fumigant action. There were seven treatments including an untreated check in each of the three experiments. The treatments were replicated three times.

Population Buildup:

The population build up data was recorded 60 days after release of 30 larvae of insects. Latent effects of these treatments on insect population buildup were recorded after the emergence of F1 and F2 generations.

Feeding Deterrence and Toxic Action (Mortality):
1000 g clean, washed, dried under shade, and uninfected wheat grains were kept in experimental jars and 5g and 1g plant powder mix with these grains. In each jar 30 larvae of insect *T. granarium* (E.) of first instar released in each jar and one untreated jar for observation comparison. For this purpose, the procedure described by Jillani and Haq, (1984) was followed. The observation on percent grain infestation, grain weight loss and insect mortality were recorded at 10, 20, 30 and 40 days after insect release.

Fumigant action:

Smoke will be produced from test plant materials into a close specific prepared port. Transfer of smoke through a pipe into experimental jars for a fixed interval of time for different doses of treatment. Observation on insect mortality was recorded 24

hours After Fumigation Treatment (AFT) and 3 days AFT, 5 days AFT, 10 days AFT.

Statistical Analysis:

Data obtained were subjected to analysis of variance (ANOVA) using a general linear model procedure and significant difference ($P>0.05$), means were separated, (SAS, 2000).

RESULTS AND DISCUSSION:

Larval mortality on different concentration of Red Chilli, Black pepper and Withania

Larval mortality on red chilli

To check the larval mortality on red chilli we have used two different concentrations (5%, 1%) along with control treatment and the data was calculated after 10days, 20 days, 30 days and 40 days intervals, the detail of the results is described here

Table-1: Larval mortality of the khapra beetle on different concentration of Red Chilli after 20 days observation

Treatment	R1	R2	R3	Mean	% Mean	SD
Chilli 5%	29	28	30	29	96.67	1
Chilli 1%	27	25	28	26.67	88.88	1.52
Control	23	25	21	23	76.67	2

To check the larval mortality we used two different concentrations along with control and data was recorded after 10days, 20 days, 30 days and 40 days interval. According to our data after 10 days the highest mortality (29) was recorded on 5% concentration followed by (27) on 1% concentration while the lowest (23) on control treatment (Table-1).

Table-2: Larval mortality of the khapra beetle on different concentration of Red Chilli after 20 days observation

Treatments	R1	R2	R3	Mean	% Mean	SD
Chilli 5%	27	25	29	27	90	2
Chilli 1%	25	23	25	24.33	81.11	1.15
Control	21	22	20	21	70	1

According to table-2, after 20 days the highest mortality (27) was recorded on 5% concentration followed by (25) on 1% concentration while the lowest (21) on control treatment.

Table-3: Larval mortality of the khapra beetle on different concentration of Red Chilli after 30 days observation

Treatments	R1	R2	R3	Mean	% Mean	SD
Chilli 5%	25	23	26	24.67	82.22	1.57
Chilli 1%	23	20	22	21.67	72.22	1.55
Control	18	19	17	18	60	1

According to our data after analysis, after 30 days the highest mortality (25) was recorded on 5% concentration followed by (23) on 1% concentration while the lowest (18) on control treatment.

Table-4: Larval mortality of the khapra beetle on different concentration of Red Chilli after 40 days observation

Treatment	R1	R2	R3	Mean	% Mean	SD
Chilli 5%	24	33	23	26.67	88.89	5.51
Chilli 1%	21	17	19	19	63.33	2
Control	15	14	13	14	46.67	1

According to table-4, after 40 days the highest mortality (24) was recorded on 5% concentration followed by (21) on 1% concentration while the lowest (15) on control treatment.

Larval mortality on black pepper

To check the larval mortality on black pepper we have used two different concentrations (5%, 1%) along with control treatment and the data was calculated after 10 days, 20 days, 30 days and 40 days intervals, the detail of the results is described here

Table-5: Larval mortality of the khapra beetle on different concentration of Black pepper after 10 days observation

Treatments	R1	R2	R3	Mean	% Mean	SD
Black pepper 5%	29	29	29	29.33	97.78	0.55
Black pepper 1%	26	28	24	26	86.67	2
Control	22	25	24	23.67	78.89	1.25

According to table-5, after 10 days the highest mortality (29) was recorded on 5% concentration followed by (26) on 1% concentration while the lowest (22) on control treatment.

Table-6: Larval mortality of the khapra beetle on different concentration of Black pepper after 20 days observation

Treatments	R1	R2	R3	Mean	Mean%	SD
Black pepper 5%	29	28	28	28.33	94.44	0.55
Black pepper 1%	24	25	22	23.67	78.89	1.55
Control	19	22	21	20.67	68.89	1.55

According to our data after analysis, after 20 days the highest mortality (29) was recorded on 5% concentration followed by (24) on 1% concentration while the lowest (19) on control treatment.

Table-7: Larval mortality of the khapra beetle on different concentration of Black pepper after 30 days observation

Treatments	R1	R2	R3	Mean	Mean%	SD
Black pepper 5%	26	27	27	26.67	88.89	0.55
Black pepper 1%	21	23	20	21.33	71.11	1.55
Control	15	17	18	16.67	55.56	1.55

According to table-7, after 30 days the highest mortality (26) was recorded on 5% concentration followed by (21) on 1% concentration while the lowest (15) on control treatment.

Table-8: Larval mortality of the khapra beetle on different concentration of Black pepper after 40 days observation

Treatments	R1	R2	R3	Mean	Mean%	SD
Black pepper 5%	25	27	26	26	86.67	1
Black pepper 1%	19	20	17	18.67	62.22	1.55
Control	9	11	13	11	36.67	2

According to our data after analysis, after 40 days the highest mortality (25) was recorded on 5% concentration followed by (19) on 1% concentration while the lowest (9) on control treatment.

Table-9: Larval mortality of the khapra beetle on different concentration of Withania after 10 days observation

Treatments	R1	R2	R3	Mean	Mean%	SD
Withania 5%	29	30	29	29.33	97.78	0.55
Withania 1%	27	28	26	27	90	1
Control	24	27	26	25.67	85.556	1.55

According to our data after analysis, after 10 days the highest mortality (29) was recorded on 5% concentration followed by (27) on 1% concentration while the lowest (24) on control treatment.

Table-10: Larval mortality of the khapra beetle on different concentration of Withania after 20 days observation

Treatments	R1	R2	R3	Mean	Mean%	SD
Withania 5%	28	29	29	28.67	95.56	0.55
Withania 1%	26	27	25	26	86.67	1
Control	21	25	24	23.33	77.78	2.06

According to table-10, after 20 days the highest mortality (28) was recorded on 5% concentration followed by (26) on 1% concentration while the lowest (21) on control treatment.

Table-11: Larval mortality of the khapra beetle on different concentration of Withania after 30 days observation

Treatments	R1	R2	R3	Mean	Mean%	SD
Withania 5%	27	28	28	27.67	92.22	0.55
Withania 1%	23	26	23	24	80	1.71
Control	19	23	22	21.33	71.11	2.06

According to our data after analysis, after 30 days the highest mortality (27) was recorded on 5% concentration followed by (23) on 1% concentration while the lowest (19) on control treatment.

Table-12: Larval mortality of the khapra beetle on different concentration of Withania after 40 days observation

Treatments	R1	R2	R3	Mean	Mean%	SD
Withania 5%	26	27	27	26.67	88.89	0.55
Withania 1%	21	23	20	21.33	71.11	1.55
Control	17	20	18	18.33	61.11	1.55

According to table-12, after 40 days the highest mortality (26) was recorded on 5% concentration followed by (21) on 1% concentration while the lowest (17) on control treatment.

Grain damage loss

Grain damage loss on different concentrations on red chilli

To find out grain damaged loss by the insects' pest on treated grains we have used the two different concentrations (1%, & 5%) along with control treatment (untreated) and the data was calculated after 10 days, 20-, 30- and 40-days interval of treatment, the detailed results are described in the below tables.

Table-13: Grain damaged loss by khapra beetle treated with different concentration of red chilli after 10 days interval

Treatments	R1	R2	R3	Mean	% mean	SD
Control	925	940	949	938	93.80	12.16
Chilli 5%	980	975	969	974.67	97.46	5.51
Chilli 1%	960	970	965	965	96.50	5

According to data for 10 days of the treatments the lowest damaged (5%) was done on 5% concentration, while on 1% concentration the damage was 5.0 % and the damage on untreated grains was 12% (table-13).

Table-14: Grain damaged loss by khapra beetle treated with different concentration of red chilli after 20 days interval

Treatments	R1	R2	R3	Mean	% mean	SD
Control	855	870	885	870	87	15
Chilli 5%	975	969	965	969.67	96.97	5.03
Chilli 1%	957	967	960	961.33	96.13	5.11

According to data shown in table-14, the lowest damaged (5%) was done on T1 (5.03%) concentration, while on 1% concentration the damage was 5.11 % and the damage on untreated grains was 15%.

Table-15: Grain damaged loss by khapra beetle treated with different concentration of red chilli after 30 days interval

Treatments	R1	R2	R3	Mean	% mean	SD
Control	800	810	783	797.67	79.77	13.64
Chilli 5%	971	965	960	965.33	96.53	5.51
Chilli 1%	955	965	967	962.33	96.23	6.41

According to data for 30 days of the treatments the lowest damaged (5%) was done on T1 (5.51% concentration, while on 1% concentration the damage was 6.41 % and the damage on untreated grains was 13.64% (table-15).

Table-16: Grain damaged loss by khapra beetle treated with different concentration of red chilli after 40 days interval

Treatments	R1	R2	R3	Mean	% mean	SD
Control	750	730	732	737.33	73.73	11.04
Chilli 5%	968	962	957	962.33	96.23	5.50
Chilli 1%	952	962	965	959.67	95.97	6.89

According to data after 40 days of the treatments the lowest damaged (5%) was done on T1 (5.50% concentration, while on 1% concentration the damage was 6.89 % and the damage on untreated grains was 11.04% (table-16).

Grain damage loss on different concentrations on black pepper

Table-17: Grain damaged loss by khapra beetle treated with different concentration of Black pepper after 10 days interval

Treatments	R1	R2	R3	Mean	% mean	SD
Control	930	945	942	939	93.9	7.93
Black pepper 5%	982	978	972	977.33	97.73	5.03
Black pepper 1%	963	973	968	968	96.8	5

According to data after 10 days of the treatments the lowest damaged (5%) was done on T1 (5.03% concentration, while on 1% concentration the damage was 5% and the damage on untreated grains was 7.93% (table-17).

Table-18: Grain damaged loss by khapra beetle treated with different concentration of Black after 20 days interval

Treatments	R1	R2	R3	Mean	Mean%	SD
Control	862	889	873	874.67	87.47	13.54
Black pepper 5%	977	971	966	971.33	97.13	5.51
Black pepper 1%	959	970	963	964	96.40	5.54

According to data for 20 days of the treatments the lowest damaged (5%) was done on T1 (5.51% concentration, while on 1% concentration the damage was 5.54% and the damage on untreated grains was 13.54% (table-18).

Table-19: Grain damaged loss by khapra beetle treated with different concentration of Black after 30 days interval

Treatments	R1	R2	R3	Mean		SD
Control	806	816	793	805	80.5	11.56
Black pepper 5%	974	967	962	967.67	96.77	6.04
Black pepper 1%	957	969	969	965	96.5	6.93

According to data after 30 days of the treatments the lowest damaged (5%) was done on T1 (6.04% concentration, while on 1% concentration the damage was 6.93% and the damage on untreated grains was 11.56% (table-19).

Table-20: Grain damaged loss by khapra beetle treated with different concentration of Black after 40 days interval

Treatments	R1	R2	R3	Mean		% GWL	SD
Control	752	732	736	740	74	26	10.51
Black pepper 5%	970	965	967	967.33	96.73	3.27	2.51
Black pepper 1%	955	964	967	962	96.2	3.8	6.28

According to data for 40 days of the treatments the lowest damaged (5%) was done on T1 (2.51% concentration, while on 1% concentration the damage was 6.28% and the damage on untreated grains was 10.51% (table-20).

Grain damage loss on different concentrations on Wathania

Table-21: Grain damaged loss by khapra beetle treated with different concentration of Wathania after 10 days interval

Treatments	R1	R2	R3	Mean	% Mean	SD
Control	920	935	930	928.33	92.83	7.66
Wathania 5%	979	972	965	972	97.22	7
Wathania 1%	958	967	960	961.67	96.17	4.76

According to data for 10 days of the treatments the lowest damaged (5%) was done on T1 (7% concentration, while on 1% concentration the damage was 4.76% and the damage on untreated grains was 7.66% (table-21).

Table-22: Grain damaged loss by khapra beetle treated with different concentration of Wathania after 20 days interval

Treatments	R1	R2	R3	Mean	% Mean	SD
Control	858	882	862	867.33	86.73	12.82
Wathania 5%	971	967	961	966.33	96.63	5.03
Wathania 1%	955	965	956	958.67	95.87	5.51

According to data after 20 days of the treatments the lowest damaged (5%) was done on T1 (5.03% concentration, while on 1% concentration the damage was 5.51 % and the damage on untreated grains was 12.82% (table-22).

Table-23: Grain damaged loss by khapra beetle treated with different concentration of Wathania after 30 days interval

Treatments	R1	R2	R3	Mean	% Mean	% GWL	SD
Control	800	801	780	793.67	79.37	20.63	11.84
Wathania 5%	961	963	955	959.67	95.97	4.03	4.12
Wathania 1%	953	961	952	955.33	95.53	4.47	4.93

According to data for 30 days of the treatments the lowest damaged (5%) was done on T1 (4.12% concentration, while on 1% concentration the damage was 4.93% and the damage on untreated grains was 11.84% (table-23).

Table-24: Grain damaged loss by khapra beetle treated with different concentration of Wathania after 40 days interval

Treatments	R1	R2	R3	Mean	% Mean	SD
Control	748	726	727	733.67	73.37	12.41
Wathania 5%	957	959	950	955.33	95.53	4.76
Wathania 1%	948	955	949	950.67	95.07	3.79

According to data after 40 days of the treatments the lowest damaged (5%) was done on T1 (4.76% concentration, while on 1% concentration the damage was 3.79 % and the damage on untreated grains was 12.41% (table-24).

Larvae transformation to adults on different concentration of Red Chilli, Black pepper and Withania

Table-25 Larvae transformation to adults on different concentration of Red chilli after 10 days observation

Treatments	R1	R2	R3	Mean	SD
Control	9	8	10	9	6.31
Red Chilli 1%	6	7	7	6.67	4.21
Red Chilli 5%	5	4	4	4.33	3.54

According to table-25, after 10 days the lowest larvae to adult transformation (4.33) was recorded on 5% concentration followed by (6.67) on 1% concentration while the highest (9) on control treatment.

Table-26 Larvae transformation to adults on different concentration of Red chilli after 20 days observation

Treatments	R1	R2	R3	Mean	SD
Control	12	11	13	12	8.41
Red Chilli 1%	7	9	8	8	4.97
Red Chilli 5%	6	5	5	5.33	4.21

According to our data after analysis, after 20 days the lowest larvae to adult transformation (5.33) was recorded on 5% concentration followed by (8) on 1% concentration while the highest (12) on control treatment.

Table-27 Larvae transformation to adults on different concentration of Red chilli after 30 days observation

Treatments	R1	R2	R3	Mean	SD
Control	12	11	14	12.33	8.41
Red Chilli 1%	7	9	10	8.67	4.97
Red Chilli 5%	7	6	7	6.67	4.97

According to table-27, after 30 days the lowest larvae to adult transformation (7) was recorded on 5% concentration followed by (8.67) on 1% concentration while the highest (12.33) on control treatment.

Table-28 Larvae transformation to adults on different concentration of Red chilli after 40 days observation

Treatments	R1	R2	R3	Mean	SD
Control	14	15	19	16	9.85
Red Chilli 1%	8	10	11	9.67	5.64
Red Chilli 5%	8	7	8	7.67	5.64

According to our data after analysis, after 40 days the lowest larvae to adult transformation (7.67) was recorded on 5% concentration followed by (9.67) on 1% concentration while the highest (16) on control treatment.

Table-29 Larvae transformation to adults on different concentration of Black pepper after 10 days observation

Treatments	R1	R2	R3	Mean	SD
Control	8	9	9	8.67	5.64
Black pepper 1%	5	6	6	5.67	3.54
Black pepper 5%	5	5	4	4.67	3.54

According to table-29, after 10 days the lowest larvae to adult transformation (4.67) was recorded on 5% concentration followed by (5.67) on 1% concentration while the highest (8.67) on control treatment.

Table-30 Larvae transformation to adults on different concentration of Black pepper after 20 days observation

Treatments	R1	R2	R3	Mean	SD
Control	11	12	10	11	7.75
Black pepper 1%	6	7	7	6.67	4.21
Black pepper 5%	5	6	5	5.33	3.54

According to our data after analysis, after 20 days the lowest larvae to adult transformation (5.33) was recorded on 5% concentration followed by (6.67) on 1% concentration while the highest (11) on control treatment.

Table-31 Larvae transformation to adults on different concentration of Black pepper after 30 days observation

Treatments	R1	R2	R3	Mean	SD
Control	12	13	15	13.33	8.41
Black pepper 1%	7	9	8	8	4.97
Black pepper 5%	6	7	6	6.33	4.21

According to table-31, after 30 days the lowest larvae to adult transformation (6.33) was recorded on 5% concentration followed by (8) on 1% concentration while the highest (13.33) on control treatment.

Table-32 Larvae transformation to adults on different concentration of Black pepper after 40 days observation

Treatments	R1	R2	R3	Mean	SD
Control	13	13	16	14	9.18
Black pepper 1%	8	9	11	9.33	5.64
Black pepper 5%	7	8	7	7.33	4.97

According to our data after analysis, after 40 days the lowest larvae to adult transformation (7.33) was recorded on 5% concentration followed by (9.33) on 1% concentration while the highest (14) on control treatment.

Table-33 Larvae transformation to adults on different concentration of Withania after 10 days observation

Treatments	R1	R2	R3	Mean	SD
Control	8	10	10	9.33	5.64
Withania 1%	6	8	8	7.33	4.21
Withania 5%	5	7	7	6.33	3.54

According to our data after analysis, after 10 days the lowest larvae to adult transformation (6.33) was recorded on 5% concentration followed by (7.33) on 1% concentration while the highest (9.33) on control treatment.

Table-34 Larvae transformation to adults on different concentration of Withania after 20 days observation

Treatments	R1	R2	R3	Mean	SD
Control	9	12	12	11	6.31
Withania 1%	8	10	10	9.33	5.64
Withania 5%	7	8	8	7.67	4.97

According to table-34, after 20 days the lowest larvae to adult transformation (7.67) was recorded on 5% concentration followed by (9.33) on 1% concentration while the highest (11) on control treatment.

Table-35 Larvae transformation to adults on different concentration of Withania after 30 days observation

Treatments	R1	R2	R3	Mean	SD
Control	11	14	12	12.33	7.75
Withania 1%	10	11	12	11	7.08
Withania 5%	8	10	9	9	5.64

According to our data after analysis, after 30 days the lowest larvae to adult transformation (9) was recorded on 5% concentration followed by (11) on 1% concentration while the highest (12.33) on control treatment.

Table-36 Larvae transformation to adults on different concentration of Withania after 40 days observation

Treatments	R1	R2	R3	Mean	SD
Control	14	16	16	15.33	9.85
Withania 1%	12	13	13	12.67	8.41
Withania 5%	9	11	11	10.33	6.31

According to table-36, after 40 days the lowest larvae to adult transformation (10.33) was recorded on 5% concentration followed by (12.67) on 1% concentration while the highest (15.33) on control treatment.

Discussion:

It was observed in table that by increasing concentration mean mortality was also increased, Pal et al. (1996), Mohiuddin et al. (1993), EL-Lakwah and Kashlan (1999), El. Nadi, et al. (2001) supported our findings.

Review of work done on neem by Broeke et al. (2004) reported that many plant extract powder could be applied to protect seed in storage against insect pests. Similar finding of Sudesh (1990), Sharma (1999), Sahayraj and Paulraj (2000), Pardhan et al. (1962). Girish and Jain (1974) used plant powder and use

almost same doses has been tested in the present studies but could not control *Rhizopetha dominica*, however could considerably reduce *Trogoderma granarium*.

The present study relating with the work done in the past by Shah and Ahmad (1983), Moreira et al. (2007) who reported that seeds, flowers, leaf, stem and roots of datura plant has insecticidal activity against insect pests. The result of present study agreement with Pascual- Villalobos and Robledo (1998) who reported 70-100% mortality occurs by applying datura extracts, Kuganathan et al. (2008) who reported that the

mortality of insects increase by increasing concentration of datura extracts, Ahmed et al. (2005) reported that datura extracts were more effective than insecticides.

These results are agreement with those of Girish and Jain (1982) who reported that neem derivatives considerably reduce *Trogoderma granarium*, Bowry et al. (1986), Jacob and Sheila (1993), Susha and Karnavar (1993), Sharma (1999), Jilani et al., (2003) who reported neem extract significantly reduce the F1 progeny. Odeyemi and Ashamo (2005) reported that by increasing NSO and NLE concentrations emergence of *Trogoderma granarium* was decreased, Rahman and Talukder (2006) reported neem oil give better results against oviposition inhibition. Mahatma, (2006) used same doses and observed neem derivatives enhanced the mortality of egg, 4th and 6th larval stages of *Tribolium castaneum*. In the present studies red chilli, black pepper and withania have been tested against *Trogoderma granarium* on wheat treated in the concentration of 1gm and 5gm, in powder formulation each of red chilli, black pepper and withania for one complete insect generation. Results have shown that the 5gm concentration comparatively gave better results than 1gm concentration. However both the concentration that is 1gm and 5gm yielded good control with regard to mortality %, larvae formation, grain weight loss and grain damage loss.

REFERENCES

- Anonnyous, (2005). Plant health Australia grains industry bio-security plan, 1-21.
- Omar, K., Muhammad, N., Faraj, N.M., Malik, S.A.A., & Al-Farhani, M. I. (2012) Effect of some medicinal plants extracts and cypermethrin against Khapra Beetle (*Trogoderma granarium* Everts). *Em i rat e Jo u r n a l o f F o o d A g r i c u l t u r e* , 2244((22)), 120-127.
- Alam, M.S., S.S. Shaukat, M. Ahmad, S. Iqbal and A. Ahmad, 1999. A survey of resistance to phosphine in some coleopterous pests of stored wheat and rice grain in Pakistan. *Pak. J. Biol. Sci.*, 2 (3): 623-626.
- Al-Moajel, N.H. (2006). Use of Sesbana (L.) Merr Seed extracts for the protection of wheat grain against the Granary Weevil, *Sitophilus granaries* (L.) (Coleoptera: Curculionidae). *Sci. J. King Faisal Univ., (Basic Appli. Sci.)/ V. 7(2)*.
- Al-Moajel, N.H. and M.M. Al-Dosary (2002). Mesquite plant, *Prosopis juliflora* (SW). D.C. powders as protectants of mung been, *Vigna unguiculata* L. Walp. against *Callosobruchus maculatus* (Fab.) infestation. *J. Egypt. Ger. Soc. Zool. (39E): Entomology.* 67-77.
- Al-Moajel, N.H. and N.A. Al-Fuhaid (2003). Efficacy and persistence of certain plant powders against khapra beetle, *Trogoderma granarium* Everts. *Fayoum J. Agric. Res. & Dev.*, 17 (2) : 107 – 114.
- Asawalam E. F., S. O. Emosairue, F. Ekeleme, and Wokocha, 2007. Insectidal effect of powdered parts of eight Nigerian plant species against Maize Weevil, *Sitophilus zeamais* (Motschulsky) (Coleoptera: Curculionidae). *Electronic J. Environ., agric. Food Chem.*, ISSN: 1579-4377.
- Das, D.R., S. Parween, and S.I. Faruki, 2006. Efficacy of commercial neem-based insecticide, Nimbicidine® against eggs of the red flour beetle *Tribolium castaneum* (Herbst). *Univ. J. Zool., Rajshahi Univ.*, 25: 51-55.
- Haque, I., M.S. Anwar and B. Anisa, 1969. Control of “Khapra” beetle in larval stages by the use of malathion. *Agri. Pak.*, 20: 279-286.
- Hassan, M., M. Sagheer, A. Ullah, W. Wakil and A. Javeed, 2006. Responses of *Trogoderma granarium* (Everts) to different doses of *Haloxylon recurvum* extract and Deltamethrin. *Pak. Entomol.*, 28 (2): 25-29
- Jilani, G., R. Nazli, F. Ibrahim, A.H. Solangi and A.R. Kazmi, 2003. Growth inhibiting effect of neem seed oil obtained from different locations of Pakistan against red flour beetle. *Pak. Entomol.*, 25 (1): 95-99.
- Jood, S. And A.C. Kapoor, 1994. Vitamin contents of cereal grains as affected by storage and insect infestation. *Pl. Foods for Human Nutri.*, 46: 237-243.

- Keita, S.M, Vincent Ch., J.P. Schmit, J.T. Arnason and A. Belanger, 2001. Efficacy of essential oil of *Ocimum basilicum* L. and *O. gratissimum* L. applied as an insecticidal fumigant and powder to control *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). J. Stored Prod. Res. 37: 339-349.
- Kim S. I., C. Park, M.H. Ohh, H.C. Cho and Y.J. Ahn, 2003a. Contact and fumigant activities of aromatic plant extracts and essential oils against *Lasioderma serricorne* (Coleoptera : Anobiidae). J. Stored Prod. Res. 39, 11-19.
- Nawaz, A., 1999. Appraisal of weight losses in stored grains by *Oryzaephilus surinamensis* (L.) (Coleoptera: Cucujidae) and its mortality by plant extracts. M.Sc. (Hons) Thesis. Dept. Entomol., NWFP Agri. Univ., Peshawar. pp. 39.
- Nazli, R., G. Jilani, F. Ibrahim, A.R. Kazmi and A.H. Solangi, 2003. Repellency of neem seed oil obtained from different localities of Pakistan against red flour beetle. Pak. Entomol., 25 (2): 201-206.
- Niber, B.T., 1994. The ability of powders and slurries from ten plant species to protect stored grain from attack by *Prostephanus truncatus* Horn (Coleoptera: Bostrichidae) and *Sitophilus oryzae* L. (Coleoptera: Curculionidae). J. Stored Prod. Res. 30 (4) : 297-301.
- Ofuya, T. I. and E. O. Dawodu, 2002. Aspects of Insecticidal Action of Schum and Thonn Fruit Powders against (F.) (Coleoptera: Bruchidae). Nigerian J. Entomol., 19: 40-50
- Okonkwo, E.U., W.I. Okoye, 1996. The efficacy of four seed powders and their essential oils as protectants of cowpea and maize grains against infestation by (Fabricius) (Coleoptera: Bruchidae) and (Motschulsky) (Coleoptera: Curculionidae) in Nigeria. Intern. J. Pest Manage. 42: (3) 143-146
- SAS Institute (2000). Statistical Analytical Systems SAS/STAT User's guide version 8
- Shah, Z.H. and S. Ahmad, 1983. Evaluation of *Datura* (*Datura alba*) extract as an insecticide. Pak. Entomol., 5 (1-2): 5-8.
- Sharma, R.K., 1999. Efficacy of neem products against storage pests in maize. Ann. Agri. Res., 20 (2): 198-201.