INSECTICIDAL PROPERTIES OF *MORINGA OLEIFERA* L. (SOHANJNA) LEAF EXTRACT AGAINST *TROGODERMA GRANARIUM* IN STORED WHEAT

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ABSTRACT

Wheat (*Triticum aestivum)* is a major cereal crop and staple food for large part of the world. Unfortunately it is infested by large number of insect pests during storage. *Trogoderma granarium* is one of these pests. 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. *Moringa oleifera* has insecticidal properties against wide variety of insect pests. It can be grown easily and its growth is rapid as compared to other trees. Trees of *Moringa oleifera* are frequently observed in Pakistan. So, we tried to find its effectiveness against *Trogoderma granarium* in six varieties of stored wheat. Extract of *Moringa oleifera* in methanol was used. Hundred gram grains of each variety were treated with two concentrations i.e. 1% and 5% of *Moringa oleifera* extract. In case of control, seeds were treated with distilled water only. Then individuals were allowed to feed the treated grains. Effects of its exposure on larvae, pupae and adults were studied. Results indicated that it was highly promising for management of *Trogoderma granarium*. All concentrations performed better as compared to control. Effectiveness of *Moringa oleifera* extract was directly dependent upon concentration.

KEYWORDS:
Adult Survival, Botanical extract, % grains weight loss, larval mortality, larval, pupae, Wheat grains

INTRODUCTION

Wheat (*Triticum aestivum)* is considered as most significant crop among the cereals and serves as staple food in Pakistan. Its production was 25 million tones when it was grown on 9.045 million hectare [1]. It occupies maximum area under single crop. Wheat contributes 10.0 percent to value added in agriculture and 2.1 percent to GDP. Among wheat producing countries, Pakistan is included in top ten higher wheat producer countries.

The agricultural pests including insects, microbes and other physical factors caused loss of 10-25% after harvesting the crops [2, 3]. One third of total food product is lost during pre-harvest and post-harvest infestation by insect pests. Stored cereals are heavily damaged by beetles and moths [4]. Approximately 2000 insect species have been found to be pests of food products. It is estimated that khapra beetle can cause the loss of 0.2-2.9% of stored products within the period of 1-10.5 months. It is very serious pest of wheat, but its infestation is also observed on bajra, sorghum, rice, gram, maize and pulses during storage [5].

Khapra beetle *Trogoderma granarium* is one of the world's most damaging pests of whole and ground cereals, oilseeds, dry fruits and other stored products. Infestation of khapra beetle observed in grain storages, food processing plants, warehouses and other buildings [6]. The larval stage of khapra beetle is most destructive for stored wheat and many other stored products in Indo-Pakistan [7]. The larvae start its infestation on the germ portion of the grains and feed deep into them. It reproduces so rapidly that large population of larvae is found in the surface layers of binned grain, suggesting that, in stored grain most damage takes place within the top 30 cm. The larvae maintained its presence in stored products with very low moisture content and it is able to survive for a long period of time in inactive state [8]. Khapra beetle is more tolerant to

high temperature and low humidity as compared to any other insect. It frequently destroys the wheat grains and reduces the rate of germination of wheat [9].

One of environment friendly technique is the use of botanicals for pest management of storage. Botanical extract plays a significant role in the management of insect pests and approximately 2000 plant species have been explored that have insecticidal properties but unfortunately only few of them are being used against insect pests [10]. Many plant species posses insecticidal properties. Some botanicals possess the properties of pyrethrins, nicotine and rotenone [11, 12]. The plant extracts are safe to the environment, non-pollutant and are easily degraded. Some plants have been investigated which protect the stored products because they have repellent effects against the certain stored grain insect pests [13-16]. It is necessary to investigate the insecticidal properties of plants. Under the present investigation, therefore, insecticidal properties of *Moringa oleifera* leaf extract in stored wheat against *Trogoderma granarium* were evaluated.

MATERIALS AND METHODS

The experiment was performed to explore the insecticidal properties of *Moringa oleifera* against *Trogoderma granarium* in stored wheat. Six varieties of wheat (Galaxy-2013, Punjab-2011, Pasban-90, ASS-2011, Sahar-2006 and Faisalabad-2008) were infested with *Trogoderma granarium* at larval stage. Seeds of each variety were obtained from Punjab Seed Certification department and Punjab Seed Corporation in D. G. Khan. Research was conducted at zoological lab. of Ghazi University Dera Ghazi Khan, Pakistan. Completely Randomized Design (CRD) with factorial arrangement having three replications was applied. The experiment was performed for a period of 3 months during 2017.

Materials used in experiment were test population of *Trogoderma granarium*, leaf extract of *Moringa olifera*, seeds of 6 varieties, methanol, jars, petri dishes, cotton, filter paper No. 40, butter paper, muslin cloths, rubber band, sieves mesh, camel hair brush, beakers, bowls, distilled water and electrical balance.

Rearing and Collection of *Trogoderma granarium*. Required population of *Trogoderma granarium* was obtained from University of Agriculture, Faisalabad. Insects were taken to laboratory for rearing purpose to obtain homogeneous population. Insects were reared on grains. Insects were kept in plastic jar of 3 kg capacity. The jar was covered with muslin cloth with the help of rubber band. The insects were reared for about two weeks.

After rearing, the damaged grains containing eggs, larvae, pupae and adults were screened and then, healthy and equal sized larvae were transferred to experimental jars.

Preparation and Application of *Moringa oleifera* Leaf Extract. *Moringa oleifera* leaves were collected from different location of Dera Ghazi Khan. The fresh leaves washed with distilled water. The leaves were dried in under the shade. The shaded dried leaves of *Moringa oleifera* were powdered in an electrical grinder to prepare fine powder. *Moringa oleifera* leaf extract was prepared by using 200ml of Methanol with 100 Gram of powered. Electric shaker was used to shake materials. The extract was filtered with help of filter paper (Whatman No. 40). The extract was filtered three times to obtain maximum extractable. 0%, 1% and 5% concentrations were prepared and grains were treated with these concentrations. Three replications of each concentration were used. The jars were kept opened for few hours to allow evaporation of moisture. 25 larvae of test population were released in each concentration.

Preparation of Different Leaf Extract. Different concentrations i.e. 1% and 5% were prepared from crude leaves extracts of *Moringa oleifera.* The 1%concentration was prepared by using 1ml of *Moringa oleifera* extract which was poured into 99 ml of distilled water and for 5%, 5ml *Moringa oleifera* crude extract was poured into 95 ml of distilled water. While in case of 0% concentration, 100 ml of distilled water was used.

Data Recording. The data of all the treatments were recorded twice a week on the following parameters.

Larval Survival. The larval Survival of *Trogoderma granarium* was recorded by counting the number of larvae which was transformed into pupae.

Pupal Survival. The pupal survival of *Trogoderma granarium* was recorded by counting the number of pupae which was transformed in to the adult.

Adult Survival. Adult survival of *Trogoderma granarium* was recorded by counting the number of adults which was placed in the jars.

Larval Mortality %. The larval mortality of *Trogoderma granarium* was recorded by counting the number of larvae.

$$\text{Mortality\%} = \frac{\text{No. of insects alive in test}}{\text{No. of insects alive in control}} \times 100$$

Loss in Grain Weight%. Percent losses in grain weight were calculated by using given formula and percent gain weight loss of treated jars was compared with control.

$$\% \text{ weight loss} = \frac{(W\mu \times Nd) - (Wd \times N\mu)}{W\mu \times (Nd + N\mu)} \times 100$$

Wμ= Weight of undamaged grains
Nμ= number of undamaged grains
Wd= weight of damaged grains
Nd= number of damaged grains

TABLE 1
Comparison of Means for Larval Mortality

Varieties	After 3 days	After 7 days	After 11 days
V_1 = Galaxy-2013	4.33 A	7.11 A	11.00 A
V_2 =Punjab-2011	1.77 D	4.44 C	8.44 C
V_3 =Pasban-90	2.22 D	4.88 C	9.22 BC
V_4 = Aas-2011	3.22 BC	6.11 B	9.77 B
V_5= Sahar-2006	3.55 B	6.44 AB	9.88 B
V_6 = Faisalabad-2008	2.77 CD	5.00 C	9.44 B
LSD 0.01	0.9416	1.3173	1.5050

TABLE 2
Comparison of Means for Larval Survival

Varieties	After 3 days	After 7 days	After 11 days
V_1 = Galaxy-2013	12.33 D	8.22 D	4.55 C
V_2 =Punjab-2011	18.33 A	12.66 A	7.00 A
V_3 =Pasban-90	16.44 B	11.11 B	6.22 B
V_4 = Aas-2011	16.44 B	9.88 C	6.11 B
V_5= Sahar-2006	15.44 C	9.77 C	5.11 C
V_6 = Faisalabad-2008	16.44 B	10.88 B	6.11 B
LSD 0.01	1.0161	1.5787	1.1992

Statistical Analysis. Completely Randomized Design (CRD) with factorial arrangement having three replications was applied. Data recorded for entire parameters was examined. For means comparison, LSD test was employed.

RESULTS

Larval Mortality. Maximum larval mortality was occurred in Galaxy-2013(4.33%) that significantly ($p<0.01$) affected from other tested varieties due to the application of different concentrations (0%, 1% and 5%) of *Moringa oleifera* leaf extract after 3 days. While minimum mortality was observed in Punjab-2011 (1.77%). Non-significant results were recorded among Punjab-2011 (1.77%), Pasban-90 (2.22%) and Faisalabad-2008 (2.77%) as well as Aas-2011 (3.22%) and Sahar-2006 (3.55%) varieties. Larval mortality means comparison after 7 days represented that maximum mortality was recorded in Galaxy-2013 (7.11%), Sahar-2006 (6.44%) and Aas-2011 (6.11%) whereas minimum larval mortality was observed in Punjab-2011 (4.44%), Pasban-90(4.88%) and Faisalabad-2008 (5.00%) varieties, respectively. After 11 days of *Moringa oleifera* leaf extract application, increased mortality was noticed in Galaxy-2013(11.00%). Whereas decreased mortality was recorded in Punjab-2011 (8.44%) and other tested varieties showed non-significant results among each other.

Larval Survival. Maximum larval survival (18.33%) was observed in Punjab-2011 while minimum larval survival (12.33 and 15.44%) was recorded in Galaxy-2013 and Sahar-2006, respectively. Remaining varieties showed non-significant differences after 3 days exposure of various concentrations (0%, 1% and 5%) of Moringa leaf extract. After 7 days, lowest larval survival was recorded in Galaxy-2013 (8.22%) but highest survival noted in Punjab-2011 (12.66%). Statistical similar outcomes were observed between Sahar-2006 (9.77%) and Aas-2011 (9.88%) as well as Faisalabad-2008 (10.88%) and Pasban-90(11.11%). The means comparison after 11 days as given in Table 2 showed that increased larval survival (7.00%) was in Punjab-2011 variety that significantly differed from all varieties.

Pupal Survival. Comparison of means in Table 3 represented that maximum pupal survival (18.66%) was observed in Punjab-2011 while minimum pupal survival (12.88%) was recorded in Galaxy-2013. Some varieties such as Faisalabad-2008 (16.88%), Pasban-90 (16.66%) and Aas-2011 (16.22%) showed similar resultsexceptSahar-2006 (14.88%) after 3 days exposure of various concentrations (0%, 1% and 5%) of *Moringa oleifera* leaf extract. After 7 days, highest survival was noted in Punjab-2011 (11.44%) and lowest pupal survival was recorded in Galaxy-2013 (7.33%). Non-significant outcomes were observed among Aas-2011 (10.22%), Faisalabad-2008 (10.22%) and Pasban-90(10.11%). The means comparison after

11 days as given in Table 3 showed that decreased pupal survival was in Galaxy-2013(4.00%) and Sahar-2006 (4.77%) varieties that greatly differed from all varieties at exposure of 0%, 1% and 5% concentrations of *Moringa oleifera* leaf extract.

Adult Survival. Similar results were noticed among Pasban-90 (17.88%) and Faisalabad-2008 (17.44%) as well as Aas-2011 (17.00%) and Sahar-2006 (17.00%) varieties. Highest adult survival was recorded inPunjab-2011 (18.66%) while lowest adult survival was found in Galaxy-2013 (15.55%)

TABLE 3
Comparison of Means for Pupal Survival

Varieties	After 3 days	After 7 days	After 11 days
V_1 = Galaxy-2013	12.88 E	7.33 D	4.00 D
V_2 =Punjab-2011	18.66 A	11.44 A	6.88 A
V_3 =Pasban-90	16.66 BC	10.11 B	5.55 BC
V_4 = Aas-2011	16.22 C	10.22 B	5.44 BC
V_5= Sahar-2006	14.88 D	8.88 C	4.77 CD
V_6 = Faisalabad-2008	16.88 B	10.22 B	5.77 B
LSD 0.01	0.8415	1.7353	1.6391

TABLE 4
Comparison of Means for Adult Survival

Varieties	After 3 days	After 7 days	After 11 days
V_1 = Galaxy-2013	15.55 D	8.88 D	3.77 D
V_2 =Punjab-2011	18.66 A	12.33 A	6.88 A
V_3 =Pasban-90	17.88 B	12.11 A	6.55 AB
V_4 = Aas-2011	17.00 C	11.22 B	5.66 C
V_5= Sahar-2006	17.00 C	10.33 C	5.33 C
V_6 = Faisalabad-2008	17.44 BC	11.33 B	6.00 BC
LSD 0.01	1.2586	0.9329	1.3214

TABLE 5
Comparison of Means for % Grain weight loss

Varieties	After 15 days
V_1 = Galaxy-2013	97.48 A
V_2 =Punjab-2011	96.38 E
V_3 =Pasban-90	96.66 D
V_4 = Aas-2011	96.93 C
V_5= Sahar-2006	97.18 B
V_6 = Faisalabad-2008	96.84 C
LSD 0.01	0.2083

variety after 3 days. At exposure of various concentrations (0%, 1% and 5%) of *Moringa oleifera* leaf extract after 7 days, Galaxy-2013 (8.88%) significantly varied from all varieties. Non-significant results recorded among Punjab-2011 (12.33%) and Pasban-90(12.11%) as well as Aas-2011 (11.22%) and Faisalabad-2008 (11.33%) varieties except Sahar-2006 (10.33%). In Table 4, means comparison after 11 days showed that Galaxy-2013 (3.77%) had minimum adult survival. Maximum adult survival observed in Punjab-2011 (6.88%). Other varieties represented statistically similar results.

% Grains weight loss. Percent grains weight loss by the *Trogoderma granarium* in stored wheat was observed after 15 days. Maximum % grains weight loss was recorded in Punjab-2011 (96.38%) and Pasban-90 (96.66%). While minimum grains weight loss percent was observed in Galaxy-2013 (97.48%) and Sahar-2006 (97.18%) varieties. Statistically non-significant results were observed in Aas-2011 (96.93%) and Faisalabad-2008 (96.84%) varieties.

DISCUSSION

Synthetic insecticides in the form of fumigants are frequently used for management of *Trogoderma granarium* worldwide. Although these insecticides provide quick and satisfied results regarding insect pests. But excessive use of these insecticides is undesirable because it creates problems of toxicity, development of pesticide resistant populations, high cost of most of these chemicals, contamination of the environment. Recently the use of botanical insecticides has evolved as an alternative of synthetic insecticides [17, 18]. A large number of plants have been investigated that possess insecti-

cidal properties against stored insect pests. *Moringa oleifera* is one of them. It is native of the western and sub-Himalayan tracts, India, Pakistan, Asia Minor, Africa and Arabia [19, 20].

In Pakistan, *Moringaoleifera*is locally known as 'Sohanjna' and is grown throughout the country [21, 22]. *Moringa oleifera* is very impressive and amazing plant due to its tested, trusted and potential benefits from nutritional as well as medicinal point of views. It is frequently grown in Pakistan. Its insecticidal properties are being investigated against wide range of insect pests and it has proved highly effective against wide range of insect pests.

In the current investigation, we tested effectiveness of various concentrations of *Moringa oleifera* leaf extract against khapra beetle at larval, pupal and adult stages. Results indicated that all concentrations were effective against test population. Mortality was higher at all tested stages of test population as compared to control. Mortality was directly dependent upon the concentrations. Survival of test population was substantially lower at all concentrations of treatment as compared to control. Performance of botanical was at peak in wheat variety Galaxy-2013 in storage.

These insecticidal properties of *Moringa oleifera* are probably due to presence of phytochemicals like catechol tannins, gallic tannins, steroids, triterpenoids, flavonoids, saponins, anthraquinones, alkaloids and reducing sugars produced by plants for defense purpose [23].

Previously published work favors our results. Similar results were observed by [24]. They found that extracts of various parts of *Moringa oleifera* caused satisfactory mortality of larvae at 3rd instars of khapra beetle. *Moringa oleifera* leaf powder was more effective against adult stage of khapra beetle as compared to larval stage. [25] investigated that *M. oleifera* leaves and *Allium sativum*at 6% (w/w) caused 100% mortality of khapra beetle after five days of exposure. Work of [26] proved that *M. oleifera* leaf powder was significantly effective against *Callosobruchus maculates* in stored cowpea. Mortality was dependent upon concentration of extract. [27] explored that *Moringa oleifera* root powder was significantly effective against *C. maculates* in cowpea seed. [28] proved that *Moringa oleifera* leaf extract was more effective against *Odontotermes obesus* as compared to seed extract of *Moringa oleifera*.

[29] reported that *Moringa oleifera* leaf powder was effective on both the larvae and adults of *Trogoderma granarium* and showed repellent properties. [30-33] found that leaf extract of *Moringa oleifera* was repellent against khapra beetle.

Results of current study would encourage the use of *Moringa oleifera* for management of Khapra beetle. It would drive the attention of researchers to find its effectiveness against other stored insect pests. The results of research would hopefully reduce the use of fumigations which are hazardous for human health and environment.

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