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# Evaluation of Botanical Insecticides against Lentil weevil, *Bruchus lentis* Frolich (Coleoptera: Chrysomelidae: Bruchinae) under Laboratory Conditions

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**ABSTRACT**

**Environmental friendly pesticides with a natural origin can be used as an alternative to chemicals in plant pests control programs. Lentil weevil, *Bruchus lentis* Frölich, is one of the important pests of stored gram and pulses. Lentil weevil, *B. lentis* has developed resistance against fumigants and synthetic insecticides in developing countries. These chemicals are a big source of environmental pollution and also affect the non-target animals. This study was carried out in order to find alternate control program for management of insect pests seen in stored pulses. Therefore the present project was conducted in order to evaluate the effect of different doses of *Melia azedarach* L. (White cedar), *Achillea wilhelmsii* L. (Yarrow) and *Allium sativum* L. (Garlic) powders on adult population of *B. lentis*. The triply replicated experiment, using Completely Randomized Design (CRD), was carried out in the Agricultural and Natural Research Center of Yasouj, Iran. Three different doses (2.0g, 3.0g and 4.0g per 100g of grains) of each plant powder were used. The data for percent mortality was collected after three different exposure times (20, 40 and 60 days). Collected data was analysed statistically using Statistical software. Results indicated that among the different extracts, maximum mortality of adult lentil weevil was caused by powder of white cedar compared to other studied plants such as garlic and yarrow. Garlic showed maximum reduction of lentil weevil compared to yarrow.**

**Keywords:** *Achillea wilhelmsii*, *Allium sativum*, IPM, *Melia azedarach*, Pesticide, toxicity.

## INTRODUCTION

Genus *Lens* Miller includes six species: *Lens culinaris* Medikus, *L. tomentosus* Ladiz., *L. odemensis* Ladiz., *L. ervoides* (Brign) Grande, *L. nigricans* (M. Bieb) Godr. and *L. lamottei* Cezfr. Two subspecies are comprised in *L. culinaris* taxa; the cultivated lentil (*L. culinaris* subsp. *culinaris*), and the putative ancestor of the crop, *L. culinaris* subsp. *orientalis* (Boiss) (Cokkizgin and Shtaya, 2013).

Due to its protein and fiber contents, lentil is a worldwide food legume used in the human diet and livestock feed (Bhatty, 1987). This herbaceous plant needs very low agronomic inputs and it is frequently used in crop rotations because of its nitrogen fixing capacity (Bicer and Sakar, 2010). Lentil, an important leguminous crop, is the cheap source of protein in most countries including Iran (Ahlawat et al., 1991). All of these facts provide this crop with a huge potential in a climate changing world, rationing water for agriculture, elevating prices for fertilizers, and increasing demand for secure and available highly nutritional products (Kara, 2006).

The area under lentil cultivation is about 300,000 hectares in Iran with an average annual production of 160,000 tons (Center of Statistics of Ministry of Agriculture Iran, 2013). This size of cultivation has been promoted due to the policies set by the Iranian Ministry of Agriculture. Hence, the province of Kohgiluyeh va Boyerahmad increased the cultivation area from 4500 hectares in the farming year of 2008 to 6350 hectares in the farming year of 2012 (Ministry of Agriculture Iran, 2013). The increase in cultivation area prepares the situation for harmful activities of pests, diseases, weeds and finally crop damage and yield decrement.

Bruchids belonging to genus *Bruchus* (Coleoptera: Chrysomelidae: Bruchinae) are the most damaging pests of lentil crop as seed weevils (Malik and Saxena, 1992). *Bruchus lentis* Frolich is one of the most important pests causing serious damages to lentil in Iran and around the world (Campbell and Runnion, 2003). They appear in high population in fields and storages in central and western Europe (Gorham, 2010), Mediterranean coasts (Good, 2000) and Iran (in the provinces of east- Azerbaijan, west-Azerbaijan, Hamedan, Ghazvin, Tehran, Isfahan and Fars) (Taghizadeh-Saroukolahi and Meshkatalsadat, 2010). Currently, this is a major pest of lentil in Iran (Taghizadeh-Saroukolahi and Meshkatalsadat, 2010). In Gachsaran, the warm regions of Kohgiluyeh va Boyerahmad, *B. lentis* have been reported by Saeidi (1999) for the first time in 1998. It is known as the main pest of lentil in this province and one of the most important insect threats to stored grains. It is cosmopolitan and also a serious pest of peas, cowpeas, cotton seed, sorghum and maize (Aydogan et al., 2003). Bruchid larvae cause major losses of grain legume crops throughout the world. Some bruchid species, such as the cowpea weevil and bean weevil, are pests that damage stored seeds. Others, such as the pea weevil (*Bruchus pisorum*), attack the crop growing in the field. Both larvae and beetles are responsible for causing the damage. Duke and Yadav (2000) reported 30-60% loss in seed weight and 40-65% loss in protein content due to its damage and pulse seeds become out of shape for human consumption as well as for planting.

The control of this pest in storage systems mainly depends on fumigants such as methyl bromide or phosphine, and fogging with pyrethrins or dichlorvos. However, methyl bromide has been banned in many countries since 2004 because of its ozone depleting properties (Hansen and Jensen, 2002; Saeidi and Yousefi, 2013; Saeidi and Hassanpour, 2014).

Synthetic pesticides have been considered the most effective and accessible means of controlling insect pests of stored products (Raghuvanshi and Singh, 2008). These chemicals are associated with undesirable effects on the environment due to their slow biodegradation and some toxic residues in products, affecting mammalian health (Benhalima et al., 2004; Isman, 2006; Halder et al., 2010). Nevertheless, this method has some drawbacks like infested lentils are no longer suitable for human consumption (FAO), and their germination capacity may be reduced up to 45% (Smith and Turan, 2006). Pesticides application during flowering in order to decrease the adult population of the pest in the field is also feasible, but it is not usually performed due to the high cost of the treatment in comparison with the low prices of the crop in the market (Smith and Turan, 2006). Literature concerning method to control this pest is scarce and only refers to phenological escape in some *L. culinaris* varieties (Duke and Yadav, 2000). The adverse effects of synthetic pesticides have amplified the need for an effective and biodegradable pesticide.

Natural products are excellent alternatives to synthetic pesticides as a mean to reduce negative impacts on human health and the environment. Essential oils of aromatic plants among the various kinds of natural substances have received particular attention as natural agents for insect management. Plant powders are renewable, non-persistent in the environment and relatively safe to natural enemies, non-target organisms and human beings (Halder et al., 2010). Therefore, botanicals insecticides (plant powders) are used as grain protectants as they have insecticidal properties against stored grain insect pests (Isman and Machial, 2006; Bahl et al., 2008) as well as being safer for human health and the environment (Warkentin et al. 1991; Rehman et al., 1992). Therefore, the main goal of the present study was to evaluate the insecticidal activities of powders from *M. azedarach*, *A. wilhelmsii* and *A. sativum* against *Bruchus lentis* under laboratory conditions.

## MATERIALS AND METHODS

### Experimental Condition:

The studies were conducted in the Agricultural and Natural Resources Research Centre of Yasouj, Iran. The culture medium was the whole lentil grains sterilized at 60°C for 60-90 minutes. Ten jars of 300 mg were used. Each jar was filled with 250g lentil grains and 30 beetles were added to each jar. The jars were then covered with muslin cloth, tied with rubber bands to avoid the escape of beetles and the entry of ants. Beetles were left in the culture medium for 3 days for egg laying and then were removed with the help of sieves and fine camel hair brushes.

The lentil grains containing eggs were placed again in the same jars and put in the incubator for incubation at 30±2°C and 65% RH to get the homogenous (same age) population. Relative humidity was maintained inside the incubator by placing an open tray filled with saturated solution of $NaNO_2$.

### Treatments:

In this experiment, dried plant materials were used in the powder form against lentil beetles. To prepare plant powders, 500 g of white cedar leaves, 500 g seeds of yarrow and 500 g bulbs of garlic were shade dried until they become crisp dry. The powder of these plant materials was obtained by grinding their dried form separately in a mechanical grinder and by sieving through a 60 mesh sieve. The resulting fine powder was used as direct admixture to the grains at different application rates of 2.0g, 3.0g and 4.0g per 100g of grains. Adults of *B. lentis* L. were subjected to various doses of *Melia azedarach*, *Achillea wilhelmsii* and *Alliun sativum* L. powders (2.0, 3.0, 4.0 g) for different exposure times (20, 40, 60 days).

Jars were used as exposure chambers. The required doses of botanical powders were applied thoroughly on the grains. Then, 20 adults of *Bruchus lentis* was put in each jar having 100 g sterilized grains dusted with different doses of botanical powders. Jars were covered with the muslin cloth tied with rubber bands to avoid the escape of beetles. The experiment was conducted using CRD. Each treatment was replicated three and was a control for each treatment. The mortality data was collected after 20, 40 and 60 days of application.

**Data Analysis:**

The data were analysed statistically by using MSTAT-C Software and means were compared using DMRT (Duncan Multiple Rage Test).

## RESULTS AND DISCUSSION

Adults of *B. lentis* L. were subjected to various doses of *Melia azedarach*, *Achillea wilhelmsii* and *Alliun sativum* L. powders (2.0, 3.0, 4.0 g) for different exposure times (20, 40, 60 days). Their interaction was determined in relation to percent mortality of the test insects. As seen in the tables 1-3, the percent mortalities were affected by natural pesticide application.

**Table 1.** The effect of *Bruchus lentis* mortality by application of different *Melia azedarach* L. powder doses at different exposure times.

| Treatment | $D_1$(2.0g) | $D_2$ (3.0G) | $D_3$(4.0g) | $D_4$ (0.0g) | Mean |
|---|---|---|---|---|---|
| **$T_1$(20 days)** | 70.00 d† | 75.00 cd | 78.33 cd | 11.667 e | 58.75 b |
| **$T_2$(40 days)** | 75.00 cd | 80.00 cd | 83.33 bc | 11.667 e | 62.50 b |
| **$T_3$ (60days)** | 90.00 ab | 93.33 a | 93.33 a | 10.00 e | 71.67 a |
| **Mean** | 78.33 b | 82.78 ab | 85.00 a | 11.111 c | |

†Means with different letters are significantly different at P≤5%.

As shown in table 1, by application of *Melia azedarach* L. powder, the maximum mortality occurred in the maximum dose of 4.0 g with 85% and lowest mortality occurred in the control treatment (0g) with 11.11%. It also shows that maximum mortality occurred in T3 exposure time of 60 days with 71.67% and lowest mortality occurred in the case of T1 exposure time with 58.75%. The interaction of concentration and time, maximum mortality occurred in T3D2 and T3D3 combinations with 93.33% and 93.33%, respectively and lowest mortality occurs in T3D4 10% treatment.

**Table 2.** The effect of *Bruchus lentis* mortality by application of different *Achillea wilhelmsii* L. powder doses at different exposure times.

| Treatment | $D_1$(2.0g) | $D_2$ (3.0G) | $D_3$(4.0g) | $D_4$ (0.0g) | Mean |
|---|---|---|---|---|---|
| **$T_1$(20 days)** | 58.33 c† | 63.33 bc | 66.67 b | 10.000 d | 49.58 c |
| **$T_2$(40 days)** | 66.67 b | 70.00 b | 70.00 b | 10.000 d | 54.17 b |
| **$T_3$ (60days)** | 78.33 a | 80.00 a | 83.33 a | 10.000 d | 62.92a |
| **Mean** | 67.78 b | 71.11 ab | 73.33a | 10.000 c | |

†Means with different letters are significantly different at P≤5%.

As shown in table 2, by application of *Achillea wilhelmsii* L. powder, maximum mortality occurred in the treatment of D3 dose (4.0g) with 73.33% and lowest mortality occurred in D4 (Control) treatment with the value of 10%. It also be seen that maximum mortality occurs in T3 exposure time of 60 days with the value of 62.92% and lowest mortality occurs in case of T1 exposure time of 49.58%. It can also be seen that there is a great interaction between exposure time and concentration of Achillea powder. Considering the interaction, maximum mortality occurs in T3D1, T3D2 and T3D3 combinations with the value of 78.33%, 80.00% and 83.33%, respectively and the lowest mortality occurred in T3D4 treatment with the value of 10%. The findings of present experiments were parallel with those of Togay et al. (1993), Polanco and Rennie (1995), Hawtin et al. (1996), Shade et al. (1996), Voelker and Sturm (1999), Osborn and Blake (2003) and Gulati (2007).

**Table 3.** The effect of *Bruchus lentis* mortality by application of different *Allium sativum* L. powder doses at different exposure times.

| Treatment | $D_1$(2.0g) | $D_2$ (3.0G) | $D_3$(4.0g) | $D_4$ (0.0g) | Mean |
|---|---|---|---|---|---|
| **$T_1$(20 days)** | 46.67 f† | 53.33 e | 56.67de | 11.667g | 42.08 c |
| **$T_2$(40 days)** | 58.33 cde | 61.67 bcd | 65.00 abc | 11.667g | 49.17 b |
| **$T_3$ (60days)** | 66.67 ab | 70.00 a | 71.67a | 10.000 g | 54.58a |
| **Mean** | 57.22 b | 61.67a | 64.44a | 11.111c | |

†Means with different letters are significantly different at P≤5%.

For *Allium sativum* L. powder, data of table 3 shows the maximum mortality occurs in D3 dose (4.0g) with the value of 64.44% and lowest mortality occurred in D4 treatment (0.g) with the value of 11.11%. It also shows that maximum mortality occurs in T3 exposure time of 60 days (54.58%) and lowest mortality occurred in T1 exposure time (42.08%). It also shows dose and exposure time interaction are significant. In case of interaction maximum mortality occurs in T3D2 and T3D3 combinations with the values of 70.00% and 71.67%, respectively. The least mortality occurred in T3D4 treatment with the value of 10.00%. The result of present study agrees with the results of Bahl et al. (2008) and White et al. (2007) for our findings. Both the scientists worked on Yarrow and it was found as effective legume pulse grain protection.

## CONCLUSION

Overall, the present study showed that maximum mortality of bean beetle was caused by powder of white cedar (*Melia azedarach*) compared to other studied plants such as garlic (*Allium sativum*) and yarrow (*Achillea wilhelmsii*). Garlic showed maximum reduction of bean beetle compared to yarrow. Mortality of bean beetle increased with exposure time increment. Further researches should be conducted on the extracts and essential oils of these plants on stored beans. We also recommend the application of the studied plant products with other bio-rational approaches.

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