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Research Article

Effect of Neem Leaf and Seed Powders Against Adult Maize Weevil (*Sitophilus zeamais* Motschulsky) Mortality

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Abstract

A laboratory study with the objective of investigating the effects of neem leaf and seed powder against maize weevil was conducted at Ziway Soil Research Centre of Ethiopia. The study had one factor neem seed powder at rates of 1, 2 and 3% w/w and control and another factor of neem leaf powder at rates of 1, 2 and 3% w/w and control. The treatments were arranged in CRD with three replications. Data were collected on dead adult weevils only. The dead adult weevils were counted within 10, 30 and 45 days after the infested maize was treated by neem seed powder and leaf powder. The collected data were subjected to one way ANOVA using the General Linear Model (GLM) procedures of SAS. Results showed that there were significant differences ($p<0.5$) in the mean percent mortality of *S. zeamais* among the different concentration of leaf and seed powder with time of storage. The highest mean mortality percent were recorded at the 3% w/w concentration. The 1, 2 and 3% w/w concentration rates of neem seed powder killed about 63.30, 70.72 and 82% of adult weevils, respectively throughout the storage period. Whereas the leaf powder treatment killed 61.13, 68.76 and 77.75% adult weevils respectively. It is concluded that the application 3% w/w of both neem seed and leaf powder are effective in the control of maize weevil and could be used as an alternative control option in integrated stored pest management strategies by small scale farmers.

Key words: Weevil, neem, seed, leaf, maize, powder, pest, mortality, concentration

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Maize (*Zea mays* L.) is a cereal grass related to wheat, rice, oat and barley. In terms of world grain production, it is ranked second next to wheat (Ogunsina *et al*., 2011). Maize can thrive in diverse climates conditions and is grown by small holder families in many countries of the world. It is considered as versatile plant with many uses (Ogunsina *et al*., 2011). First of all, it is one of the major sources of food for both human and animals. Apart from this, it is being processed into various food and industrial products including starches, sweeteners, oil, beverages, industrial alcohol and fuel ethanol. Likewise, thousands of foods and other everyday items such as toothpaste, cosmetics, adhesives, shoe polish, ceramics, explosives, construction materials, metal molds, paints, paper goods clothing, packaging, carpeting, recreational equipment and food utensils of renewable resource and textiles contain corn components. In addition, maize products are rapidly replacing petroleum in many industrial applications (Ogunsina *et al*., 2011).

Despite the mentioned uses of maize, it is attacked by various field and storage pests. Maize weevil (*Sitophilus zeamais*) is a major pest that attack stored maize grains in the tropics and temperate regions of the world (Sagheer *et al*., 2013; Adedire, 2001). The attack may start in the mature crop when the Moisture Content (MC) of the grain had fallen to 18-20% (Radha, 2014). Subsequent infestations in store result from the transfer of infested grain into store or from the pest flying into storage facilities, probably attracted by the odor of the stored grain. In stored maize, heavy infestation of this pest may cause weight losses of as much as 30-40% (Radha, 2014; Ogunsina *et al*., 2011). The pest also infests other stored cereal grains as alternative hosts. Notable among its secondary hosts is wheat, rice, sorghum and barley both in field before harvest and in storage (Adedire, 2001). According to Yohannes *et al*. (2014) the estimated global annual losses due to pest's activity in the field and storage are valued more than $100 billion.

In order to reduce serious losses experienced during storage, various techniques and control methods have been developed and more are still being developed. The destructive activities of insects and other storage pests have been adequately subdued by synthetic chemical control methods comprising fumigation of stored commodity with carbon disulphide, phosphine or dusting with malathion, carbaryl, pirimiphosmethyl or permethrin (Ileke and Oni, 2011). However, there are problems associated with the use of these synthetic chemicals. The problems of many synthetic insecticides include high persistence, poor knowledge of application, increasing costs of application, pest resurgence, genetic resistance by the insect and lethal effects on non-target organisms in addition to direct toxicity to users (Oni and Ileke, 2008; Akinkurolele *et al*., 2006).

Recently, there is a steady increase in the use of plant products as a cheaper, renewable and ecologically safer means of controlling insect pest infestations of stored cereal and grains especially in the tropics where the resource poor farmers are found (Ileke and Oni, 2011). Such plant materials include powders from parts of the neem tree (*Azadirachta indica* A. Juss). Mixing dried neem leaves with grain in storage is a classic example of natural product use that has been practiced by farmers in many countries for many years. Neem is well known for its insecticidal properties and it is very effective against a wide range of insect pests (Radha, 2014). The most active insecticidal ingredients are present mostly in the seeds, leaves and other parts of the neem (Sonalkar *et al*., 2014). Its various plant parts have been traditionally used to control domestic insects pests in stored grains, crop, in human and livestock medicine. These properties have been attributed to hundreds of chemicals present in the tree. Hence, the objective of this laboratory experiment was to determine the effect of ground neem leaf and seed against maize weevil and prolonged storage of neem leaf and seed powder on its insecticides activity.

MATERIALS AND METHODS

Experimental site: The study was conducted at Ziway Soil Research Centre. The Centre is found in Adami Tullu district of East Shoa Zone of Oromia regional state which is 160 km South of Addis Ababa. The geographical location of Adami Tullu districtis between 38°20′ and 38.5°5′ E and 7°35′ and 8°05′ N with an altitudinal range of from 1500-2000 m a.s.l. The average annual temperature ranges from 22-28°C. The area receives average annual rainfall ranging from 760-1000 mm in which the distribution is uneven and erratic in nature (Kebede, 2010). The major crops grown are maize, haricot bean, wheat and teff.

Plant materials collection and processing: Fresh neem seeds and leaves were collected from Ziway Office of Agriculture and Rural Development, Natural Resource Department and from nearby available trees, respectively. Whereas, maize grain and weevils were collected from local market and from earlier infested private warehouses that are found at Ziway. The collected neem seed and neem leaves were grounded by pestle and mortar separately at the laboratory.

Experimental details: The experiment had one factor neem seed powder and neem leaf powder with the rate of (1, 2 and 3% w/w). The treatments were arranged in Complete Randomized Design (CRD) with three replications.

Two hundred fifty grams of clean maize grain was placed in 1000 mL plastic beaker and thoroughly 30 adult weevils were added into it. After the infestation of weevils occurred in the beakers different rates (1, 2 and 3% w/w) of neem seed and (1, 2 and 3% w/w) leaf powder were applied in three replications. The application of treatment was taken under areas were no direct sun light affect as neem may lose its insecticidal properties if applied under direct sunlight.

Treatment details

Neem seed powder treatment:

- 1% w/w neem seed powder+250 g maize+weevils
- 2% w/w neem seed powder+250 g maize+weevils
- 3% w/w neem seed powder+250 g maize+weevils
- 0% control (maize+weevils)

Neem leaf powder treatment:

- 1% w/w neem leaf powder+250 g maize+ weevils
- 2% w/w neem leaf powder+250 g maize+weevils
- 3% w/w neem leaf powder+250 g maize+weevils
- 0% control (maize+weevils)

Data collection: Data were collected on dead adult weevils only. The dead adult weevils were counted within 10, 30 and 45 days after the infested maize was treated by neem seed powder and neem leaf powder. Dead weevils were recorded from the treated and the control plots. The first data was taken on the 11th day after the treatment application while the two later observations were taken on the 21st and 36th days after the first observation.

Data analysis: The collected data were subjected to one way analysis of variance (ANOVA) using the General Linear Model (GLM) procedures of SAS (2002). Comparison of treatment means was performed using Fisher's least significant difference test at $p<0.05$ probability level.

RESULTS AND DISCUSSION

The protection of stored products by the use of plant materials is a common practice among smallholder farms in Africa. In recent years, research efforts have focused on the use of natural products derivable from plants as viable alternatives to the conventional synthetic insecticides for protection of stored products (Abebe, 2006; Taddese, 2003). Gebeyehu (1996) indicated that plants with medicinal and biocide effects are found in Ethiopia and many of these plants may prove to have insecticidal value if properly evaluated on storage and field insect pests but little is known about their pesticidal effect so far. The analysis of this study confirms that neem materials offer a time tested novel approach to the management of stored product pests.

The analysis of variance showed that there were significant differences ($p<0.05$) in the mean percent mortality of maize weevil among the different concentration of neem leaf powder and neem seed powder with time of storage (Table 1 and 2).

The treatment of neem seed powder (with three concentration rates of 1, 2 and 3% w/w) showed different mortality potential on maize weevils. After 10 days of treatment application, the 3% w/w neem seed powder concentration was significantly different from the 2, 1 and 0% while the 2 and 1% neem seed powder were statistically at par to each other. And after 30 days of treatment application, the 3, 2 and 1% neem seed powder concentration were statistically at par with each other while they were statistically different from the control. Likewise, after 45 days of treatment application, the 2% concentration was statistically at par with the 3% concentration and the 1% concentration while the 3, 1 and 0% were statistically different. Consequently, the highest mean mortality percent were recorded at the 3% w/w concentration while the least was recorded

Table 1: Effect of neem seed powder on mortality of adult weevils within duration of treatment application

	Mortality		
Concentration of neem seed powders tested	10 days	30 days	45 days
3% w/w neem seed powder+250 g maize+weevils	27.33^{a}	26.00^{a}	28.67^{a}
2% w/w neem seed powder+250 g maize+weevils	22.12^{b}	24.00^{a}	24.60^{ba}
1% w/w neem seed powder+250 g maize+weevils	18.30^{b}	22.00^{a}	23.00^{b}
0% control (maize+weevils)	1.67^{c}	1.33^{b}	0.67^{c}
LSD	4.94	4.68	4.34
CV	10.86	11.90	8.61

Means along the same column with different superscripts are significantly different ($p<0.05$), LSD: Least significant difference, CV: Coefficient of variation

Table 2: Effect of neem leaf powder on mortality of adult weevils within duration of treatment application

	Mortality		
Concentration of neem leaf powder tested	10 days	30 days	45 days
3% w/w neem seed powder+250 g maize+weevils	25.35[a]	26.25[a]	26.15[a]
2% w/w neem seed powder+250 g maize+weevils	21.52[b]	24.12[a]	23.12[ba]
1% w/w neem seed powder+250 g maize+weevils	17.67[c]	22.31[a]	21.15[b]
0% control (maize+weevils)	1.51[d]	1.15[b]	0.45[c]
LSD	3.99	4.52	9.75
CV	9.16	9.32	4.59

Means along the same column with different superscripts are significantly different ($p<0.05$), LSD: Least significant difference, CV: Coefficient of variation

at the control. Hence, the 1, 2 and 3% w/w concentration rates of neem seed powder killed about 63.30, 70.72 and 82% of adult weevils, respectively throughout the storage period (Table 1).

The analysis of variance for the leaf powder concentration also showed statistical difference in the mortality of adult weevils. After 10 days of treatment application, the leaf powder concentration at rates of 3, 2 and 1% w/w and control were statistically different from each other while after 30 days of treatment application the 3, 2 and 1% w/w were statistically similar to each other and statistically different with the control. Besides, after 45 days of treatment application, the 2% concentration was statistically at par with the 3 and 1% while the 3, 1 and 0% were statistically different to each other.

Therefore, the leaf powder treatment (with 1, 2 and 3% w/w concentration) killed 61.13, 68.76 and 77.75% adult weevils, respectively. As the case with the seed powder treatment, still high rate of mortality was recorded at the 3% w/w of leaf powder treatment while the least was recorded at the control.

Comparing the neem seed powder treatment and neem leaf powder treatment, the highest mortality rate was recorded at the seed powder (82%). However, this high amount recorded at the seed powder is by far below than that considered the minimum effective concentration. According to Collingwood and Marchart (1971), the concentration that causes at least 95% mortality is considered the minimum effective concentration.

Comparing the findings of the present study with other findings, the present study is in line with the findings of Ileke and Oni (2011) and Khaliq *et al*. (2014). From their study on the toxicity of some plant powders to maize weevil, *Sitophilus zeamais* (motschulsky) (Coleoptera: Curculiondae) and on stored wheat grains (*Triticum aestivum*), Ileke and Oni (2011) found mortality of adult *Sitophilus zeamais* that increase with concentration from 2.5-25% w/w. Moreover, Khaliq *et al*. (2014) found at concentration of 5% w/w maize weevil mortality of 35.81% from *Glycyrrhi zaglabra* and mortality rate of 35.55% due to 24 h exposure to the same plant. From the same study Khaliq *et al*. (2014) found at concentration 5% w/w mortality rate of 55.01 and 63.56% from *Chicorium intybus* and *Terminalia chebula,* respectively and mortality rate of 46.11 and 48.88% due to exposure for 24 h for the same plants.

But, the present study mortality rate was lower than that found from the study conducted by Yohannes *et al*. (2014). Yohannes *et al*. (2014) found that after 10 days of exposure period, maize seed treated with 10 g of Mentha and Schinus leaf powder recorded 96.6% mortality followed by Melia (93.3%) and Phytolacca (90%). But the lower values recorded from the present study does not mean neem seed and leaf powder is not effective against the death of adult maize weevil. The result is due to the fact that the lower concentration level that was used in the present study. The leaf and seed powder insecticidal effect may increase or decrease with time as significant effect of the treatment is dependent on the active ingredient of each rate and the amount of powder that come in contact to each individual weevil. However, in this study there was no any trend of increase or decrease with time that we cannot conclude.

CONCLUSION AND RECOMMENDATION

Based on the high mortality results of the present study, it is concluded that the application neem seed and leaf powders on maize seeds might control the damage caused by the maize weevil, *Sitophilus zeamais*. Hence, use of neem seed powder and leaf powder as an alternative control option in integrated stored pest management strategies by small scale farmers as well as further research to reach the minimum effective concentration and on other plants of indigenous origin is recommended.

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