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Essaying some Plant Powders against Maize Weevil, *Sitophilus zeamais* (Motsch.), for Protecting Maize Grains from Damage

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ABSTRACT

The experiment was conducted to essay the efficacy of five plant powders, camphor (*Cinnamomum camphora* L.), datura (*Datura stramonium* L.), jatropha (*Jatropha curcas* L.), lantana (*Lantana camara* L.) and moringa (*Moringa oleifera* L.) against maize weevil, *Sitophilus zeamais*. The effect of the powders were observed at different doses, 0.0 (Control), 3.0, 6.0 and 9.0g /100g of maize grains on oviposition, adult emergence and percentages of weight loss and damaged grains. The lowest number of laid eggs was recorded in datura treatment at 3.0g dose, where it was 6.33 eggs then decreased gradually by dose increase to attain 1.66 eggs at 9.0g. Adult emergence decreased significantly by increasing powders doses to attain 1.33, 3.00, 4.66, 13.33 and 21.00 for datura, jatropha, lantana, camphor and moringa powders at 9.0g dose respectively. The highest percentage reduction of eggs and adult emergence were recorded in datura treatment at 9.0g dose, where it was 95.38 and 97.52%; then decreased gradually by decreasing dose to attain 82.41and 83.22% at 3.0g respectively. The lowest percentage of weight loss and infestation at 3.0g/100 grams in datura were 1.92% and 2.66% in average; increasing dose to 9.0g/100 grams gave 0.70 and 0.66% in average, respectively.

Keywords: *Sitophilus zeamais,* oviposition, adult emergency, weight loss, grain damage, plant powders.

INTRODUCTION

The maize weevil, *Sitophilus zeamais* (Motsch.) (Coleoptera: Curculionidae), is a main pest of stored maize grains in the tropics and temperate regions of the world (Adedire, 2001). Maize (*Zea mays* L.) belongs to the Gramineae family and is considered as the most important cereal crop after wheat and rice (Lyon, 2000). Searching for alternative insect control methods due to high costs of commercial synthetics, their toxicity and insect resistance to pesticides are a crucial need (Tembo and Murfitt, 1995). Currently, attention is being given to the use of edible plant materials as grain protectants (Ivbijaro and Agbaje, 1986; Adedire and Lajide, 2003; Akinkurolere *et al*., 2006; 2009 and Adedire *et al*., 2011). There is an increasing interest in plant products in the management of stored products (Arthur, 1996 and Haque *et al*., 2000). In many parts of Africa farmers mixed seeds with herbal materials to protect them against insect infestation (Ofuya, 1990). Some researchers found that plant powders are effective as plant insecticides in protecting grain and resisting stored grain pests (Ogunleye *et al*., 2004; Ogunleye, 2000 and Onu and Baba, 2003). Most of botanical products are non toxic to consumers and are readily available (Hassanali *et al*., 1990; Niber, 1994; Asawalam *et al*., 2006). Lots of plants are a rich source of new natural materials that can be used to develop environmentally safe ways to control insects (Arnason *et al*., 1989). Researchers have been tried to use plant products, which are readily cheap price, available and friendly-environmental to control stored grain pests such as *S. zeamais* (Ibe and Nwufo, 2001 and Wahedi, 2012). There have been many studies on different aspects of *Sitophilus* species, especially *S. zeamais*, and their economic importance and wide distribution (Udo, 2005; Asawalam and Emosairue, 2006; Abulude *et al*., 2007; Asawalam *et al*., 2007; Parugrug and Roxas, 2008; Efidi *et al.*, 2009 and Makate, 2010).

The aims of the study were to evaluate the effectiveness of camphor, datura, jatropha, lantana, and moringa leaves on oviposition and adult emergence of *S. zeamais* as well as the percentage of damage and weight loss of maize grains.

MATERIALS AND METHODS

Insect Rearing:

The weevils used in the study were obtained from naturally infested maize grains from Assiut market. Adults of *S. zeamais* were cultured in incubator at constant temperature of 27 ± 2°C and 70 ± 5% R.H. in the Laboratory of the Department of Plant Protection, Faculty of Agriculture, Al-Azhar University, Assiut Governorate during 2018. The healthy maize grains used in the experiment were sterilized by placing them in an oven at 40 ° C for 4 hours according to (Santhoy and Rejesus, 1975). Stock culture was introduced into the rearing bottles containing five hundred gram grains. The plastic jars were wrapped with muslin cloth and rubber band. The adults were sieved out after ten days of oviposition, then the infected grains with eggs were kept in the incubator for adult emergence which used of the experiment.

Plant powders:

The plant material used in the study was camphor, datura, jatropha, lantana and moringa leaves. These plant leaves were obtained from the Farm of Al-Azhar University, Assiut Governorate. Plant leaves were dried in the laboratory of the Department of Plant Protection, Faculty of Agriculture under shade for three weeks. After that it was grinded independently in to a very fine powder using an electric mixer and each powder was sieved by a 0.1 mm wire sieve. Plant powders were kept separately in polyethylene bags in the laboratory's refrigerator until to be used in the experiment (Mundi *et al*., 2012). Three doses per plant were used 3.0, 6.0 and 9.0g /100g of maize grains.

Table 1. List of plant common and scientific names, family and the parts used for preparing the powder.

Common name	Scientific name	Family	Used parts
Camphor	*Cinnamomum camphora* L.	Lauraceae	Leaves
Datura	*Datura stramonium* L.	Solanaceae	
Jatropha	*Jatropha curcas* L.	Euphorbiaceae	
Lantana	*Lantana camara* L.	Verbenaceae	
Moringa	*Moringa oleifera* L.	Moringaceae	

Experimental set up:

To determine the effect of the experimental materials against *S. zeamais*, one hundred grams of sterilized clean maize grains were placed in plastic jars 250 ml and treated with the doses 3.0, 6.0 and 9.0g. Powders were thoroughly mixed with the maize grains with the aid of glass rod to ensure thorough admixture each of the plant powders with grains. For each plastic jar five pairs of newly emerged adult were introduced, after that wrapped with muslin cloth and rubber band to allow ventilation and also to prevent the insects from escaping. In the control, there was no plant powders mixed with maize grains. Three replicates were made for each treatment. Experiments were carried out in incubator at 27 ± 2°C and 70 ± 5% R.H. On day five, all insects, both dead and alive were removed from each plastic jar and the grains returned to their respective jars.

1- Effect of plant powders on the reduction of eggs

Laid eggs were determined using the acid fuchsin staining method. Fifty grains of maize from each jar were randomly picked up on the 10th day, and were immersed in warm water for two to three minutes, then were drained in 0.5% acid fuchsin stain for two to five minutes. The grains were rinsed in water and were determined for cherry red gelatinous egg plugs, and the numbers of eggs on them were counted (Wahedi *et al*., 2013). The percentage of egg reduction was calculated according to Eman and Abbass (2010)

$$\%\,IR = \frac{\text{Number of eggs laid on control - Number of eggs laid on treated}}{\text{Number of eggs laid on control}} \times 100$$

2- Effect of plant powders on the adult emergence

At six weeks (42 days) of treatment, the adult emergence (F1) was then recorded. Percentage reduction in adult emergence or inhibition rate (% IR) was calculated according to Silassie and Getu (2009) using the following formula:

$$\%\,IR = \frac{\text{Number of F1 progeny in control - Number of F1 progeny in treatment}}{\text{Number of F1 progeny in control}} \times 100$$

3- Percentage of damaged grains and weight loss

At six weeks (42 days) of treatment, the weight loss of the grains was evaluated by subtracting the final weight from the initial weight for each jar. The percentage loss in weight was determinedaccording to Ileke and Oni (2011) as follow:

$$\%\,\text{Weight loss} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

After re-weighing, the percentage of grain damage was evaluated randomly by selecting 100 grains from each jar and counting the number of holes on each grain for all treatments, percentage grain damaged was also calculated as follows:

$$\%\,\text{Grain damage} = \frac{\text{Number of perforated grains}}{\text{Total number of grains counted}} \times 100$$

4- Data analysis:

Collected Data were subjected to the Analysis of Variance (ANOVA) using statistical analysis software (SAS) at 5% (P>0.05) level of significance, while the mean differences were separated using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Evaluation of five plant powders against the maize weevil, *Sitophilus zeamais*

1- Oviposition and reduction of eggs

Data in Table (2) showed the number of eggs laid on maize grains in untreated grains which was 36.00 eggs/ 50 grains. The mean numbers of eggs were laid on maize grains treated with 3.0g moringa and camphor powders were 21.66 and 17.33 eggs / 50 grains and were decreased by increase of powder dose to attain 12.00 and 9.33 eggs / 50 grains at 9.0g respectively. Jatropha and lantana powders exhibited a moderate effect on eggs laid by maize weevil at 3.0g dose. The mean numbers of eggs laid in jatropha and lantana treatments were 8.00 and 15.00 eggs / 50 grains. The number of laid eggs decreased as the dose of the powders was increased to attain 4.33 and 7.66 eggs / 50 grains at 9.0g respectively. The lowest number of laid eggs was recorded in datura treatment at 3.0g dose (6.33 eggs / 50 grains) then decreased gradually by increasing dose to attain 1.66 eggs / 50 grains at 9.0g. The highest percentage reduction of eggs was recorded in datura at 9.0g dose (95.38%) then decreased gradually by decreasing the dose to attain 82.41% at 3.0g / 50 grains, while the lowest percentage reduction of eggs was recorded in moringa at 3.0g dose (39.83%) then increased gradually by increasing the dose to attain 66.66% at 9.0g.

Table 2. Oviposition of *S. zeamais* on maize grains treated with different doses of plant powders.

Treatments	Dose (g/100g) grains	Mean no. of eggs / fifty grains ± SE	% Reduction of eggs
Control	0.0	36.00 ± 2.08 ^{a}	0.0
Camphor	3.0	17.33 ± 1.45 ^{cd}	51.86
	6.0	13.66 ± 2.33 ^{def}	62.05
	9.0	9.33 ± 0.33 ^{ghi}	74.08
Datura	3.0	6.33 ± 0.33 ^{ijk}	82.41
	6.0	4.00 ± 0.57 ^{kl}	88.88
	9.0	1.66 ± 1.20 ^{l}	95.38
Jatropha	3.0	8.00 ± 1.52 ^{hij}	77.77
	6.0	7.33 ± 0.88 ^{hijk}	79.63
	9.0	4.33 ± 1.45 ^{jkl}	87.97
Lantana	3.0	15.00 ± 1.15 ^{cde}	58.33
	6.0	10.33 ± 1.76 ^{fgh}	71.30
	9.0	7.66 ± 0.66 ^{hijk}	78.72
Moringa	3.0	21.66 ± 1.33 ^{b}	39.83
	6.0	18.00 ± 0.88 ^{bc}	50.00
	9.0	12.00 ± 0.00 ^{efg}	66.66

Means, in the same column, followed by the same letter are not significantly different at 0.05 level of probability.

2- Reduction of the adult emergence

Data in Table (3) showed the mean number of adult emergence of maize weevil, *S. zeamais* from maize grain treated with five plant powders as compared with untreated grains. The mean number of adult emerged from untreated maize grains was 53.66 adult. The mean numbers of maize adults emerged at 3.0g dose were 9.00, 11.33, 14.00, 20.33, and 32.00 for datura, jatropha, lantana, camphor and moringa powders. Adult emergence decreased significantly by increasing powder doses to attain 1.33, 3.00, 4.66, 13.33 and 21.00 adults for the aforementioned five powders, respectively. The highest percentage reduction of adult emergence was recorded in datura at 9.0g dose (97.52%) then decreased gradually by decreasing the dose to attain 83.22% at 3.0g. The lowest percentage reduction of adult emergence (40.36%) was recorded in moringa at 3.0g dose, then increased gradually by increasing the dose to attain 60.86% at 9.0g.

Table 3. Adult emergence of maize weevil, *S. zeamais*, from maize grains treated with different doses of plant powders.

Treatments	Dose (g/100g) grains	Mean no. of adult emerged ± SE	% Reduction of emerged adult
Control	0.0	53.66 ± 2.33 ^{a}	0.0
Camphor	3.0	20.33 ± 0.33 ^{d}	62.11
	6.0	15.00 ± 0.00 ^{e}	72.04
	9.0	13.33 ± 1.45 ^{ef}	75.15
Datura	3.0	9.00 ± 0.00 ^{gh}	83.22
	6.0	4.33 ± 0.66 ^{ij}	91.93
	9.0	1.33 ± 0.88 ^{j}	97.52
Jatropha	3.0	11.33 ± 0.66 ^{fg}	78.88
	6.0	5.66 ± 0.88 ^{hi}	89.45
	9.0	3.00± 1.52 ^{ij}	94.40
Lantana	3.0	14.00 ± 2.64 ^{ef}	73.90
	6.0	9.00 ± 1.15 ^{gh}	83.22
	9.0	4.66 ± 0.33 ^{ij}	91.31
Moringa	3.0	32.00 ± 0.57 ^{b}	40.36
	6.0	26.66± 0.66 ^{c}	50.31
	9.0	21.00 ± 1.00 ^{d}	60.86

Means, in the same column, followed by the same letter are not significantly different at 0.05 level of probability.

3- Infestation rate and grain weight loss

Data in Table (4) showed the mean loss in maize grain weight when treated with five plant powders at three doses, compared with untreated grains. The mean of loss in grain weight in untreated grains was 9.74%. In datura treatment, the loss in grain weight at 3.0g/100g dose was 1.92%, then increasing the dose to 9.0g/100g decreased the loss to be 0.70%. Jatropha powder followed datura powder in its efficiency in reducing maize grain weight loss at 3.0g dose; the mean of loss was 2.13%, then decreased gradually with the dose increase to attain 1.03% at 9.0g/100g. Moreover, moringa powder was the lowest one in reducing grain weight loss at 3.0g/100g dose where it was 4.02%, then decreased gradually to attain 2.44% at 9.0g/100g. However, lantana and camphor powders exhibited a moderate effect on grain weight loss at 3.0g/100g. The mean of loss was 2.88 and 3.19% and decreased gradually by dose increase to attain 1.38 and 1.92% at 9.0g/100g, respectively.

Results of the percentage of infestation in maize grains treated with three doses of five plant powders as compared with untreated grains are presented in Table (4). The percentage of infestation in untreated maize grains was 22.00% in average. However, moringa powder exhibited the highest infestation rate. The percentage of infestation at 3.0g/100g dose was 9.66% in average, and decreased gradually by increasing the powder doses to attain 4.00% at 9.0g/100g, in average. Datura powder showed the highest effect. The percentage of infestation ranged from 2.66% at 3.0g/100g dose to 0.66% at 9.0g/100g dose. Jatropha, lantana and camphor powders exhibited moderate effect; the percentages of infestation at 3.0g/100g dose were 3.00, 5.66 and 7.00% then gradually decreased to attain 1.33, 2.00 and 2.33% in average, at 9.0g/100g dose.

The results here are in the same line with the following studies: Kassa and Tadesse (1995) reported that lantana showed insecticidal activity against maize weevil by causing lower F1 progeny emergence compared to the untreated control. Ogendo *et al.* (2003) wrote up that the plant powders *Lantana camara* and *Tephrosia vogelii* and synthetic insecticide (Actellic Super™ 2% dust) reduced the first generation insects of maize weevil, *S. zeamais* by more than 75% compared to control. Ahmed and Din (2009) studied the effect of plant leaf powders of *O. basilicum, L. camara* and *Gardenia jasminoides* on some biological properties of *C. chinensis*.

Table 4. Percentage loss of grain weight and infestation maize treated with different doses of plant powders due to *S. zeamais*.

Treatments	Dose (g/100g) grains	Mean ± SE	
		Weight loss (%)	Infestation(%)
Control	0.0	9.74 ± 0.20 ^{a}	22.00 ± 1.15 ^{a}
Camphor	3.0	3.19 ± 0.03 ^{c}	7.00 ± 0.00 ^{cd}
	6.0	2.87 ± 0.09 ^{d}	5.33 ± 0.88 ^{de}
	9.0	1.92 ± 0.07 ^{gh}	2.33 ± 0.33 ^{ghij}
Datura	3.0	1.92 ± 0.05 ^{gh}	2.66 ± 0.33 ^{fghi}
	6.0	1.02 ± 0.06 ^{j}	1.00 ± 0.57 ^{ij}
	9.0	0.70 ± 0.04 ^{k}	0.66 ± 0.33 ^{j}
Jatropha	3.0	2.13 ± 0.00 ^{fg}	3.00 ± 0.57 ^{fgh}
	6.0	1.89 ± 0.09 ^{h}	2.00 ± 1.00 ^{hij}
	9.0	1.03 ± 0.05 ^{j}	1.33 ± 0.33 ^{hij}
Lantana	3.0	2.88 ± 0.07 ^{d}	5.66± 0.33 ^{de}
	6.0	2.17 ± 0.02 ^{f}	4.33 ± 0.33 ^{ef}
	9.0	1.38 ± 0.08 ^{i}	2.00 ± 0.57 ^{hij}
Moringa	3.0	4.02 ± 0.01 ^{b}	9.66 ± 1.20 ^{b}
	6.0	3.24± 0.12 ^{c}	7.66 ± 0.33 ^{c}
	9.0	2.44 ± 0.04 ^{e}	4.00 ± 0.00 ^{efg}

Means, in the same column, followed by the same letter are not significantly different at 0.05 level of probability.

In control, the number of eggs on chickpea grains was 158.7 eggs, while the lowest number of eggs was 9.33 eggs at dose 4% of basil powder as compared control. Ileke and Oni (2011) studied the effect of four plant powders including Neem (*Azadirachta indica),* Cheesewood (*Alstonia boonei*)*,* Drumstick (*Moringa oleifera*) and Bitter kola (*Garcina kola*) on the emergence of maize weevil, *S. zeamais* on stored wheat grains. The results indicated that *A. indica* and *A. boonei* provided the highest protection of the treated grains, and can be used as good protectants against *S. zeamais*, while *G. kola* and *M. oleifera* were not good enough protectants at the same tested concentrations. Mesbah *et al.* (2011) reported that the effect of plant powders of black pepper seeds, camphor leaves, dried peels of orange, cloves seeds and Latania leaves on *S. oryzae*. The results proved that camphor powder was the most potent material in preventing grains perforation and reducing the grain damage. Suleiman *et al*. (2012) tested the effect of some plant powders *Citrus sinensis* L., *Euphorbia balsamifera* L., *Jatropha curcas* L., *Leptadenia hastata* L. and *Lawsonia inermis* L. to protect sorghum grains against *S. zeamais* in storage. The highest adult emergence was observed when 0.5g of *L. hastata*, while the lowest adult emergence was at 2.0g of *J. curcas*. Ojo and Ogunleye (2013) evaluated the effect of eight plant powders namely; *Aristolochia repens* (stem), *Alstonia boonei* (stem bark), *Piptadeniastrum africanum* (root bark), *Piptadeniastrum africanum* (leaf), *Xylopia aethiopica* (fruit), *Picralima nitida* (seed), *Garcinia kola* (seed) and *Piper guineense* (seed) on the adult emergence of *S. zeamais* The results showed that the plant powders of *P. africanum* and *A .repens* completely suppressed the emergence of *S. zeamais* having the mean adult emergence to be zero (0) in all used concentrations. This was followed by the powders of *P. guineense* and leaf of *P. afrcanum* which had similar effect. The activities of plant powders of *A. boonei*, *X. aethiopica*, *G. kola* and P. nitida were moderate in reducing the number of adult emergence of *S. zeamais*. Chebet *et al*. (2013) investigated the efficiency of raw powders from *Azadirachta indica*, *Lantana camara* and *Tephrosia vogelii* and found that powders reduced the damage of grain and F1 offspring of *Prostephanus truncates*. Ojo *et al*. (2013) found that all concentrations of *M. oleifera* leaf powder considerably reduced the oviposition, emergence of F1 progeny of *C. maculatus*, seed damage and seed weight loss as compared to control. Nasiru *et al*. (2016) studied the effect of leaves powders from *Azadirachta indica* and *Jatropha curcas* and *Tamarindus indica* on laying eggs and adult emergence of maize weevil, *Sitophilus zeamais*. Neem was more effective in reducing oviposition and adult emergence than jatropha. Alemnew (2017) investigated the Effectiveness of leaf and seed powders for four plant plants, *Azadirachta indica* Juss, *Lantana camara* L., *Jatropha curcas* L. and *Croton macrostachys* Hochst against maize weevil, *S. zeamais* on corn grain stored under laboratory conditions. All plant powders reduced F1 emergence, seed damage and weight loss. In general, *J. curcas* and *A. indica* seed powder were found to be the most effective ones against maize weevil.

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اختبار بعض المساحيق النباتية ضد سوسة الذرة (Motsch.) *Sitophilus zeamais* لحماية حبوب الذرة من التلف

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أجريت التجربة الحالية لتحديد فعالية خمسة مساحيق نباتية، الكافور (*Cinnamomum camphora* L.)، الداتورا (*Datura stramonium* L.)، الجاتروفا (*Jatropha curcas* L.)، لانتانا(*Lantana camara* L.) و المورينجا (*Moringa oleifera* L.) ضد سوسة الذرة، *Sitophilus zeamais*. لوحظ تأثير المساحيق عند جرعات صفر (الكنترول) ، 3 ، 6، 9جم / 100جم من حبوب الذرة. تم تطبيق الاختبار علي كل من عدد البيض ، ظهور الحشرات الكاملة والنسبة المئوية لفقد الوزن و نسبة اصابة الحبوب. تم تسجيل أقل عدد من البيض في معاملة الداتورا عند جرعة 3جم حيث كان 6,33 بيضة لتتناقص تدريجيا بزيادة الجرعة لتصل إلى 1,66 بيضة عند 9جم. انخفض معدل ظهور الحشرات البالغة بشكل كبير بزيادة جرعات المساحيق لتصل إلى 1,33 ، 3,00 ، 4,66 ، 13,33 و21,00 لكل من الداتورا ، الجاتروفا ، لانتانا ، الكافور ومسحوق المورينجا بجرعة 9جم على التوالي. تم تسجيل أعلى نسبة انخفاض في البيض و ظهور للحشرات الكاملة في معاملة الداتورا عند جرعة 9جم حيث كان 95,38 و 97,52٪ ثم انخفضت تدريجيا بخفض الجرعة لتصل إلى 82,41 و 83,22٪ عند3 جم على التوالي. كانت أدنى نسبة إصابة وإنخفاض في الوزن في كل من المساحيق عند 3جم في الداتورا حيث بلغت 1,92 و 2,66٪ في المتوسط ، و عند زيادة الجرعة إلى 9جم بلغت نسبة الاصابة والفقد في الوزن 0,70 و 0,66٪ على التوالي.