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Evaluating Grain Protectant Efficacy of Some Botanicals against Maize Weevil, *Sitophilus zeamais* M

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Abstract The production of sorghum is threatened by a wide range of pre-and post harvest pests like stalk borer, sorghum chafer, and Sitophilus spp. Three botanical plants (*Tagitus minuta*, *Datura stramonium* and *Carissa schimperi*) with five concentrations were tested for efficacy to control maize weevil (*Sitophilus zeamais Mostch*) on stored sorghum seeds under laboratory conditions. The objective was to study the efficacy of some locally available botanicals to control *Sitophilus zeamais Mostch* and to determine the length of period the grain could be protected by the different treatments. For comparison, two more treatments-standard check Malathion 5% dust plus control (untreated check) were included; and the experiment was replicated three times. The experiment was conducted under room temperature at 25-28°C and relative humidity at 70±5% in Kombolcha Plant Health Clinic Laboratory. Powders of each plant component were then mixed thoroughly with 500 gram grains in plastic jars roofed with muslin cloth and tightened with rubber band. Thirty adult weevils were released in each plastic jars. Number of dead weevils was recorded every 21, 42 and 84 days after the treatments were applied. The data was transformed to arcsine scale prior to analysis. Corrected observations were subjected to statistical analysis, factorial ANOVA. All botanicals significantly affected weevil mortality compared to untreated check, but not as effective as synthetic insecticides (Malathion 5% dust). *Carissa schimperi* (merez) 5% was significantly more effective than the rest botanical rates and the control ($P < 0.05$). In general the result shows that treatment *Carissa schimperi* (merez) 5% and *Tagitus minuta* (gimi) 5% can solve poor resources farmers' problems by integrating them with other cultural measures. However further research are needed to fix the rate graph and the long term effect in large stores of farmers conditions.

Keywords: *pre-and post harvest pests, botanical plants, synthetic insecticides*

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1. Introduction

Sorghum, *Sorghum bicolar* (L) Moench, is the major food crop grown by millions of people in Ethiopia. It grows in a wide range of environments although it is dominant in low land regions where drought and poor harvest are common occurrence (Birhane, 1977). *Sorghum bicolor* is an important crop in the North eastern part of Amhara National Regional State. Sorghum is grown particularly in areas with low rainfall. In most sorghum growing areas the farmers consume bread or *'Injera'* made of sorghum flour alone or mixed with Teff.

The production of sorghum is threatened by a wide range of pre-and post harvest pests like stalk borer, sorghum chafer, sitophilus spp, etc. Till date more than 38 insect pests of stores are recorded attacking sorghum in Ethiopia (Adhanom and Abraham, 1986). Of these insect pests, Sitophilus spp.is the most common and perhaps the most destructive of all storage insect pests recorded in the northeastern region. Two species of Sitophilus sp. have been reported to attack sorghum. These include the maize weevil (*Sitophilus zeamais Mostch*) and the rice weevil (*Sitophilus oryzae* L.). It occurs in the tropical and subtropical belts as well as in warmer temperate region of all continents and is recorded very serious major pest of stored sorghum (Schumuttere 1990). Infestation often starts in the field and is carried later into the grain stores. About 15 percent weight loss had been reported in traditional storage facilities in Ethiopia (Yemane and Yilma, 1989).

Many farmers are interested in learning about non-chemical pest control, either because they have had insufficient money for pesticides, or because they are interested in farming more organically. So farmers in Ethiopia, use local herbs by mixing with grain to reduce infestation in stored grains (Yemane and Yilma, 1989). Based on the investigation made by Adane and Abraham (1995) and Mekuria (1995), there are promising botanicals which have insecticidal activity in the control of weevil. According to the practical field guide for the control of crop insects' report of BOA (1997) and Stoll (1996,1998 and 2000), plants (*Carissa schimperi* leaves, *Tagitus minuta* leaves, *Datura Stramonium* leaves, *Croton macrostachys* leaves, *Phytolace dodecandra* leaves, etc…)

have been identified for storage insect pest control. The objective of this study was, therefore, to evaluate the efficacy of some locally available botanicals to control *Sitophilus zeamais Mostch* and to determine the length of period the grain could protect by the different treatments.

2. Material and Methods

The trial was conducted under room temperature of 25-28^{0}c and relative humidity at 70±5% in Kombolcha Plant Health Clinic Laboratory. The experimental sorghum seed (local) that were brought from a market that is more susceptible for such weevil were disinfected by phostoxin gas in the bulk before used for the experiment. The leaves of *Tagitus minuta, Datura stramonium and Carissa schimperi* were collected for the study in North Wollo. Collected leaves were washed with distilled water and shade dried at room temperature for twenty days and crushed into fine powder using domestic grinder (Table 1). Powders were kept in polythene bags at room temperature and properly sealed to prevent quality loss (Chayengia *et al*. 2010). Powders of each plant component were then mixed thoroughly with 500 gram grains in plastic jars roofed with muslin cloth and tightened with rubber band. Thirty adult weevils were released in each plastic jars. The combinations of the treatments were 3 botanicals plants (*Tagitus minuta, Datura Stramonium and Carissa schimperi*) with five concentrations (1%, 2%, 3%, 4%, 5%) w/w and standard check Malthion 5% dust at the rate of 10ppm (50 gram/100kg of seed). The sample without powder served as control. The 17 treatments were replicated three times. The design of the experiment was laid in Complete Random Design (CRD). A total of 51 plastic jars and 25.5 kg of Sorghum grains were needed for the experiment. Number of dead weevils was recorded every 21, 42 and 84 days after the treatments were applied. Hundred seeds were taken at random from each replication of a treatment for germination test. The seeds were placed in petri dishes containing moistened paper and number of germinated seeds was recorded after seven days. Percent weight loss was estimated using count and weight method taking 1000 seeds randomly from each replication from all treatments (Gwinner *et al*., 1996). The data was transformed to arcsine scale prior to analysis. Corrected observations were subjected to statistical analysis, Factorial ANOVA. The data was analyzed by using the general linear model procedure of the statistical analysis system (SAS Institute, 2003).

$$\text{Weight loss} = \frac{(\text{Wu} \times \text{Nd}) - (\text{Wd} \times \text{Nu}) \times 100}{\text{Wu} \times (\text{Nd} + \text{Nu})}$$

Where Wu = weight of undamaged grains
Nu = number of undamaged grains
Wd = weight of damaged grains
Nd = number of damaged grains

Table 1. Botanicals with their scientific, local and common names and their parts used in the study

No	Botanical scientific name	Local name	Common name	Parts used
1	*Tagitus minuta*	Gimi	Marigold	Leaf
2	*Datura stramonium*	Atsefaris	Thorn apple	Leaf
3	*Carissa schimperi*	Merez	Merez	Leaf
4	Malathion 5% dust	Yetebay merz	Insecticide	Dust

3. Results and Discussion

There were (p<0.05%) significant differences among treatments in the rate of mortality (Table 2). All botanicals significantly affected weevil mortality compared to untreated check, but not as effective as synthetic insecticides (Malathion 5% dust). *Tagitus minuta* (gimi) 1%, *Datura stramonium* (atsefaris) 1% and *Carissa schimperi* (merez) 1% were significance compared to untreated check, where as the remaining treatments where highly significance compared to untreated check. *Tagitus minuta* (gimi) 5% was highly significance to *Tagitus minuta* 1-3%, *Datura stramonium* 1-4% and *Carissa schimperi* 1-4%, while *Carissa schimperi* (merez) 5% were highly significance compared to *Tagitus minuta* (gimi) 1-4%, *Datura stramonium* (atsefaris) 1-5% and *Carissa schimperi* (merez) 1-4%. On the other hand the mean effects of *Tagitus minuta* 1-5% was significantly affect weevil mortality as compared to the remaining two botanicals mean effect. Maximum mortality caused by *Carissa schimperi* (merez) 5% followed by *Tagitus minuta* (gimi) 5%. In general, mortality rate was increased with increasing the concentration of plant extracts and exposure time. Among different plant powders, the grains treated with *Tagitus minuta* (gimi) 1%, *Datura stramonium* (atsefaris) 1% and *Carissa schimperi* (merez) 1% produced low mortality (Table 2).

All botanical treatments revealed significantly (p<0.05) higher mortality at 21 and 42 days of exposure when compared to the control. The killing effect of almost all botanicals at different concentration rates was high at 42 days after treatment than 21 and 84 days after treatment. All weevils with sorghum seed treated with malathion 5% dust died within 21 days of treatment; and couldn't produce their progenies. In general the killing effect of all botanicals at different rat was highly reduced after 42 days after treatment (Table 3). That means the active ingredient persistence were lower after 42 days of treatments. Similar to Asmare (2002), the killing effect of botanicals is not acute as chemical insecticides in the first week after treatment. According to Adane and Abraham (1995) differences were observed among botanicals in speed of action within a month of storage period, i.e. some botanicals with different rate caused high mortality at 42 days after treatment.

Even though like weevil damage other factors, such as fungus and other storage insects also accounts for weight loss and germination percentage, the botanical treatment did not affect the germination percentage of sorgum. Good germination percentage was observed with malathion 5%,

Datura stramonium (atsefaris) 5%, *Carissa schimperi* (merez) 5% and *Tagitus minuta* (gimi) 5%. Moreover there was significance difference among treatments in weight loss (Table 2).

Table 2. Effect of different treatments on germination and weight loss of sorghum seeds

No	Treatments	Percent average record mention the figures at days after treatment					
		Weevil Mortality		Seed Germination		Seed Weight loss	
			Mean		mean		Meen
1	*Tagitus minuta* (gimi) 1%	20.75K	33.174B (B)	54.70K	64.62C (BC)	13.70E(EF)	11.38D (c)
2	*Tagitus minuta* (gimi) 2%	24.02J		63.50I		11.40F(g)	
3	*Tagitus minuta* (gimi) 3%	37.27E		66.70G		11.60F(g)	
4	*Tagitus minuta* (gimi) 4%	38.61D		68.50F		11.40F(g)	
5	*Tagitus minuta* (gimi) 5%	45.23C		69.70D		08.80G(h)	
6	*Datura stramonium* (atsefaris) 1%	20.87K	30.07D (C)	52.70L	63.48D (C)	18.80C	13.84C (B)
7	*Datura stramonium* (atsefaris) 2%	24.45J		59.70J		13.80E	
8	*Datura stramonium* (atsefaris) 3%	31.45I		63.30I		18.00D	
9	*Datura stramonium* (atsefaris) 4%	34.79F		69.70D		13.80E	
10	*Datura stramonium* (atsefaris) 5%	38.79D		72.00B		04.80I(j)	
11	*Carissa schimperi* (merez) 1%	20.67K	31.30bC (BC)	59.83J	66.21B (B)	21.60B	14.36B (B)
12	*Carissa schimperi* (merez) 2%	23.46J		64.10H		13.20E (F)	
13	*Carissa schimperi* (merez) 3%	32.46H		67.00G		18.00D	
14	*Carissa schimperi* (merez) 4%	33.50G		69.10E		13.20E(F)	
15	*Carissa schimperi* (merez) 5%	46.41B		71.00C		05.80H(i)	
16	Malathion 5% dust	100.00A	100.00A	75.30 A	75.30A(A)	04.90I(j)	4.90E(D)
17	Untreated check	08.630L	8.627E(D)	49.10M	49.10E(D)	33.40A(A)	33.40A(A)
CV %		1.7731	5.260	0.5152	2.39	2.3903	13.80
LSD		1.0084		0.5523		0.5523	

*Mean Values with the same letter indicate no significant differences among treatments ($p<0.05\%$)
*Letters inside the bracket indicate means comparison method by Fisher's LSD test
*Letters outside bracket indicate means comparison method by Duncan's multiple range test.

Table 3. Effect of treatments on adult weevil mortality (%) at days after treatment in laboratory

No	Treatments	Percent average mortality mention the figures at days after treatment		
		21	42	84
1	*Tagitus minuta* (gimi) 1%	28.200**L**	31.440**O**	2.610**N**
2	*Tagitus minuta* (gimi) 2%	26.687**M**	41.653**K**	3.723**L**
3	*Tagitus minuta* (gimi) 3%	48.870**F**	54.970**F**	7.970**E**
4	*Tagitus minuta* (gimi) 4%	57.521**E**	49.470**I**	8.830**D**
5	*Tagitus minuta* (gimi) 5%	62.010**B**	60.697**B**	12.973**A**
6	*Datura stramonium* (atsefaris) 1%	23.207**O**	36.367**M**	3.040**M**
7	*Datura stramonium* (atsefaris) 2%	29.840**K**	41.233**L**	2.273**O**
8	*Datura stramonium* (atsefaris) 3%	36.100**I**	53.200**G**	5.050**I**
9	*Datura stramonium* (atsefaris) 4%	42.680**G**	55.320**E**	6.370**H**
10	*Datura stramonium* (atsefaris) 5%	57.563**D**	49.473**H**	9.334**C**
11	*Carissa schimperi* (merez) 1%	23.097**P**	32.233**N**	6.667**G**
12	*Carissa schimperi* (merez) 2%	25.733**N**	42.933**J**	1.700**P**
13	*Carissa schimperi* (merez) 3%	35.740**J**	56.940**C**	4.700**J**
14	*Carissa schimperi* (merez) 4%	39.680**H**	56.327**D**	4.503**K**
15	*Carissa schimperi* (merez) 5%	57.980**C**	69.657**A**	11.593**B**
16	Malathion 5% dust	100.00**A**	No weevil	No weevil
17	Untreated check	05.123**Q**	14.060**P**	06.707**F**

*Values with the same letter indicate no significant differences among treatments ($p<0.05\%$)

4. Summary and Conclusion

The result shows that *Tagitus minuta (gimi) 5% and Carissa schimperi* (merez) 5% can solve poor resource farmers' problems by integrating them with other cultural measures. The present study has shown the effectiveness of some botanicals at different rate in controlling maize weevil on stored sorghum in Ethiopia. However further research are needed to fix the rate graph and the long term effect in large stores of farmers conditions.

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