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# Evaluation of five botanical powders against maize weevil, *Sitophilus zeamais* (Motsch.) (Coleoptera: Curculionidae) on maize (Jibat variety) under laboratory condition

**Tufa Bulto[1*], Mohammad Dawd[2] and Surendra Kumar Singh[1]**

[1]Department of Plant Sciences, College of Agriculture and Veterinary Sciences, and Horticulture, Ambo University, Ambo, Ethiopia.
[2]Entomology Research Center, Ambo Plant Protection Research Center, Ethiopian Agricultural Research Institute, Ambo, Ethiopia.

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**The present study was emphasized on low input technology entitled "Evaluation of five botanical powders against maize weevil, *Sitophilus zeamais* (Motsch.) (Coleoptera: Curculionidae) on maize (Jibat variety) under laboratory condition", thereby decreasing the loss of maize in storage. Leave powder of five botanical used at four doses such as 2, 5, 8 and 11% weight by weight with maize seeds were evaluated in completely randomized design. The data was taken within 24, 48, 72 and 96 h after treatment application. The botanical powder caused medium to maximum mortality of adult *S. zeamais*, *Calpurnia aurea* powder caused high adult mortality with mean 36.67 and 63.33% by doses of 2 and 11% (w/w) within 96 h, respectively. *Leonotis ocymifolia*, 46.67 and 56.67% at rate of 2 and 11% (w/w) caused high mortality next to *C. aurea*. While *Eucalyptus globules* 30.00 and 50.00% at rate of 2 and 11% (w/w), *Vernonia amygdalina* and *Justica schimperiana* caused low to medium adult mortality when compared with untreated control, but Malathion 5% dust at a rate of 0.1% caused 100% adult mortality within 24 h. Therefore, since these botanicals have no any adverse effects on the seeds and safe to the environment, they are recommended for future usage in storage grains to control of *S. zeamais*.**

**Key words:** Evaluation, botanicals, powder, *Sitophilus, Zea mays*.

## INTRODUCTION

Maize, *Zea mays* (L.) belonged to family Gramineae and is one of the third most important cereal crops after wheat and rice (Lyon, 2000). It occupies less land area than either wheat or rice, but has a greater average yield per unit area of about 5.5 tonnes per hectare (Ofori et al., 2004). The grain is very nutritious, with about 70 to 72% digestible carbohydrate, 4 to 4.5% fats and oils and 9.5 to 11% proteins (Larger and Hill, 1991). The maize kernel is also rich in vitamins and fats and makes the crop compare favorably, as an energy source, with root and tuber crops per unit quantity (Kling, 1991). Worldwide, about 66% of all maize is used for feeding livestock, 25%

*Corresponding author. E-mail: bultotufa@yahoo.com. Tel: +251912808067.

for human consumption and 9% for industrial purposes. In the developing world, about 50% of all maize is consumed by humans as food, while 43% is fed to livestock and the remainder for industrial purposes (IITA, 2003).

In sub-Saharan Africa, maize is mostly grown by small-scale farmers, generally for subsistence as part of mixed agricultural systems. Africa produced 7% of the 598 million tonnes produced worldwide in 138 million hectares per year (FAO, 2000). In Ethiopia, maize ranks first in total production and yield per hectare in cereals. It is a leading cereal crop with main season production of total average yield per hectare was 1.83 tons (CSA, 2005). However, maize seeds have been lost by different factors such as insect pests, diseases, rodents and environmental factors.

From insect pests, maize weevil, *Sitophilus zeamais* (Mostch.) (Coleoptera: Curculionidae) is an important insect-pest of maize in the tropics, causing serious losses to many poor farmers who stored grains on farm for use as food and seed (Bosque-Perez and Buddenhagen, 1992; Thanda and Kevin, 2003). Worldwide, seed losses from *S. zeamais* are 20 to 90% from untreated maize (Derera et al., 1999). *S*. *zeamais* causes significant loss of maize in the developing world reducing the 4.9 t/ha world average grain yield production to 1.5 t/ha average in sub-Saharan Africa (SSA). An annual average of 20 to 30% of this little grain is then lost through damage by this pest (Demissie et al., 2008).

*S. zeamais* is controlled by various management techniques: cultural practices, physical, biological control, botanicals, and chemicals control methods. Botanical method is one of the compatible methods to fit in IPM. Extracts of different plant materials are commonly used in insect pest control because it is relatively efficacious against virtually all life stages of insects (Adedire, 2002; Don-Pedro, 1990).

The widespread use of insecticides for the control of stored-product insect pests of global concern with respect to environmental hazards, insecticide resistance development, chemical residues in food, side effects on non-target organisms and the associated high costs (Cherry et al., 2005). To this effect, the increased public awareness and concern for environmental safety has directed research to the development of alternative control strategies such as the use of botanical plants against *S. zeamais*.

Thus, five botanicals (*Calpurnia aurea* (Ait.), *Eucalyptus globules* (Labill), *Vernonia amygdalina* Del., *Leonotis ocymyfolia* (Burm) and *Justica schimperiana* (Hochst)) were selected from Ambo Woredas of West Shoa, Oromia Regional State, Ethiopia. The botanicals were selected to see the effects of botanical powder on adults of maize weevil mortality at different hours Plant parts used for medicinal purposes indicated that, the local communities mostly use leaves (31.5%) and followed by roots (28.3%), fruit (8.2%), seed (6.5%), bark (4.9%), stem (3.4%), sap (3.3%), latex (1.6%), flower (0.5%), and others (13.1%). Endalew (2007) reported that fresh and matured leaf parts are effective against human and animal diseases than any other of its parts. *C. aurea* leaf powdered and mixed with cold water and a cup of coffee given to human cure ear pain; leaf of *E. globulus* powdered and added to soup of wheat powder and given to hen cure pain; powdered leaf of *J. schimperiana* is added to barley malt powder, 3/4 glass of tella given to cattle, horse and donkey can heal oral and internal parasites and intestinal parasites can be killed by using powdered leaf of *V. amygdalina* (Endalew, 2007).

## MATERIALS AND METHODS

### Tested plant

Fresh and matured leaf powder of local plants: *C. aurea* (Ait), *E. globules* (Labill), *V. amygdalina* (Del.), *L. ocymifolia* (Burm.f.) and *J. schimperiana* (Hochst) were collected, dried under shade, air-dried, pulverized and kept in separate plastic containers inside a refrigerator till the time for application. The dried plant samples were ground to fine powder using an electric laboratory hammer mill.

### Effect of plant powders on maize weevil's mortality

The toxic effect of plants on adult of *S. zeamais* was accomplished in jars (20 cm diameter) containing 200 g of maize grains with dose of 2, 5, 8, and 11% (w/w) of plant powders. The powder was thoroughly mixed with the aid of a glass rod and agitated for 5 to 10 min to ensure uniform coating. Ten pairs of emerged adults of weevils were introduced into the jars for experiment. The standard check, Malathion 5% dust, was used at the dose of 0.1%. Untreated control was also included. Adult mortality was observed daily. Adults were considered dead when no response was observed after probing them with forceps/brush (Ileke and Oni, 2011).

### Data collected

The data were collected from adult mortality of weevils applied by dose of 2, 5, 8, and 11% (w/w) of plant powders from each glass and the mortality was counted from each treatment at 24, 48, 72 and 92 h after application. At each observation, dead weevils were removed and counted.

### Experimental design and treatments

Completely randomized design (CRD) with three replications was used in double two way factorial arrangements in weevil's mortality. The number of treatments is 22 and the total number of treatments was 66 including standard check and untreated or control.

## RESULTS AND DISCUSSION

### Effects of plant powder on adults of maize weevil mortality

The results of adult *S. zeamais* mortality recorded for 24, 48, 72 and 96 h are shown in Table 1. 100% mortality of

**Table 1.** Mean percent cumulative mortality of adults of maize weevil after application of different botanicals.

| Botanical species | Doses (% w/w) | Mean % adult mortality, hours after exposure (h) | | | |
|---|---|---|---|---|---|
| | | 24 | 48 | 72 | 96 |
| *Calpurnia aurea* | 2 | 20.00[d] | 25.00[bcd] | 25.00[c] | 36.67[bcde] |
| | 5 | 33.33[cd] | 40.00[ab] | 36.67[cb] | 40.00[bcd] |
| | 8 | 40.00[b] | 40.00[ab] | 46.67[ab] | 56.67[b] |
| | 11 | 45.00[b] | 50.00[a] | 50.00[b] | 63.33[a] |
| *Eucalyptus globules* | 2 | 20.00[d] | 20.00[ed] | 30.00[c] | 30.00[de] |
| | 5 | 20.00[d] | 26.67[bcd] | 30.00[c] | 33.33[cde] |
| | 8 | 20.00[d] | 26.67[bcd] | 33.33[c] | 40.00[bcd] |
| | 11 | 30.00[b] | 40.00[ab] | 46.67[ab] | 50.00[ab] |
| *Vernonia amygdalina* | 2 | 20.00[d] | 30.00[bcd] | 26.67[bc] | 30.00 [de] |
| | 5 | 20.00[d] | 23.33[d] | 30.00[c] | 33.33[cde] |
| | 8 | 26.67[cb] | 36.67[bc] | 30.00[abc] | 30.00 [de] |
| | 11 | 30.00[b] | 40.00[ab] | 36.67[ab] | 36.67[bcde] |
| *Leonotis ocimifolia* | 2 | 20.00[d] | 26.67[cd] | 36.67[c] | 46.67[ab] |
| | 5 | 20.00[d] | 30.00[bcd] | 36.67[c] | 36.67[bcde] |
| | 8 | 20.00[d] | 30.00[bcd] | 40.00[bc] | 40.00[bcd] |
| | 11 | 30.00[b] | 45.00[b] | 56.67[a] | 56.67[b] |
| *Justica schrimperiana* | 2 | 20.00[d] | 15.00[de] | 20.00[c] | 20.00[e] |
| | 5 | 20.00[d] | 20.00[cd] | 20.00[c] | 20.00[e] |
| | 8 | 20.00[d] | 26.67[bcd] | 26.67[abc] | 23.33[de] |
| | 11 | 30.00[b] | 30.00[bcd] | 30.00[abc] | 36.67[abc] |
| Malathion 5% dust | 0.1 | 100.00[a] | - | - | - |
| Control | 00 | 6.67[e] | 10.00[e] | 3.33[d] | 6.67[f] |
| Means ±SE | | 4.54 | 12.12 | 12.12 | 21.21 |
| LSD (0.05) | | 6.65 | 10.87 | 10.87 | 14.38 |
| CV | | 9.26 | 11.26 | 9.53 | 11.18 |

*Means within a column followed by different letters are significantly different (P<0.05). Tukey Studentized test (HSD).

*S. zeamais* was recorded on seeds treated with Malathion 5% dust at rate of 0.1% w/w. All the extracts were not effective at the lowest dose rates. Maximum mortality 63 to 56% in 11% was recorded on *C. aurea* and *L. ocmyfolia* after 96 h and 20 to 45% and 20 to 30% mortality was recorded in *C. aurea* and *L. ocmyfolia* treated maize seed at the dose of 2 and 11% (w/w) for 24 h after application, respectively. There was highly significant difference with respect to the applied doses and length of time. As the doses of the treatments increased with extended time, the mortality rate of the *S. zeamais* was also increased. *E. globules* were recorded next to *C. aurea* and *L. ocmyfolia. E. globules* recorded high mortality of 20 to 30% at the dose of 2 and 11% (w/w) for 24 h after application and 30 to 50% at the dose of 2 and 11% (w/w) for 96 h after application.

Thus, there was significant difference between the different doses applied and the time interval. However, the applied doses of *V. amygdalina* and *J. schrimperiana* showed significantly lower mortality rate of 20 to 40% within 24 and 96 h after application, respectively. The mortality rate is the least significant difference within applied doses and time interval. Malathion was highly significant both at low time intervals. The mortality of *S. zeamais* adults recorded at 24 and 96 h after application was 100%. However, all treatments recorded high mortality rate and were highly significant (p≤0.05) against *S. zeamais* at 8 and 11% (w/w) for 96 h after treatment application (Table 1).

*C. aurea* is used for multiple purposes in Ethiopia. As Hutchings (1996) reported, *C. aurea* is a plant commonly used in traditional medicine to treat diverse medical conditions and parasitic infestation, both in humans and animals. Extracts of *C. aurea* have been used in South

Africa to treat maggot-infested wounds and in Ethiopia to treat scabies (Jansen, 1981). The use of dry leaf extracts is more effective than extracts of fresh leaves because of more concentration of insecticidal ingredient (Pandey et al., 2007).

In Western Ethiopia, the juice of crushed leaves is used for tick control (Regassa, 2000). The Borena people of Southern Ethioppia soak leafs of *C. aurea* in cold water to treat louse infestations in humans and calves (Heine and Brenzinger, 1988) and to control ticks on cattle. It has also been used as a natural pesticide to improve grain storage (Blum and Bekele, 2002). The extracts of *C. aurea* leaves were toxic to ticks at concentrations of 1, 5, 10 and 20% and records dormant, unable to walk and dead at higher doses (Zorloni, 2007). The result in this study also indicated that *C. aurea* can be used to protect maize crop from the *S. zeamais* damage and can be a good candidate for future consideration of IPM for the management of *S. zeamais.* But further work needs to be done with other formulations.

Essential oil of *E. globule* was tested as a fumigant to find out its toxicity on eggs of *Acanthoscelide ohtectus* (Say.) (Papachristos and Stamopoulos, 2004). The ovicidal activity of the essential oils of *Eucalyptus camoldulensis* and *Origanum syriacum* were tested on eggs of the confused flour beetle (*Tribolium confusum*) and the Mediterranean flour moth (*Ephestia kuehniella*) (Tunç et al., 2000).

The previous report showed that *E. globules* leave extracts was tested against *S. oryzae* and *Tribolium castaneum*. Kambouzia et al. (2009) also reported toxicities of essential oils of *E. globules* as fumigants against three major stored insects: *C. maculates*, *S. oryzae* and *T. castaneum*. Tayoub et al. (2012) reported that *E. globules* treated with 0.5, 1, 2.5, 5, 10, 20 and 30 μl/160 $cm^3$ air were highly fumigant toxicity effect on the khapra beetle larvae.

The presence of *V. amygdalina* extracts, oxalates, phytates and tannins has been reported against tooth infection, stomach ache, fibril illness and evil spirit (Ejoh et al., 2007; Eleyinmi et al., 2008). To clean evil eye and evil work from home, crushed leaves are sprayed on utensils, on bed and gate (Ejoh et al., 2007).

In general, there was highly significant difference ($p<0.05$) in mortality rate of *S. zeamais* adults with increased doses and extended time in all botanical treatments and the effectiveness varied when compared with untreated control. However, Malathion 5% dust at the dose of 0.1% (w/w) recorded 100% mortality of *S. zeamais* both at short and extended duration and germination percentage was not also affected.

## Conclusion

The results of adult *S. zeamais* mortality recorded for 24, 48, 72 and 96 h after introduction of the botanical powders at different doses are shown in Table 1. 100% mortality of *S. zeamais* was recorded on seeds treated with Malathion 5% dust at rate of 0.1% w/w. *C. aurea* and *L. ocmiyfolia* treated maize seeds recorded high mortality (50 to 65% in 8 and 11%) of *S. zeamais* 96 h after application. As the doses of the treatments increased with extended time, the mortality rate of *S. zeamais* was also increased.

In general, there was highly significant difference ($p < 0.05$) in mortality rate of *S. zeamais* adults with increased doses and extended time in all botanical treatments and the effectiveness varied when compared with untreated control. However, Malathion 5% dust at the dose of 0.1% (w/w) recorded 100% mortality of *S. zeamais* both at short and extended duration (24 to 96 h time) and germination percentage was not also affected.

In conclusion, *C. aurea* has shown consistent and effective result in controlling *S. zeamais* in all the parameters tested. The result of this study indicated that *C. aurea* powder formulation can be used to kill *S. zeamais.* It can be a good candidate for future consideration of IPM for the management of *S. zeamais.* However, further work needs to be done with other formulations.

## RECOMMENDATION

C. *aurea* and *L. ocimyfolia* were highly effective against *S. zeamais* than others and the safest to seed germination. So, further research will be needed in their formulation composition to familiarize for use in the future.

Since the powder of these plants is toxicus against adults of maize weevil, cheap and safe, farmers should use it to decrease the loss of maize seeds at storage. The stored maize should be stored at low to optimum temperature and relative humidity in order to decrease the loss of maize seeds at storage condition. The storage materials should be cleaned or changed in the second period of storing the harvesting maize produced.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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