EVALUATING THE PESTICIDAL EFFICACY OF *LANTANA CAMARA* AND *EUCALYPTUS GRANDIS* AGAINST *PROSTEPHANUS TRUNCATUS* (*HORN.*) IN STORED MAIZE GRAIN IN ZIMBABWE

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ABSTRACT

Use of plant compounds in grain protection has shown great potential as an alternative to insecticides in Sub-Saharan Africa. During storage, maize grains are severely destroyed by storage pests. One of the primary causes of grain loss in stored maize as high as 70-80% is the damage caused by larger grain borer, Prostephanus truncatus. The use of insecticides of chemical origin can affect human health directly or indirectly. Release of synthetic chemicals into the environment can have negative global impacts and there is therefore need to safer analogues. Also they have a residual effect in the grain. The study was conducted to evaluate the insecticidal action of Lantana camara and Eucalyptus grandis for effectiveness as grain protectants against Prostephanus truncatus. Ground leaf powders of these plants were compared with untreated control and synthetic chemical (Actellic super Gold). The experimental design was laid out in a factorial 3x2+2 controls factorial in a completely randomized design (CRBD) all the treatments were replicated three times. The amount of powder mixed with grain was calculated on a weight of powder per weight of grain basis (w/w). Different variables such as mortality, grain germination percentage, grain weight loss and grain colour and odour were assessed. Findings of the study showed that there was a significant difference between treatments (P<0.001). . Grain weight, and germination percentage was preserved by L.camara showed least number of live infestation when compared to Eucalyptus grandis and when compared to the positive and negative controls. All tested plant leaf powders reduced larger grain borer reproduction during maize storage as compared to the untreated maize grain (P<0.001) and grain colour and odour was not affected. Cultural methods of using plant leaf powders (botanical) is a key tool in countering house hold food security, providing cheap and readily available substitute for chemical control and mitigation of the shortfalls of chemical methods to most poor resource small scale holder farmers.

Keywords: *lantana camara*, *eucalyptus grandis*, *prostephanus truncatus*

INTRODUCTION

Zea mays (L.) is the major staple grain in most Southern countries especially Zimbabwe, cultivated by 80% of small holder farmers. It is estimated that about 60-80% of the maize grain produced in Southern Africa and is stored at farm level (Golob et al., 1999). It is also estimated that a third of stored maize grain is lost to insect pests (FAO-World Bank, 2010); representing a losses of 1.3 billion tonnes of food per year in a world where over 870 million people go hungry (Gustavson et tal 2011).

Recent revelations indicate that synthetic insecticides penetrate into stored grain and maybe toxic (Laalah and Wandiga, 1996; El Sheamy et tal., 1998). Synthetic pesticides also contaminate water bodies. Moreover, Jood et al. (1993) reported that insect infested grain is adversely affected in taste, aroma and rendering the grain unsuitable for human consumption. This has stimulated scientists to search for natural pesticides that are environmentally friendly, safe to man and other untargeted organisms and have no adverse effects on the organoleptic taste and market quality of stored grains.

Several studies have been carried out in the efficacy of plant extracts of *Eucalyptus spp, Targetes minuta, Lantana camara* as grain protectants against maize weevil *Stophillus Zea mais* showing high degree of effectiveness (Muzemu *et tal*. 2013; Mulungu *et al*. 2007.; Modgil and Samuels 1998.).The use of these natural methods of protecting harvested crops from insect's damage is not only gaining prominence but (Golob *et tal* 1999) but it has also general and positive results; (Elhang *et tal* 2003). Extracts from different plants species are known to possess insecticidal properties against a wide range of insects (Abdul and Mohammad 1998).)."

It is against this background that this study was conducted to unearth the pesticidal efficacy of *Lantana camara* and *Eucalyptus grandis* leaf powder formulations against *Prostephanus truncatus* in stored maize grain.

OBJECTIVES

(1) To determine the most effective plant species and rate against larger grain borer on live infestation of *Prostephanus truncatus* on stored maize grain.

(2) To evaluate the weight loss of maize grain post treatment with *Lantana camara* and *Eucalyptus grandis* leaf powder formulations.

(3) To test the germination of viability maize grain post treatment with *Lantana camara* and *Eucalyptus grandis* leaf powder formulations.

METHODOLOGY

2(3) +2 controls in an RCBD factorial were used in this research. Lantana camara and Eucalyptus grandis at three rates (1.0 2.5, 5.0%w/w basis) were admixed with 2kg of disinfested maize, the untreated sample and synthetic insecticide treatment.

Table 1 : Experimental treatments

Plant species	Application rate / 2 kg
E.grandis	1.0%w/w
	2.5%w/w
	5.0%w/w
L.camara	1.0%w/w
	2.5%w/w
	5.0%w/w
Untreted grain	
Actelic super gold	0.05%w/w

Insect culturing

Prostephanus truncutus was sourced from a pure colony at Hunderson research station Mazowe, Zimbabwe. The unsexed insects approximately 600 was reared in a one litre jar containing 500g of uninfested whole maize grain as described by Haines (1991).The top jar with a nylon mesh and fastened with a rubber band under ambient temperatures of 17-280c and 38-69% relative humidity .(Tefere et tal 2011). Insects oviposited for ten days after which all adults were removed through sieving. Sieved insects were placed in a clean jar, allowed to complete their life cycle in relative humidity of 70% and optimum temperature of 30 degrees Celsius (Golob and Wright 1984).Emerging adults was collected and kept in separate jars according to their age that is insects emerging at the same day were considered to be of the same age. Research was carried out using the first generation of insects reared on the same maize batch which was also be used in this research and a total of 40 insects was be initially inoculated in each treatment.

Preparation of grain and plant material

Disinfesting of test maize grain : Shelled 50kg maize grain was sourced from a single farmer in Admore farm Chegutu district plot 56, variety PAN53.Any hidden infestation was removed by placing the grain in refrigerator at -4degrees for 4hours (Bekele et al.,1996) and allowed defreeze for 2hours before use. Moisture content, percentage of broken seed, viability will be accessed before the commencement of the experiment.

Test plant materials : Fleshy Lantana camara and Eucalyptus grandis leaves and flowers was collected in Norton, Zimbabwe during the month of August whilst they will be still green. Plant species identification will be done at Harare Botanical gardens before the commencement of the study. The plant leaves and flowers were spread and air dried under room temperature of 27-30degreesCelsius for 10-12 days to minimize the degradation of volatile compounds. The dried leaves were grounded using a pestle and motor and sieved using a1.5mm sieve to obtain a finer powder. The grounded leaf powder was applied manually, evenly throughout the grain in each treatment.

Data collection

Grain quality evaluations : Data was collected on 30, 60, 90, and 190 days post treatment application. Data was collected on insect live infestation, germination percentage viability index, grain weight loss, grain odour and colour.

Live infestation : A procedure by Chikukura *et al*. (2011) with modifications was used to estimate insect infestations in the experiment. One kilogram sub-sample was weighed and sieved trough a 1.5 µm sieve. Live insects were physically counted and recorded after every 30, 90 and 190 days. A variety of botanical plants or their extracts have been shown to cause a number of insect population depressing effects such as mortality (Wanyika *et a*l., 2009), anti-feeding (Liu et al., 2002), repellence and anti-oviposition (Ukeh and Umoetok, 2011; Ukeh *et al*., 2011) when applied against storage insect pests. For this study indirect assessments of these effects were assessed by estimating the population of the resultant progeny of infested insects. Under the prevailing experimental conditions (Hill, 1987) estimated a life cycle period of 28 days. Our assessments were therefore done after every 30 days to capture the population of newly emerging adults. Grain samples and insects were returned to the respective treatments after assessments. New independent samples were drawn from respective treatments in subsequent assessments.

Seed germination viability percentage : Unbiased 100 undamaged seed was obtained according to methods described by Haines (1991) and germinated on a filter paper exposed to all condition necessary for germination and count and record germinated grain after 7days.Seed viability index to express the percentage of germination will be computed according to Zibokore (1994) as follows:

$$\textbf{Viability index }\% = \frac{NG}{TG} \times 100$$

Where NG=Number of seeds that germinated and TG=Total number (=100)

Weight loss : Sub-samples were assessed for damage caused by insect infestations from day 30, 90 and 190 days. Two hundred gram sub-samples were weighed using an Adams® scale. The weight and number of undamaged and insect damaged grains were assessed and used to calculate the percentage grain weight loss using the method described by Gwinner et al. (1996).

Percentage grain weight loss : Where U=weight of undamaged grain, D=weight of insect damaged grain, Nu=number of undamaged grain and Nd=number of insect damaged grain

(C) Grain colour and odour : The procedure of colour and odour was adopted from (Ogendo *et al* 2004.) Scouring for change in grain colour was done according to the following scale:

(1) No detectable change i.e. natural white with a few yellow grains.

(2) Slight change (≤5%) from natural white /yellow to light brown

(3) Moderate change (>5-30%) from natural white /yellow brown

(4) Great change (30-50%) from natural white/yellow to dark brown

(5) Highly significant change (>50%) making grain unacceptable for human consumption.

Scouring for the grain odour was done as follows:

(1) Grain is odourless

(2) Grain has little offensive odour

(3) Grain has moderately offensive odour

(4) Grain has offensive odour

(5) Grain has very offensive odour making grain unacceptable for human consumption.

RESULTS AND DISCUSSION

The larger grain borer mortality counts were transformed using square root transformation and analysis of variance was carried out using the GenStat 14th edition statistical package. Separation of mean was done using (LSD) test at 5%level of significance

Live infestation

(a) Effects of botanicals on Prostephanus truncatus live infestation at day 30 : The insecticidal efficacy of Lantana camara on Prophestanus truncatus live infestation at 30days was noted significantly different (P<0.001) as it recorded the least number of live insects 15% and Eucalyptus grandis with 20% live insects, compared to the untreated control with live insect 49.9% and Actellic Super Gold with 0.1% after 30 days of exposure to plant leave powder formulations. Among all the botanical powders L.camara showed to be effective

Insert. 1 (a)The damaged and undamaged maize grain weighed (b) Weighing of grain

on Prostephanus truncatus at a rate of 5.0%w/w.

(b) Effects of botanical pesticides on Prostephanus truncatus mortality at day 60 : The trends in live insects in all grain treated with botanicals were significantly different (P<0.001) from maize treated with Actellic super gold. Prostephanus truncatus live infestation trends in botanicals treatments showed slight increase with time. Among botanicals, E.grandis recorded the highest number of live insects, 30.1% at 1.0%w/w concentration followed by L.camara which recorded 18% of live insects. The trends differ from that of Prostephanus truncatus live infestation from maize treated with Actellic super gold and which recorded 0.9% and untreated control where the live infestation is at 62%.

(c) Effects of botanical pesticides on Prostephanus truncatus live infestation at day 90 : At day 90 there was significant difference between treatments all botanicals treatments had effects on the increase of Prostephanus truncatus with L.camara recorded 38% at 5.0%w/w and Eucalyptus grandis 47% at 1.0%w/w. Actellic super treated grain recorded 0% increase in live infestation.

(d) Effects of botanical pesticides on Prostephanus truncatus live infestation at day 190 : At day 190 there was a significant difference between treatments all botanicals treatments (P<0.001) had effects on the increase of Prostephanus truncatus live insects with recorded 42% on L.camara while E. grandis recorded more than50% at all concentration. Actellic super Gold treated grain recorded 0.9% of live insects.

Effects of botanicals on maize grain colour and odour

Most panellist scoured 2 in the first month indicating the grain was little oudorless.They also gave a score of 2 for grain colour indicating uniform grain colour at the beginning of the experiment. After every month post treatment, the modal score for colour was 1 (no detectable change in colour) and 1 for odour (grain was oudourless) for grain treated with L.camara . However, grain treated with E. grandis at both application rates had a modal odour score of 2, indicating that grain had little offensive odour. This was the case at both assessments periods done monthly up to 190 days post application.

Table 1 : panelist score for grain colour and odour

Treatment Rate	%W/W	Modal panellist score			
		Colour		Odour	
		3 months after treatment	6 months after treatment	3 months after treatment	6 months after treatment
L.camara	1.00	1	1	1	1
	2.50	1	1	2	1
	5.50	2	2	1	1
E.grandis	1.00	2	2	1	1
	2.50	1	1	1	2
	5.00	2	2	1	1
Actelicsupergold	0.05	1	1	1	1
Untreated	0	1	1	1	1

Score for colour 1 no. detectable charge that is natural white with no yellow grains 2. Slightly change <5% from natural white / yeallow to light brown 3. Moderate change (>5%-30%) from natural white / yeallow brown 4. Great change 30-50% from natural white / yeallow dark 5. Hightly significant change >50% making grain unacceptable for human consumption. Score fro Ordour 1. Grain is odourless 2. Grain has little offensive odour 3. Grain has moderately offensive odour 4. Grain has offensive odour. 5. Grain has very offensive odour.

There was a significant (P<0.001) decrease in grain weight with storage period across all treatments. The highest mean percent weight loss was % on the untreated control. There were significant effects attributed to different forms of grain treatment types and application rates over the 190 days (≈ six months) storage period. There were also significant interaction effects (p,<.001) between grain treatments and storage duration. After 30 days post treatment, minimal damage was observed across all treatments, however, with a slight increase in the untreated control. From 60 days onwards, L.camara applied at 1.0, 2.5%w/w a decrease in weight loss was noted as compared to the untreated control, while powders from the same plant cultivar applied at 5.0%w/w showed significantly ($P<0.001$) lower weight loss compared to half the application rate. E. grandis plant powders applied at both 2.5 and 5 g/kg showed significantly lower ($P<0.05$) weight loss compared to L.camara application rates and untreated control and to the same low level as the positive control Actellic Super Gold ® dust

Effects of botanicals on germination viability

There were significant differences (F pr <0.001 due to the effect of storage duration on the germination percentage of the grains .Untreated gain stored for 190 days had generally lower percentage germination across all plant powder treatments. After 90 days of storage, grain treated with E. grandis at 1.0,2.5 and 5.0%w/w, L.camara at 5.0%w/w and untreated control showed significantly higher ($P<0.001$) percent germination compared to the rest of the treatments. However, there were no significant treatment and storage duration by treatment interaction effects on the percent germination of grains. The highest percent germination across treatment was 38.7% (L.camara at 5.0%w/w) followed by E.grandis with15% when compared to 95.7% of Actellic super Gold and 4.5% of untreated grain at 190 days post treatment.

Plant powders of L. camara and E. grandis can be used as natural pesticides in maize storage and can significantly reduce grain damage and live insect infestation with no adverse effects on seed germination, colour and odour. For the purposes of the adoption of these botanicals, E. grandis should be air dried and ground into powder and admixed with grain at 5.0%w/w as a single application at the beginning of the storage season. Protection can be guaranteed for three months. However, for L.camara application rates of 5.0%w/w or more are recommended. The plant materials are effective over a short storage period therefore effective use may be achieved by reapplication of the powders after every three months. E. grandis and L. camara leaf powders offer promise as alternative to the synthetic pesticides and may be used to retard the development of insect resistance to widely used conventional insecticides. Also the newly introduced Actellic super gold very effective in the control of P.truncatus in stored maize grain.

CONCLUSION

With regards to the results obtained from the study, smallholder farmers and all the other outlying farmers across Zimbabwe should take L.camara and E.grandis leaf powder formulations seriously considering the impact is has shown on reducing live infestation of Prostephanus truncatus . In case of adoption of L.camara should be used at a rate of 5%w/w for a period of 3 months.

L.camara and E.grandis can be used in the control of Prostephanus truncutus without altering grain coluor and odour, however small holder farmers are recommended to clean the grain by winnowing before consumption to minimise plant powders into the maize meal.

Smallholder farmers are in desperate need of measures that can enable them to cope with notorious P.trantatus to avoid food losses at house hold level. Weight of grain contributes to quality so recommendation are to use L.camara to reduce weight loss of maize grain at a rate of 5.0%w/w and reapply after every three months for effectiveness.

Poor resource small holder farmers whose goal is to retain the seed and who wish to preserve their open pollinated varieties and aim to preserve germination percentage of maize grain are recommended to preserve using the Lantana camara at a rate of 5.0%w/w for a period of three months and reapply for effectiveness.

Government institutions and departments should work collaboratively with the private sector, NGOs, farmer organizations and funding organizations so as to close the gap between research and extension. Cultural methods of using plant leaf powders (botanical) is a key tool and a sustainable way in countering house hold food security, providing cheap and readily available substitute for chemical control and mitigation of the shortfalls of chemical methods to most poor resource small scale holder farmers.

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