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EVALUATION OF SWEET WORMWOOD (*ARTEMISIA ANNUA* L.) AS STORED GRAIN PROTECTANT AGAINST MAIZE STORAGE WEEVIL (*SITOPHILUS ZEAMAYS*, MOTSCHULSKY) AND LARGER GRAIN BORER (*PROSTEPHANUS TRUNCATUS*, HORN) ON STORED MAIZE GRAINS.

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Abstract
The objectives of the study were to evaluate the effects of Artemisia annua powder on the mortality of S. zeamays and P. truncatus in the treated maize grain. The experiments were set up as a Completely Randomized Design (CRD) with three replications. The experiments were conducted in SUA Pest Management Centre(SPMC) for 8 weeks. The treatments consisted of different levels of natural protectant A. annua powder (viz: 0.5 g, 1.0 g and 10 g) and untreated control. Actellic Super Dust was included as a standard insecticide control. The data collected included the number of dead and live insects, number of damaged maize grains and percentage damage. Grains treated with Actellic dust, and A. annua powder at all tested levels had significantly controlled S. zeamays insect. Maize seeds treated with Actellic Super Dust surpassed other treatments in controlling P. truncatus due to lower number of live insects and damaged seeds. Artemisia annua at 1.0 g and 10 g had an effect on number of damaged seeds and dead insects as compared to the control. Generally, A. annua powder is effective in controlling these tested storage pest species of maize grains.

Keywords: *Actellic, Artemisia annua, damage, live insects, Sitophilus zeamays, Prostephanus truncatus.*

INTRODUCTION

Most economic at an early stage of development, starch food-stuff account for 70-90% of the calories produced and consumed in Tropical Africa (Rwamugira, 1996). Of the major starchy-staple food crops, maize is the most widely grown. However, maize and other cereals are produced on a seasonal basis, and in many places there is only one harvest a year, which itself may be subject to failure (Miracle, 1966). This means that in order to feed the world's population, most of the global production of cereals must be held in storage for periods varying from 1-6 months (Mulungu *et al*., 2007). Grain storage, therefore occupies a vital place in the economies of developed and developing countries alike. However, storage insect pests cause significantly high losses (Mulungu *et al*., 2007; Mulungu *et al*., 2010). According to Ngugi *et al*. (1985) insects are the major pests in all the major maize producing areas of Tanzania. They cause damage to stored maize grain by boring the grains and eating the inner part which reduces maize weight and quality for consumption and germination (FAO, 1985).

Post-harvest losses make a very significant contribution to inadequate intake where the pests, particularly storage insects share the scarce resource with its human consumers (Golob and Webley, 1980). Post-harvest losses due to insects are at times, high, resulting to 35% losses in some grains (Hodges *et al*., 1983; Makundi, 2006). There are several insect pest species which are found in most tropical countries (Hill, 1983). Most of the economically important stored product insect species belong to two orders, Coleoptera and Lepidoptera (Hall, 1970).

Prostephanus truncatus (Horn) (Coleoptera: Bostrychidae) and *Sitophilus zeamays* Motschulsky (Coleoptera: Curculionidae) are the major storage pests of maize causing heavy qualitative and quantitative losses of the crop (Chiristeusein, 1974; Haubruge, 1987; Rees *et al*., 1990). World wide estimates of maize losses due to these pests range from 5-10% (De Lima, 1987). In heavy infestation, depression by insects is detectable as actual loss of weight and loss of nutritive value (De Lima, 1987).

Currently, the control of *P. truncatus* and *S. zeamays* is largely dependent on the use of synthetic insecticides (Isman, 2006). Although much success has been realized, there have been many problems associated with synthetic stored product protectants (Isman, 2006), leading to search for cheap, and easily biodegradable natural products (Akob and Ewete, 2007). In fact, control programs should rely on the use of relatively safe, low cost and locally available alternative tactics that prevent maize grain losses. Pesticides of botanical origin are seen as promising alternatives to the synthetics and are receiving attention (Akob and Ewete, 2007; Golob and Hodges, 1982; Mulungu *et al*., 2007; Mulungu *et al*., 2010).

Some plant materials have been investigated as potential pesticides. For example, the potential pesticides activities of neem, pyrethrum and tephrosia products have been reported for several insect pests in storage (Akhatar and Isman, 2004; Mbaiguinam *et al*., 2006; Iloba and Ekrakene, 2006). Some botanical insecticides such as ryania, rotenone, pyrethrin, nicotine, azadirachtin, and sabadilla are currently being used and are commercially available (Rajashekar *et al*., 2012). For *Artemisia annua*, its essential oil has been reported to have repelling effect against *Tribolium castaneum* and *Callosobruchus maculates* (Tripathi *et al*., 2000). However, there are no studies to date on its potential for controlling maize storage pests. Therefore, the objective of this study was to assess the efficacy of *Artemisia annua* L. powder on maize weevil (*S. zeamays*) and larger grain borer (*P. truncatus*) in stored maize grain.

MATERIALS AND METHODS

Study Area and Duration

The study was carried out at SUA Pest Management Centre Laboratory, Sokoine University of Agriculture, Morogoro, located

06º 51' S and 37 º 38' E at elevation of 525 m a.s.l, for eight weeks

Pests

Ten kilogram's of maize infested with Maize Weevil and Larger Grain Borer was bought from open market around Morogoro Municipality, Tanzania and used as mother stock colonies.

Maize

Twenty kilograms of clean, untreated maize grains and free from pest infestation were bought from farmers. The maize grains were adequately dried, graded manually based on size and only large maize grain was used in the study.

Botanicals

Leaves of *A. annua* found around Morogoro Municipality was harvested and thoroughly dried under shade for 14 days and ground in a grinder before sieving through a mesh of 0.25 mm pore size. The resultant fine powder was stored in air tight container and stored in cool dark place until when needed.

Experimental procedure

Five bottles of which were replicated three times were prepared. In each bottle a total of 100g of maize were placed. There were five treatments, viz., no-pesticide-application (T0), and 0.1g Actellic Super Dust (T1) as standards, *A. annua* powder in three levels, viz: 0.5 g (T2), 1.0 g (T3) and 10 g (T4). Pesticides were introduced in the bottles except for the bottle containing T0. Actellic Super Dust and *A. annua* powder leaves were weighed and introduced into 100g of shelled maize with moisture content of 15% in a container. The maize grain and pesticide powder of all chemicals were tumble-mixed thoroughly. There were two experiments, viz: experiment with Maize Weevil and the second one with Larger Grain Borer. The two experiments were independent. To each treatment, 14 storage pests for each experiment were introduced, and then covered with perforated lids, placed randomly and replicated three times.

Data collection

Data on effect of maize storage pests in stored maize were collected in each treatment and replications at 8th week for number of damaged seeds by counting individual damaged seeds and undamaged seeds with its weight using weighing balance. Similarly, the number of live and dead insects was obtained by counting them per sample. The percent of damaged seeds was calculated as the number of damaged seeds over the total number of maize seeds per treatment multiplied by hundred.

Statistical analysis

All data collected were subjected to Analysis of Variance (ANOVA) procedures (SAS, 1990) programme. The mean separation was done using Least Significant Difference ($LSD_{0.05}$) test to determine variables with significant difference between treatments.

RESULTS

Table 1 shows the ANOVA table for investigated variables for both storage insect pest species. Results show that there were significant treatment effects for all investigated variables except for live insect of *P. truncatus*. The efficacy of *A. annua* was similar to that provided by Actellic Super Dust for controlling *S. zeamays* (Table 2). However, Actellic Super Dust showed superiority in controlling the *P. truncatus* in investigated variables except for the number of live insect (Table 2). All *A. annua* powder levels studied indicate potentiality to control both insect pest species studied, however the plant was not effective in the control of *P. truncatus* at 0.5g (Table 2).

DISCUSSION

This study has revealed that Actellic Super Dust and *A. annua* powder performed better than untreated control for all tested variables for *S. zeamays*. There is much information on the use of botanicals to protect stored maize grains against *S. zeamays* by using different botanicals like *Azadirachta indica* that has been reported by other scientists (Lale and Mustapha, 2000; Schutterer, 1990). Many researchers have reported that plant parts, oil, extracts, and powder mixed with grain, reduced insect oviposition, egg hatchability, postembryonic development, and progeny production (Saxena, 1993; Talukder, 1995; Asawalam and Adesiyan, 2001). Reports have also indicated that plant derivatives including the essential oils caused mortality of insect eggs (Obeug-Ofari and Reichmuth, 1997). *Sitophilus zeamays* lays eggs inside the maize grain and this study has revealed that the use of *A. annua* powders is possibly effective in inhibiting oviposition and could be applied in the control of *S. zeamays*.

Artemisia annua is an annual herb native to Asia, most probably China (Gray, 1984; Bailey and Bailey, 1976; Klayman, 1993; Klayman, 1989; Arab *et al*., 2006). Artemisinin the extract from *A. annua* is now available commercially in China and Vietnam as an antimalarial drug efficacious against drug-resistant strains of *Plasmodium*, the malaria parasite (William and Ramzy, 2008). A semi-synthetic drug based on artemisinin (artemether) has been recently registered in Africa as Paluther. Artemisinin also has phytotoxic activity, even on *A. annua,* and is a candidate as a natural herbicide (Duke *et al*., 1987; Arab *et al*., 2006). Due to the nature of bitterness of plant leaves of *A. annua* and artemisinin**,** the natural compound that is offered by the plant, the plant was also protectant against storage pests in maize grain (Bailey and Bailey, 1976). Evaluation of this plant as storage maize protectant gives sustainable alternative storage pests control, thus contributing to increased food security by increasing higher death rate of insects (Harnisch, 1980).

For *Prostephanus truncatus* study, the Actellic Super Dust out performed other treatments to control the pest for number of damaged seeds, weight of damaged seeds, percent of damaged seeds and number of dead insect. Generally, results show that the species *S. zeamais* is more susceptible to all level of *A. annua* as protectants used in this study as compared to *P. truncatus* which could only be controlled at higher doses of the *A. annua* powder. This could be attributed by the fact that *P. truncatus* spent most of the time in maize grain while adult *S. zeamais* remained on the surface of the maize grain where it could be susceptible to powdered natural protectants. It has been pointed out by Gunther and Jeppson (1960) that vegetable oils is more effective to control insect inside the crop grains due to the fact that it penetrates and destroy eggs, reduce oviposition and kill adult insects through suffocation. Similarly, the *P. truncatus* create large amounts of bore dust which dilutes anything that is admixed in (Mulungu *et al*., 2010). This puts in the evolutionary history of *P. truncatus* living in trees – arguably a more chemically harsh environment - so they may simply be more resistant to natural toxins.

SUMMARY AND CONCLUSION

The results of this study show that *A. annua* used in this study could be useful and desirable tools in pest management programs. The efficacy of *A. annua* powder at different levels in protecting stored maize grains against maize storage pests were more clearly established as compared to no-pesticide -application treatment (control). Therefore, *A. annua* as a protectant used in this study has

shown potential to control *P. truncatus* and *S. zeamays* since it is relatively effective compared to no-pesticides-application treatment. Use of plant derived insecticides (botanicals) such as *A. annua* powder could be a better alternative to synthetic insecticides which have been proved to pose more environmental and human health hazards. However, more investigations on the active ingredients, their concentrations and methods of application are required before suitable recommendations can be made to farmers and the general public.

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Table(1) ANOVA Table the investigated variables for both *Sitophilus zeamays* and *Prostephanus truncatus* insect storage insects

Storage insect pest											
	Sitophilus zeamays						*Prostephanus truncatus*				
SV	Df	Damaged seeds	Weight loss	Percent damaged	Live insect	Dead insect	Damaged seeds	Weight loss	Percent damaged	Live insect	Dead insect
Treatment	4	2666.7*	255.6*	335*	3110*	3.3*	6592**	389.9**	901.2**	8.7	5972.8*
Error	8	54.9	5.5	7.2	108	0.5	708	63.8	96.5	8.5	387.1
Total	12										

Table(2) Mean separation for effect of treatment effects on both *Sitophilus zeamays* and *Prostephanus truncatus* insect storage insects

	Sitophilus zeamays					*Prostephanus truncatus*				
Treatment	Damaged seeds	Weight loss	Percent damaged	Live insect	Dead insect	Damaged seeds	Weight loss	Percent damaged	Live insect	Dead insect
Control	66.7	20.6	23.6	72	2.3	167	45.2	62.5	6.3	14
Actelic	0	0	0	0	0	40	14.6	15.5	2.3	27
0.5 g	0	0	0	0	0	137	38.5	51.1	3	101.3
1.0 g	0	0	0	0	0	115	30.9	42.1	2.7	98
10 g	0	0	0	0	0	117	31.2	44.8	2.3	120.7
$LSD_{0.05}$	13.9	4.4	5.1	19.6	1.3	50	15	18.5	Ns	37