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 (Christeusein, 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 sabaddila 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...
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 obtained by counting them and powdered A. annua. 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 investigate 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 Adesiyin, 2001). Reports have also indicated that plant derivatives including the essential oils caused mortality of insect eggs (Obueg-Olari and Reichmuth, 1997). Sistophilus 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 | | |
| Treatment | 4 | | 2666.7* | 255.6* | 335* | 3110* | 3.3* | | |
| Error | 8 | | 54.9 | 5.5 | 7.2 | 108 | 0.5 | | |
| Total | 12 | | | | | | | | |

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

| Treatment | *Sitophilus zeamays* | | | | *Prostephanus truncatus* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Damaged seeds | Weight loss | Percent damaged | Live insect | Dead insect | Damaged seeds | Weight loss | Percent damaged | Live insect | Dead insect |
| Control | 66.7 | 20.8 | 23.6 | 72 | 2.3 | | | | | |
| Actellic | 0 | 0 | 0 | 0 | 0 | | | | | |
| 0.5 g | 0 | 0 | 0 | 0 | 0 | | | | | |
| 1.0 g | 0 | 0 | 0 | 0 | 0 | | | | | |
| 10 g | 0 | 0 | 0 | 0 | 0 | | | | | |
| LSD0.05 | 13.9 | 4.4 | 5.1 | 19.6 | 1.3 | | | | | |
