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Full Length Research Paper

Effectiveness of Protective Agents Against Maize Weevils (*Sitophilus zeamais*) and Larger Grain Borers (*Prostphanus truncatus*) in Stored Maize

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The aim of this study was to determine the efficacy of natural available protectants to control *S. zeamais* and *P. truncatus* in stored maize grains. Results showed a reduction on live insects during maize storage in all protectants as opposed to no pesticides application. The pyrethrum flower powder and Actellic Super Dust were the most effective in killing both *S. zeamais* and *P. truncatus* followed by goat dung ash. Maize grains treated with goat dung ash indicated low weight loss, while maize grains treated with Sodium bicarbonate had high weight loss. It could be concluded that pyrethrum flower and goat dung ash are more effective in controlling *S. zeamais* and *P. truncatus* infestation. The efficacy of pyrethrum and goat dung as the powders in protecting stored maize grains against storage pests were validated in the present study. In general, all natural protectants used in this study have shown potentiality in the control *P. truncatus* and *S. zeamais* as they are more effective compared to no pesticide application treatment.

Key words: *Prostephanus truncatus*, protectants, *Sitophilus zeamais*, seed weight loss, seed damage

INTRODUCTION

Maize is a major staple crop for majority of the people in Tanzania. The crop is mainly produced under subsistence farming in rural areas and farmers primarily rely on indigenous practices for storage and handling of the harvested material. It is estimated that about 70-80% of the total grain produced in the country is stored at the farm level for varying duration and purposes (FAO, 1986; Makundi, 2006). The grains are mostly stored in improvised structures such as raised platforms, ventilated racks, open baskets and sacks (Key and Mugereza, 1982). The statistical figures show that about 35% of stored maize grains are damaged by storage pests (Makundi, 2006), the most common being *Sitophilus zeamais* **(**Motschulsky*)* and *Prostephanus truncatus* (Horn) (Golob and Hodges, 1982; Key and Mugereza, 1982). Synthetic pesticides have been used for many years to control storage pests. Although much success has been realized, chemical pesticides have several limitations like occurrence of environmental and health hazards (FAO, 1991).

Hence, there is a need to investigate the efficacy of locally available protectants against *S. zeamais* and *P. truncatus,* which are harmless to man and environment. Not only are these local protectants cheaper, but they are readily available and therefore most of the farmers in rural areas can afford and use them in controlling these storage pests. The aim of this experiment was therefore to determine the efficacy of locally available protectants to control *S. zeamais* and *P. truncatus* in stored maize grains.

MATERIALS AND METHODS

This study was conducted in the laboratory of the Pest Management Centre of Sokoine University of Agriculture, Morogoro, Tanzania in 2008.

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Table 1: Treatments used in the experiment for controlling both *S. zeamais* and *P. truncatus*.

S/No	Name of treatment	Symbol used
1	Control i.e. without pesticide	T_0
2	2% (w/w) of neem leaves powder	T_1
3	2% (w/w) pyrethrum flower powder	T_2
4	2% (w/w) of goat dung	T_3
5	2% of (w/w) of $NaHCO_3$	T_4
6	1% Actellic Super Dust as synthetic chemical	T_5
7	A mixture of 2% (w/w) of neem leaves powder and $NaHCO_3$	T_6
8	A mixture of 2% (w/w) of neem leaves powder and goat dung ash	T_7
9	A mixture of 2% (w/w) of $NaHCO_3$ and goat dung ash	T_8
10	A mixture of 2% (w/w) of neem leaves powder, $NaHCO_3$ and goat dung ash	T_9

Experimental materials

Clean, well-sieved untreated maize grains of TMV1 variety, obtained from local farmers, were used in this experiment as test material. Both *P. truncatus* and *S. zeamais* were collected from the base culture maintained at 28-30^{o}C temperature and 70% R.H. in the laboratory of the Pest Management Centre.

Plant materials

Neem tree leaves were collected and dried in diffused light i.e. under tree shade for 14 days and ground into powder. The ground materials were pulverized and sieved using 0.2 mm sieve mesh. The process of pulverization and sieving continued until no more powder was released but only fibrous matter remained on the sieve mesh. Pyrethrum flowers were collected from Mufindi- Iringa Region. The flowers similarly were dried in diffused light for 14 days, and were ground into powder. The ground materials were pulverized and sieved using 0.2 mm sieve size. The goat dung ash was prepared by drying and burning raw goat dung and stored until the study started. Sodium bicarbonate ($NaHCO_3$), obtained from local market, was ground to fine particles before use in the experiment.

Experimental layout

Treatments were arranged in a Completely Randomized Design (CRD) and each was replicated three times. Maize seeds of the variety TMV1 were disinfested by keeping them in a deep freezer at temperature of -1^{o}c for 48 hours. The seeds were then conditioned to room temperature before being used for experimental purposes. Treatments were five natural protectants, combinations of three natural protectants and two controls for both *S. zeamais* and *P. truncatus* as shown in Table 1.

Each of these treatments was mixed with 200 g of maize seeds. However, each storage pest was investigated in a separate set of experiment but the layout was the same. Different insect pesticides under this study were introduced, except in bottles containing control treatments, to maize grains at moisture content 13 -15%. The contents were then mixed thoroughly for about 5 minutes. To each bottle 20 adult storage pests were introduced. The bottles were then covered with perforated lids for aeration.

Data collection

The insects were shifted through a 3 mm sieve mesh. Data collected included the number of live storage insect pests, damaged maize seeds and its weight losses.

Data analysis

All data collected were subjected to Analysis of Variance (SAS, 1997), and Multivariate analysis of variance (MANOVA) for calculating partial correlation coefficients for all investigated variables. Means of the three replicates of treatments were tested by Tukey Test Method for significance among the treatments and graphs were drawn showing trends.

RESULTS

There were significant differences ($p \leq 0.05$) among treatments in the mean number of maize seeds damaged by both *P. truncatus* and *S. zeamais* (Figure. 1). In all treatments the number of damaged maize seeds increased with an increase in length of storage period except for seeds treated by Actellic Super Dust and Pyrethrum powder. The mean weight of damaged maize seeds was significantly different ($p \leq 0.05$) among the treatments for all two storage insect pests (Figure. 2). Seeds treated with Actellic Super Dust and pyrethrum flower powder had significantly the lowest mean weight of damaged maize seeds. Seeds treated with Sodium bicarbonate (T4) and control treatment (T0) had significantly higher mean weight of damaged seeds.

There were significant differences ($p \leq 0.05$) among treatments in the number of live storage insect pests over the study period (Figure. 3). Maize seeds treated with Actellic Super Dust and pyrethrum had the lowest number of live insects followed by the treatment with goat dung ashes (T3) and its combinations (Figure. 3).

Tables 2 and 3 show positive and highly significant ($p \leq 0.001$) correlation among investigated variables for *P. truncatus* and *S. zeamais*, respectively.

DISCUSSION

In all treatments, the number of damaged seeds increased with an increase in duration of the study period. This may be attributed to an increase in the total number of live insects in both insect species and degradation of the effectiveness of the protectants with

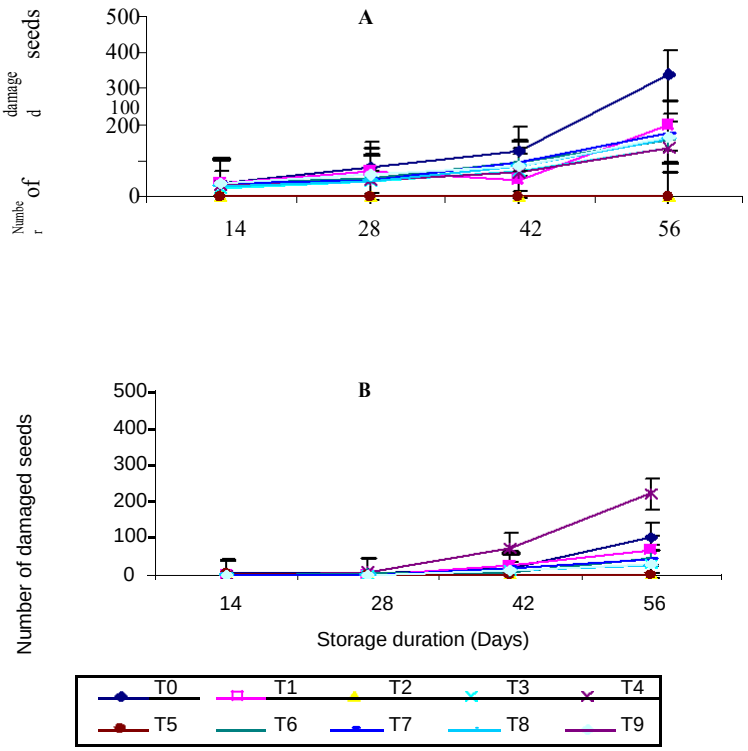

Figure 1. Mean number of damaged maize seeds by storage insect pests in different treatments of protectants by **a** *P. truncatus* and **b** *S. zeamais* in different treatments of protectants

Table 2. Partial correlation of investigated variables for *P. truncates*

	1. live insects	2. damage	3. Weight loss
1	1	0.85***	0.85***
2		1	0.95***
3			1

*** Significant (P≤ 0.001)

Table 3. Partial correlation of investigated variables for *S. zeamais*

	1. live insects	2. damage	3. Weight loss
1	1	0.97***	0.95***
2		1	0.98***
3			1

*** Significant (P≤ 0.001)

time (Tulukder and Howse, 1994). However, the efficiencies of different treatments varied, depending on the source of active ingredients and test insect species. Among the natural protectants evaluated, pyrethrum flower powder was superior in providing protection to maize seeds. Its efficiency was similar to that provided by Actellic Super Dust. Similar observation was reported by Reuben et al. (2006) that pyrethrum powder had

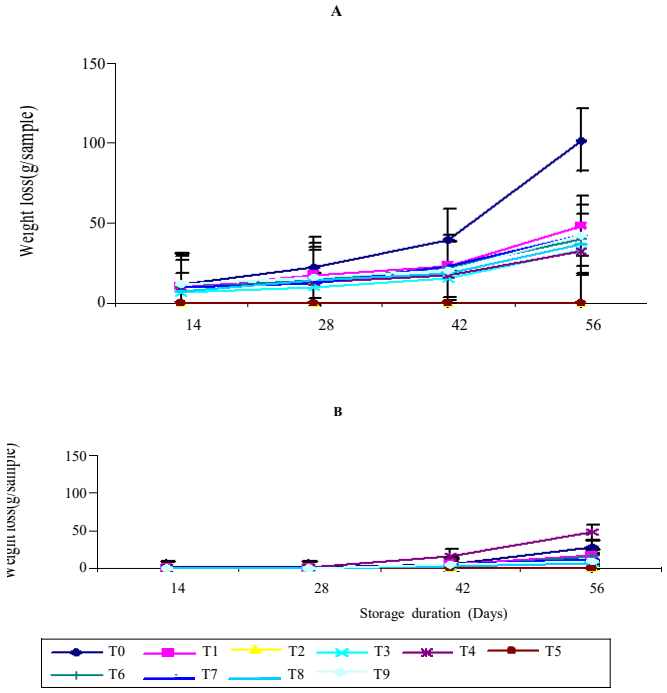

Figure 2. Mean weight loss of damaged maize seeds in different treatments of protectants by storage inset pests **a** *P. truncatus* and **b** *S. zeamais*

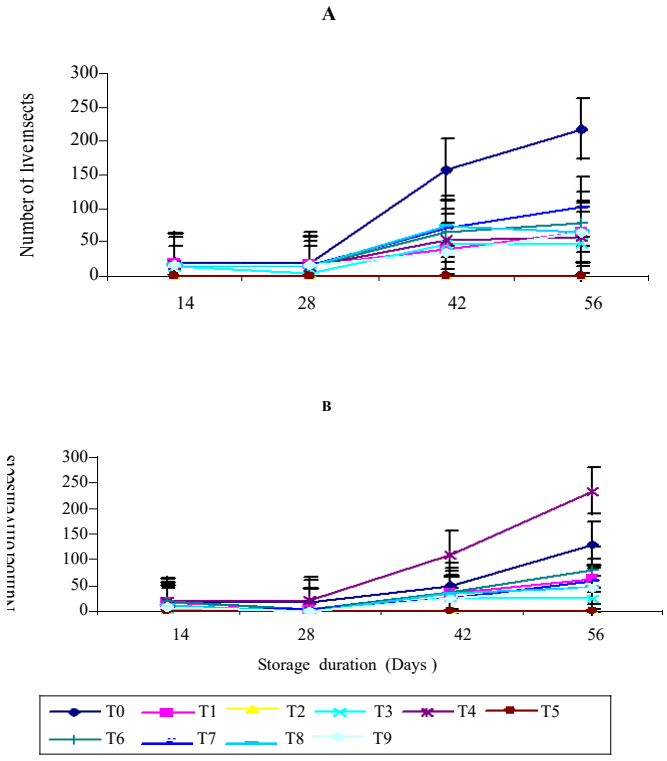

Figure 3. Mean number of live storage insect pests **a** *P. truncatus* and **b** *S. zeamais* in different treatments of protectant

pronounced effects on control of *Callosobruchus maculatus* L. in cow pea seeds as compared to seeds treated with Actellic Super Dust. Pyrethrum has contact mode of action and it affects the insect nervous system (White and Leesch, 1995). Its active ingredient pyrethrin works by creating multiple potentials across the membranes and disrupts signal transmission in the insect (White and Leesch, 1995).

Goat dung ashes also provided the next best protection against both maize seed storage pests investigated in this study. It is reported that ash is effective in controlling storage pests, mainly Coleopterae (Gwimmer et al. 1996). Different plant species contain different chemical compounds which could be suitable for controlling maize insect storage pests. These may also be contained in the goat dung ashes due to the grazing habit of the animal. It has been reported that wood ashes from *Khaya senegalensis*, *Eucalyptus spp*., *Afzelia africana*, *Ceiba pentranda* and *Parkia africana* are particularly recommended for the control of development stages of Coleopterae living on grains (Gwimmer et al. 1996). However, in this study the mode of action of the goat dung ash was not investigated, but it is most likely that the fine powder blocks the spiracles and therefore, the insects are unable to respire. This physical action is common for most inert materials such as powdered clay (Harnisch, 1980).

The results also show that the species *S. zeamais* is more susceptible to all natural protectants used in this study as compared to *P. truncatus*. This could be attributed by the fact that *P. truncatus* mostly survive within maize grain while adult *S. zeamais* remain on the surface of the maize grain where it would be more susceptible to powdered natural protectants. It has been pointed out by Gunther and Jeppson (1960) that vegetable oils is more effective to control internal feeders of crop grains due to the fact that it penetrates and destroys eggs, reduces oviposition and kills adult insects through suffocation. Similarly, the adult bore into the maize grains, making holes by their tunneling action and generating large quantities of dust which may hinder the efficiency of the natural protectants (Stoll, 2003).

The results of this study show that natural protectants used in this study could be useful and desirable tools in pest management programs. The efficacy of pyrethrum and goat dung ashes in protecting stored maize grains against storage pests has been validated and confirmed. In general, all natural protectants used in this study have shown potentiality to control *P. truncatus* and *S. zeamais* as they are more effective compared to control treatment. However, more investigations on the active ingredients, their concentrations and methods of application, would be required before any recommendations can be made to farmers.

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