INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
Volume-1, Issue-3 Sept-Nov-2011 www.ijpaes.com ISSN 2231-4490

EFFECT OF SOME LOCAL BOTANICAL MATERIALS FOR THE SUPPRESSION OF WEEVIL POPULATIONS

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ABSTRACT : The commonest method of traditional storage pest's management among small scale maize farmers in Ghana is the use of botanicals. Earlier studies on the use of plant extract showed that some minimized insect pests' damage to acceptable levels. The objectives of this study were to identify the potency of some local botanical materials: *Piper nigrum* L.(black pepper seed powder), *Cymbopogon nardus* (citronella shoot powder), *Carica papaya* (pawpaw seed powder), *Allium sativum* (garlic bulbs paste) and *Cymbopogon citrates* (lemon grass shoot powder) for the treatment of stored maize and determine their minimum effective dosage for application. In a completely randomized design in olfactometer and potency test of the botanical materials, black pepper, lemon grass, pawpaw seed powder, citronella and garlic showed varying degrees of repellency decreasing in that order as well as their potency. Fifty grammes of black pepper powder in a bag (100kg) of maize were determined as the mimnimum effective concentration. Black pepper seed powder was therefore recommended at a rate of 50g/100kg maize to farmers. It was also recommended that the active ingredient of black pepper be formulated into insecticide against/ for the management of the maize storage weevil.
Key words: Botanical materials, repellency, Minimum effective concentration

INTRODUCTION

Maize is exposed to insect pest attack prior to harvest and in storage Muyinza, [15]. Of these *S. zeamais* is the most predominant and destructive (Holst *et al*.[13]).

Chemical insecticides applied to prevent or control insect infestations have proved the simplest and most cost effective means of dealing with the pest. Insecticide application is recommended when grain is stored at high temperatures (i.e. 25-35ºC) or for a period exceeding three months (Brooker *et al.,* [7]).

Subsistent farmers treat grains with plant products and oils, use cultural methods such as open sun drying and storing in barns, earthen pots, jars, airtight containers (Dobie1[11]; Dennis [10]; Mbah [14]; Asawalam [3]). These are less cost effective for storage of large quantities of grain.

Botanical products have played important roles in traditional storage pest control in the tropics (Hassanali *et al.* [12]; Niber, [16]; Belmain et at.[5]). Most of them are non toxic to consumers and are readily available (Hassanali *et al.*[12]; Niber, [16]; Asawalan *et al.* [4]).

The objectives of this study were to identify the potency of some botanicals for the protection of maize grain in storage and determine the minimum effective dosage of the botanicals.

MATERIALS AND METHODS

Acquisition, storage and preparation of botanical materials

The botanical materials tested included garlic (*Allium sativum*) bulbs, pawpaw (*Carica papaya*) seeds, citronella (*Cymbopogon nardus*) shoots, lemon grass (*Cymbopogon citrates*) shoots and black pepper (*Piper nigrum* L.) seeds. Garlic and black pepper were bought from the Kumasi Central market and pawpaw fruits were bought from fruit sellers at the central commercial area (European market), Adum, Kumasi. Citronella and lemon grass were obtained from farmers at Bogo, near Konongo in Ashanti region and Wenchi in Brong Ahafo region respectively. Pawpaw seeds were extracted, citronella and lemon grass were washed to remove soil and dust. All the botanical materials were dried in the shade on a platform that was raised 1 m high in the insectary.

Each of the botanicals was separately milled into powder, using Christy & Norris Junior laboratory mill and sieved with a sieve with (1x1) mm pore space. Garlic was milled into paste using a blender.

Maize lines and varieties

Maize lines and varieties used for experiment included, EUDTW99STR QPM, FU20 90DYFP, TZEEY-PopSTRC4, DMLSRYQPM, GH90DYFP, FU2080DWF/DPop, TZE-Y-PopDTSTRC4, 2000SYNEEW QPM, GH90DWOP, FU2090DWDpop, DORKE SR Dodzi, and (Mamaba (flint maize moderately resistant to *S. zeamais* (Control)). An average of 10 cobs each of the maize line and variety were obtained from the maize breeding Section of the CSIR-Crops Research Institute. They were air-dried for three days and placed in a deep freezer at a temperature below 0˚C for two weeks to kill any storage insect pests. They were then shelled and further air dried in an oven to a moisture content of 12 $\pm$ 2 %. Moisture content was measured with a moisture tester at the Entomology laboratory of KNUST.

Sitophilus zeamais culture

A culture of *S. zeamais* was obtained from the insectary of the Entomology unit of the Department of Crops and Soil Sciences. Three hundred adult weevils of both sexes were introduced into four one-litre Kilner jars with 500 g of Obatampa maize. The insects were allowed to oviposit for seven days after which they were sieved out with a sieve (2mm in diameter). The opening on the Kilner jars lids were covered with metal gauze and muslin net to firmly secure them to prevent possible escape or re-infestation. The F_1 adults that emerged were introduced into other Kilner jars containing obatampa maize and the resulting F_2 adult weevils which emerged between 0-10 days were sieved and used to infest maize stock at 70% average relative humidity and a temperature of 28˚C. Adult weevils that did not respond to pointed metal probe were considered dead.

Experimental set up

Forty grains of maize were put into 28 petri dishes (9 cm in diameter) from treatment of 1 g each of the five botanical materials with 1kg of Mamaba tumbled for two minutes. They were compared with an insecticide currently found on the market (Betallic containing 80 g Pirimiphos methyl and 15 g Permethrin) at a rate of 1 ml/24 ml water/2.5 kg maize and untreated maize (control). All test materials were applied within 24 hr. Each petri dish of maize treated with one of the pesticides was infested with 0-10 day old adult weevils and allowed to stand for 4 days.

The olfactometer adapted for this work comprised three persplex dishes, 9 cm in diameter and 3 cm in height joined in a row with two short persplex pipes 6.5 cm long with 1.5 cm bore diameter. (Plate1). Each dish was lined with filter paper to facilitate movement of the weevil. The olfactometer was used to assess the repellency or attractancy of *S. zeamais* to the botanical materials. Forty grains of maize (Mamaba) were thoroughly mixed with 1 g of each botanical material in a Petri dish by shaking the dish with each material for two minutes. The treated grains were then poured into one arm of the olfactometer. Similar quantity of untreated maize was put in the opposite arm of the apparatus. Ten adult weevils of between 0-10 days old were placed in the weevil hold up dish of the apparatus (plate 1). The vacuum pump was switched on for one hour. The numbers of weevils that moved towards the opposite arms of the set up were recorded. The rest of the weevils remained within the weevil hold up dish either on the filter paper or under it.

Data collection

Data collected were the number of dead weevil after treatment with the botanicals.

Percentage repellence was calculated Uzakah formular [22].

$$PR = \frac{[NC - NT]}{[NC + NT]} * 100$$

Where PR= Per cent repellency ;
NC= Weevil number present in control treatment
NT= Weevil number present in botanical treatment

Statistical Analysis

Data obtained were subjected to statistical analysis of variance and means of numbers of insect counts were compared using PROC GLM; SAS Institute, 2004/2005 (version 9). Where significant differences were obtained ($P<0.05$), means were separated with Student Newman Keul's (SNK) Test. Insect counts were transformed to the log base 10 prior to analysis (Sokal and Rohf, [20]). Mortalities were calculated using Abortt [1] and their percentages were arcsine transformed. Olfactometer data were compared using student t-test.

RESULTS

There were significant differences among the botanicals in the mean per cent mortality of *S. zeamais*. All the weevils on the maize treated with black pepper powder and Betallic, died within 96 h of infestation (Figure 1). Garlic and citronella extracts were the least toxic to the weevils, each killing only 2.5%, while pawpaw and lemon grass killed 10% and 20% respectively within 96 h of treatment (Figure 1).

The olfactometer test showed that Black pepper, citronella and Betallic treated maize showed, significantly, the highest repelling effect on *S. zeamais* while lemon grass shoot powder and garlic treated maize gave the least.(Table 1).

Table 1: Repellence of *S. zeamais* by Betallic and five botanical powder applied to maize grains

Treatments	Percentage repulsion
Citronella	54.6 ± 0.51 c
Betallic	84.4 ± 0.2 b
Black pepper	96.3 ± 0.21 a
Pawpaw	19.2 ± 0.48 d
Lemon grass	0.0 ± 0.0 e
Garlic	0.0 ± 0.0 e
P	0.0001

Repellency of botanical materials to *S. zeamais*

Chord to switch

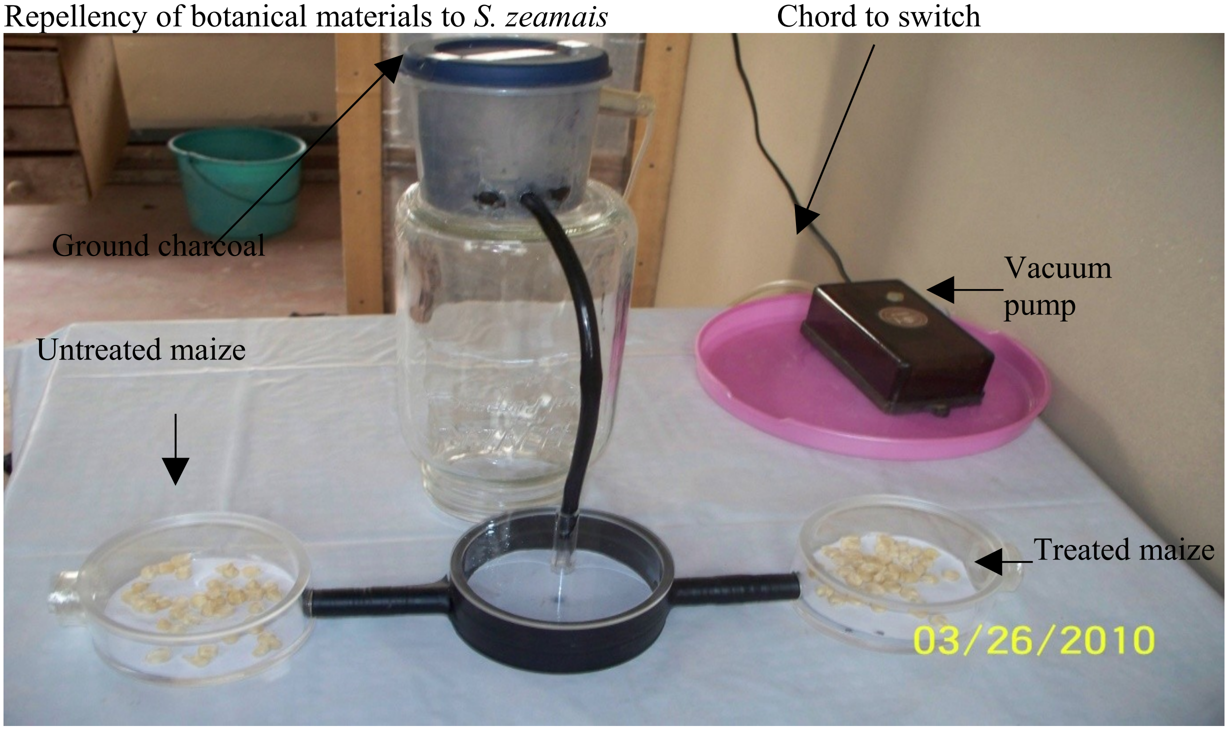

Plate 1: An olfactometer set up to study repellence of botanical extracts to *S. zeamais* (Courtesy Dr Haruna Braimah-CSIR-CRI)

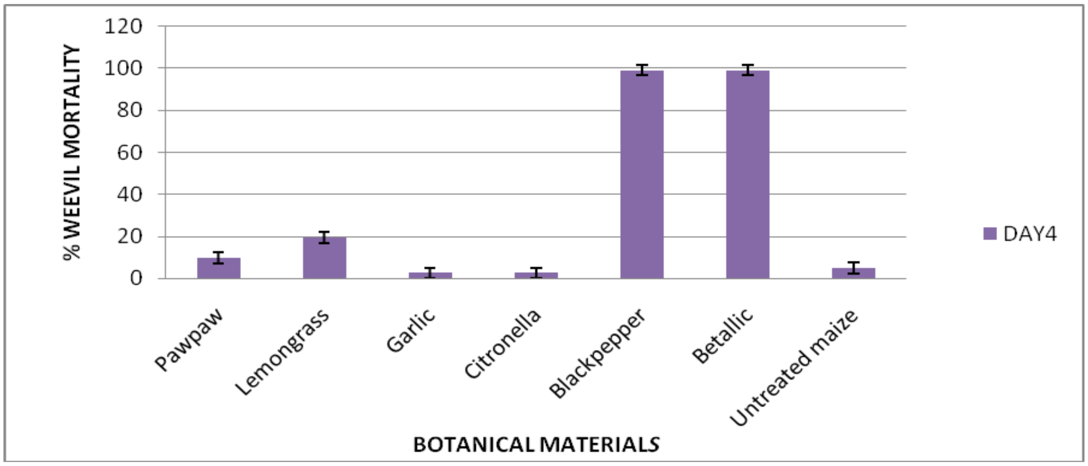

Figure 1: Effects of botanical extracts on the mortality of *S. zeamais* on treated maize for 4 days period

Earlier work in this study showed that only black pepper powder was effective in controlling the weevil. Based on this information black pepper was chosen for further test to find the minimum effective concentration. Four dosage levels of 0.25 g, 0.50 g, 0.75 g and 1.0 g of black pepper were evaluated. Each dosage was admixed with 1 kg of grains of Mamaba maize in a Kilner jar and tumbled for 2 minutes after which 40 grains were counted into Petri dishes. Ten weevils of both sexes were put into each Petri dish and kept for four days i.e, 96 h. Mortality counts were made daily. The concentration that causes at least 95% mortality is considered the minimum effective concentration (Collingwood and Marchart, [9]).
Black pepper at 0.50 g per 1 kg of maize was the least dosage that caused weevil mortality of more than 95% (Figure 2). The dosage of 0.25 g per kg of grain killed a maximum of 80% of the weevils, far below the accepted minimum level of 95%. All dosages above 0.5 g per kg grain killed more than 95% of the weevils within 48 h after treatment (Figure 2).

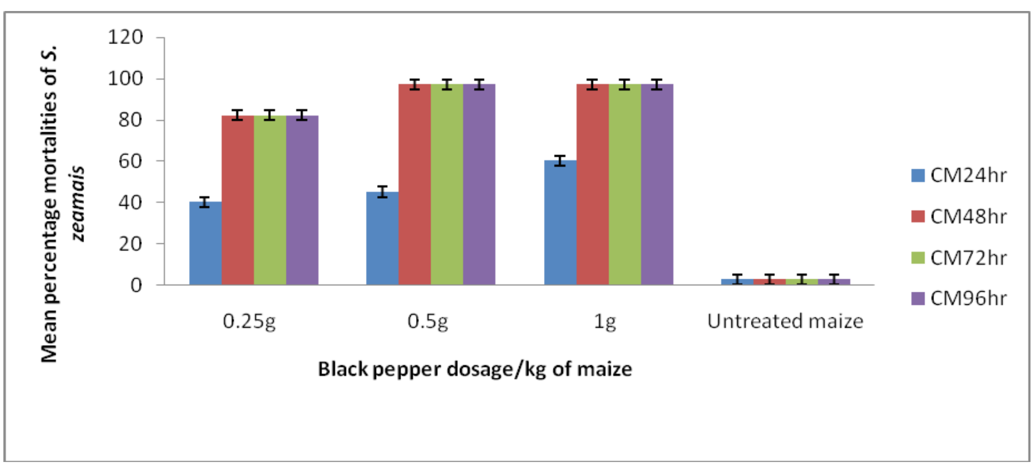

Figure 2: Mean percentage of weevils killed by various concentrations of black pepper powder

DISCUSSIONS

This study showed that some of the botanical materials even though they did not give a very high mortality of *S, zeamais* were higher than the no pesticide treatment (control) as seen in (Figure 1). They therefore might have exhibited low levels of insecticidal and/or antifeedant properties resulting in low *S. zeamais* mortality. Black pepper powder, however, might have exhibited a very high level insecticidal and/or antifeedant properties resulting in a very high *S. zeamais* mortality.

Furthermore, black pepper powder at a dosage of 0.5 g kg^{-1} of grain caused mortalities greater than 95% (Figure 2). This implies that black pepper is a good botanical for managing *S. zeamais* in storage. The other botanical materials showed varying degrees of repellency and effectiveness towards *S. zeamais* during storage (Figure 1 and Table 1). Similar work by Owusu-Akyaw [19] and Cobbinah and Appiah-Kwarteng [8] are indications that some local plants materials have insecticidal and antifeedant properties which could inhibit the pest activities of *S. zeamais*. Other earlier reports with similar trends to this study have shown that the insecticidal, repellent or antifeedant and the development of inhibiting effects of various plants parts and plant products on *S. Zeamais* showed varying degrees of success (Obeng-Ofori and *et al*., [17]; Bekele and Hassanali, [12]; Udo, [21]; Arannilewa *et al.,* [2]; Asawalam *et al*., [4].

Black pepper powder and citronella extract exhibited more than one weevil control attribute (Figure 1 and Table 2). In addition to their toxic attributes, black pepper applied at 0.5 g kg^{-1} and citronella at 1 g kg^{-1} maize repelled *S. zeamais* more than the rest of the botanicals at 1 g kg^{-1} maize (Figure 6). This agrees with the reports of Owusu-Akyaw [19] and Cobbinah and Appiah-Kwarteng [[8] that some local plants and plant parts do not only exhibit insecticidal but also antifeedant properties that inhibit the activities of *S. zeamais*. At the end of the study black pepper seed powder was therefore recommended at a rate of 50g/100kg maize to farmers. It was also recommended that for the ease of application black pepper be formulated into insecticide against the maize storage weevil.

ACKNOWLEDGEMENT

This study was sponsored by Strengthening of Agricultural Research in Developing Countries (SCARDA) in conjunction with CSIR-Crop Research Institute (CRI). The maize and legumes Unit of the CRI provided the maize lines for this study. I am gratefull to Dr. M. Owusu Akyaw and Dr H. Braimah of the Entomology Section of the CSIR-CRI, Dr B. Amoako Atta, retired entomologist of the Faculty of Natural Resourses and Dr Osekre E.A. of KNUST for their various contributions, valuable suggestions and support.

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