EFFICACY OF *CARICA PAPAYA, CITRUS SINENSIS* AND *PICRALIMA NITIDA* AGAINST COWPEA BRUCHID *CALLOSOBRUCHUS MACULATES* AND MAIZE WEEVIL, *SITOPHILUS ZEAMAIS* IN STORAGE

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ABSTRACT

Efficacy of the leaf powders of Carica papaya, Citrus sinensis, Picralima nitida and permethrin dust against Callosobruchus maculatus and Sitophilus zeamais in stored bean and maize was conducted. Treatments were admixed with 50 g of bean and maize and infested with 20 adults of C. maculatus and S. zeamais in 200 ml air-tight vials containing 0.0, 2.5, 5.0, 7.5 and 10.0 g of the plant powders and permethrin dust and were kept under prevailing laboratory conditions (60 – 65 RH, 27 ± 2^{0}C) for a period of 96 hours. The experiment was laid out in completely randomized design of 5 treatments and four replicates. The mortality of weevils to the plant powders and the synthetic insecticides were recorded. The highest mortality occurred in the permethrin dust followed by C. papaya, C. sinensis and P. nitida. Mortality rate for C. maculates and S. zeamais were 14.10 ± 12.43 and 12.95 ± 8.41 in permethrin dust, 10.95 ± 7.99 and 4.00 ± 4.52 in C. papaya powder, 8.25 ± 5.89 and 3.05 ± 3.30 in C. sinensis powder and 8.10 ± 6.60 and 2.40 ± 2.70 in P. nitida powder. The highest mortality count in all the treatments occurred in the 48 to 96 hours, while the least mortality was observed within the 24 hours. The mortality was higher in the treatments with the higher dose of the powders. The insecticidal effects were more in C. maculatus than in S. zeamais. No mortality was recorded in the control experiment.

Keywords: Efficacy, Botanicals, *Carica papaya, Citrus sinensis, Picralima nitida, Callosobruchus maculates, Sitophilus zeamais*

INTRODUCTION

Maize (*Zea mays* L) and beans (*Vigna unguiculata*) are the major food security crops in Africa and they are usually stored to provide food reserves and seed materials for planting (Mulungu *et al.,* 2007). In sub Saharan African, maize is a staple food for an estimated 50 % of the population (IITA, 2009). Thousands of legume species exist but the common beans *V. unguiculata* is eaten than any other. In some countries such as Mexico and Brazil, beans are the primary source of protein in human diet. In the world, maize is ranked third after wheat and rice in terms of leading crop production (Rukuni *et al*., 2006). *Sitophilus zeamais* is an important field and storage pest of maize grain in several part of Africa (Ibediugha, 2016).

Maize and beans weevils damage result directly in loss of both grain quantity and quality and may also reduce future production for farmers who use retained grain as seed for planting. *S. zeamais* is also responsible for the reduction in aesthetic and market value, grain germinability and loss in the nutritive value of maize (Golob and Hanks, 1990). The use of synthetic pesticide in the control of weevil is broadly recommended, but resource poor farmers in developing countries often cannot afford them due to the unfavourable macro-economic environment in their countries (Ukeh, 2008).

There are a variety of botanicals used by resource poor farmers in different parts of Nigeria, and there is need for their evaluation so as to find out the most effective among them. Botanical pesticides can play a big role in reducing pollution, health risk and crop losses due to pest attack (Kamatensi-Mugisha *et al.*, 2008).

The economic significance of maize and beans, and the devastating nature of *S. zeamis* and *C. maculatus* to the crops as well as the availability of botanical materials in the country, provided the reason for the present study. This work thus assessed the efficacy of *P. nitida*, *C. papaya* and *C. sinensis* leaves powder as alternatives to synthetic pesticides for the control of maize and beans weevils (*S. zeamais and C. maculatus*).

MATERIALS AND METHODS

The experiment was conducted in Entomology Research Laboratory of the Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture, Umudike, Abia State. Umudike is located in the tropical rainforest zone of Nigeria on latitude $05^{0}26$ – $5^{0}25$ N and longitude $07^{0}34$- $7^{0}36$E (NRCRI, 2003).

Insect Cultures: The method of Ukeh (2008) was adopted in the mass production of *C. maculatus* and *S. zeamais*. Adults of *C. maculatus and S. zeamais* obtained from infested stock of beans and maize purchased from traders in Ubani market, Umuahia, Abia State, were taken to the laboratory and cultured in different plastic containers for 4 weeks. Emerging adults from these cultures, identified by their light brown colouration were harvested and used in testing the insecticidal properties of the selected plant leaves. The breeding containers were covered with muslin cloth.

Experimental Grains: Maize and beans used for the experiment were purchased from Ubani market in Umuahia, Abia State. A preliminary experiment was conducted to ascertain whether the grains were free from chemicals (Ibediugha, 2016). The experiment was conducted in the laboratory for 96 hours. No mortality record for adults of *C. maculatus and S. zeamais* after the 96 hours indicated the grains were free from chemicals and were thus used. The grains were further sterilized by putting in a refrigerator overnight.

Plant Materials: The fresh leaves of *C. papaya*, *C. sinensis* and *P. natitda* were collected from trees of the selected plants within the campus of the Michael Okpara University of Agriculture and the premises of National Root Crops Research Institute both in Umudike. The leaves were dried under room temperature to a constant weight to ensure that their active ingredients were not lost. The dried leaves were ground separately using a hand grinder and sieved through a 0.20 mesh cloth to obtain their fine powders. The different leaf powders were put into different air tight containers, labelled appropriately and stored in a cool dry place.

Insecticidal Activity Plant Powders on *C. maculatus* and *S. zeamais*: The insecticidal activities of the plant powders (*C. papaya, C. sinensis* and *P. nitida*) and permethrin dust were assessed at 0.0, 2.5, 5.0, 7.5 and 10 g levels. 2.5, 5.0, 7.5 and 10 g of these powders and permethrin dust were weighed and placed in different Petri dishes. 20 adults, each of the *C. maculatus* and *S. zeamais* were randomly selected from the insect culture stock and introduced into the Petri dishes containing the plant powders. They were checked every 24 hours and the numbers of dead insects were counted for each of the plant materials. The experiment was carried out in four replicates.

Efficacy of the Plant Powders in Controlling *C. maculatus* and *S. zeamais* in Beans and Maize: 50 g of clean maize and beans seeds were sorted out and put into 200 ml air-tight glass vials. The different quantities of powders were introduced into the vials and thoroughly mixed together by agitating manually. A control in which no powder was included was also set up. The Permethrin powder was applied at the rate of 0.25 g per 50 g of grains (standard control). The experimental design adopted for the experiment was Completely Randomized Design (CRD) and each treatment was replicated four times. Twenty (20) brown coloured adults of *C. maculatus and S. zeamais* were randomly selected from the stock cultures and introduced into each of the vials. They were covered with muslin cloth held tightly in place by a rubber band to allow air movement and prevent the insects from escaping. Using the method reported by Ekeh *et al.* (2013), the mortality counts of the weevils were recorded at 24, 48, 72 and 96 hours post treatment. The number of dead insects which did not respond to pin probes were counted and recorded as dead. The counting was done by pouring the content of each container on a small white tray and the insects sorted out of the mixture.

Statistical Analysis: The data collected was subjected to analysis of variance (ANOVA) and significant means were separated using Fisher's LSD (Williams and Abdi, 2010).

RESULTS

The highest mortality for *C. maculatus* was recorded in the 10.0g quantity (6.25 ± 1.26) at 72 hours. The least mortality occurred in 2.5g (0.25 ± 0.50) at 24 hours and no mortality occurred in the 0.0g (control). For *S. zeamais*, the highest mortality was recorded in the 10.0g quantity (6.75 ± 2.50) at 48 hours, no mortality was recorded in the 0.0g (control) and the least mortality was observed in 2.5g (0.75 ± 0.50) at 24 hours.

Mortality of *C. maculatus* and *S. zeamais* Treated with Permethrin Dust: The result of permethrin in the control of *C. maculatus* and *S. zeamais* are shown in Table 1. The highest mortality was recorded from the 10.0 g at 48 hours treatment for both the maize and bean seed cultures with the values 6.75 ± 2.50 and 6.50 ± 1.0 respectively. The least values were from the 2.5 g at 24 hours for both beans and maize seeds (1.25 ± 0.50 and 0.75 ± 0.50). The 10.0 g treatment recorded high mortality at the various time intervals.

Mortality of *C. maculatus* and *S. zeamais* Treated with *C. papaya*: The results are shown in Table 1. *C. maculatus* recorded the highest mortality after 48 hours with the 10.0g treatment (5.50 ± 0.58) while the least was recorded in the 2.5gat 24 hours (0.25 ± 0.50). For *S. zeamais,* the highest mortality recorded was from the 10.0g at 96 hours (2.75 ± 1.50) while the least was from the 2.5g, at 72 hours (0.25 ± 0.50). No mortality occurred in 0.0g (control) for both *C. maculatus* and *S. zeamais*.

Mortality of *C. maculatus* and *S. zeamais* Treated with *C. sinensis*: *C. maculatus* recorded the highest mortality at 48 and 72 hours with the 10.0g treatment (5.25 ± 1.50), while the least was recorded in the 2.5g at 24 hours (0.50 ± 0.58). With *S. zeamais,* the highest mortality recorded was from the 10.0g at 72 hours (1.75 ± 1.96) while the least was from the 2.5g, at 24 hours (0.25 ± 0.50) (Table 1).

Mortality of *C. maculatus* and *S. zeamais* Treated with *P. nitida*: The result obtained showed no mortality in the 0.0 g (control) treatment of *P. nitida* for both *C. maculatus* and *S. zeamais.* The highest mortality for *C. maculatus* was recorded from the 10.0g quantity (6.25 ± 10.96) at 48hours and the least mortality was observed in the 2.5 and 5.0 g (0.50 ± 0.58) at 96 hours. The highest mortality for *S. zeamais* was recorded in the 10.0 g quantity (2.00 ± 1.41) at 48 hours and the least recorded was from the 2.5 g at 24 hours and 72 hours (Table 1).

DISCUSSION

The three botanical leaf powders of *C. papaya*, *C. sinensis* and *P. nitida* showed insecticidal properties. They reduced the number of cowpea bruchid *C. maculatus* and maize weevil *S. zeamais*, equally as the synthetic insecticide.

Table 1: Percentage mortality of bruchid and weevil stored products pest treated with three botanical powders and permethrin dust

Duration (hours)	TC1	TS1	TC2	TS2	TC3	TS3	TC4	TS4	TC5	TS5
	Mortality rate (%) of bruchid and weevil treated with permethrin dust									
24	0.00±0.00^{a}	0.00±0.00^{a}	1.25±0.50^{ab}	0.75±0.50^{ab}	2.00±0.00^{a}	1.50±0.58^{b}	2.00±0.00^{a}	2.75±0.50^{ab}	3.75±1.50^{cd}	3.50±0.58^{b}
48	0.00±0.00^{a}	0.00±0.00^{a}	5.00±0.00^{a}	4.75±1.50^{cd}	5.00±0.00^{a}	5.00±0.00^{a}	5.50±0.58^{b}	5.50±0.50^{ab}	6.50±1.00^{c}	6.75±2.50^{d}
72	0.00±0.00^{a}	0.00±0.00^{a}	5.00±0.00^{a}	3.75±1.50^{cd}	5.75±1.50^{cd}	3.75±1.50^{cd}	5.50±0.58^{b}	5.00±0.00^{a}	6.25±1.26^{cd}	6.00±1.41^{cd}
96	0.00±0.00^{a}	0.00±0.00^{a}	5.25±2.06^{d}	3.75±1.50^{cd}	3.75±1.50^{cd}	3.25±0.50^{ab}	4.25±1.26^{cd}	4.25±1.26^{cd}	4.50±1.00^{c}	3.00±2.16^{d}
	Mortality rate (%) of bruchid and weevil treated with *Carica papaya* powder									
24	0.00±0.00^{a}	0.00±0.00^{a}	0.25±0.50^{ab}	0.75±0.50^{ab}	0.75±0.50^{ab}	1.00±0.82^{bc}	3.75±1.50^{cd}	1.00±1.54^{cd}	2.75±0.96^{c}	1.75±0.50^{ab}
48	0.00±0.00^{a}	0.00±0.00^{a}	2.25±0.96^{c}	0.75±0.50^{ab}	2.25±0.96^{c}	1.00±0.82^{bc}	5.25±0.50^{ab}	1.25±0.50^{ab}	5.50±0.58^{b}	1.75±0.50^{ab}
72	0.00±0.00^{a}	0.00±0.00^{a}	3.00±0.82^{bc}	0.25±0.50^{ab}	4.25±0.96^{c}	1.00±0.82^{bc}	4.25±1.26^{cd}	1.25±0.50^{ab}	4.50±1.00^{c}	2.25±0.50^{ab}
96	0.00±0.00^{a}	0.00±0.00^{a}	3.75±2.06^{d}	1.00±0.82^{bc}	3.75±1.50^{cd}	1.25±0.50^{ab}	3.50±1.29^{cd}	1.00±0.82^{bc}	5.00±0.00^{a}	2.75±1.50^{ac}
	Mortality rate (%) of bruchid and weevil treated with *Citrus sinensis* powder									
24	0.00±0.00^{a}	0.00±0.00^{a}	0.50±0.58^{b}	0.25±0.80^{bc}	0.75±0.50^{ab}	0.50±0.58^{b}	0.75±1.50^{cd}	0.50±0.58^{b}	2.25±0.96^{c}	1.00±0.82^{bc}
48	0.00±0.00^{a}	0.00±0.00^{a}	1.50±0.58^{b}	0.75±0.50^{ab}	2.00±0.00^{a}	0.50±0.58^{b}	2.50±0.58^{b}	0.75±0.50^{ab}	5.25±1.50^{cd}	1.25±0.50^{ab}
72	0.00±0.00^{a}	0.00±0.00^{a}	2.25±0.96^{c}	0.50±0.58^{b}	2.75±0.96^{c}	0.50±0.58^{b}	5.25±0.50^{ab}	1.75±0.96^{c}	5.25±1.50^{cd}	1.25±0.50^{ab}
96	0.00±0.00^{a}	0.00±0.00^{a}	3.75±1.50^{cd}	1.00±0.00^{a}	3.75±1.50^{cd}	1.00±0.82^{bc}	3.25±0.50^{ab}	1.00±0.82^{bc}	2.25±0.96^{c}	1.25±0.50^{ab}
	Mortality rate (%) of bruchid and weevil treated with *Picralima nitida* powder									
24	0.00±0.00^{a}	0.00±0.00^{a}	2.50±0.58^{b}	0.00±0.00^{a}	1.25±0.50^{ab}	0.50±0.58^{b}	2.25±0.96^{c}	0.75±0.50^{ab}	3.00±1.41^{cd}	1.00±0.82^{bc}
48	0.00±0.00^{a}	0.00±0.00^{a}	2.75±1.26^{cd}	0.75±0.96^{c}	5.25±0.50^{ab}	1.25±0.50^{ab}	2.50±1.73^{cd}	1.75±0.96^{c}	6.25±0.96^{c}	2.00±1.41^{cd}
72	0.00±0.00^{a}	0.00±0.00^{a}	1.25±0.50^{ab}	0.00±0.00^{a}	5.25±0.50^{ab}	0.50±0.58^{b}	1.50±1.00^{c}	0.75±0.50^{ab}	2.75±0.96^{c}	0.75±0.50^{ab}
96	0.00±0.00^{a}	0.00±0.00^{a}	0.50±0.58^{b}	0.50±0.58^{b}	0.50±0.58^{b}	0.25±0.50^{ab}	0.75±0.50^{ab}	0.50±0.58^{b}	2.25±0.50^{ab}	0.75±0.50^{ab}

Key: TC1 - C. maculatus + no permethrin dust (control), TS1 - S. zeamais + no permethrin dust (control), TC2 - C. maculatus + 2.5 g permethrin dust, TS2 - S. zeamais + 2.5 g permethrin dust, TC3 - C. maculatus + 5.0 g permethrin dust, TS3 - S. zeamais + 5.0 g permethrin dust, TC4 - C. maculatus + 7.5 g permethrin dust, TS4 - S. zeamais + 7.5 g permethrin dust, TC5 - C. maculatus + 10.0 g permethrin dust, TS1 - S. zeamais + 10.0 g permethrin dust, Columns with different superscripts are significantly different

Permethrin dust recorded the highest mortality for both *C. maculatus* and *S. zeamais* cultures with mean mortality rate of 14.10 ± 12.43 in *C. maculatus* and 12.95 ± 8.41 in *S. zeamis*. This result was in agreement with the work of Muzemu *et al.* (2013) on the use of *Eucalyptus tereticornis, Tagetes minuta and C. papaya* as stored maize grain protectants against *S. zeamais* and Danjumma *et al*. (2009) on the control of *S. zeamais* infestation in maize grains using botanicals. In their different studies, synthetic pesticides had the highest mortality rate when compared with botanicals. *C. maculatus* was more susceptible to the insecticidal properties of the different leaf powders. Amongst the botanicals, the highest mortality occurred in 10.0 g for both *C. maculatus* and *S. zeamais* at 48 and 72 hours for the *Carica papaya* treatment with a mortality rate of 10.95 ± 7.89 and 4.00 ± 4.52 %. This is consistent with the work of Mulungu *et al.* (2007) who reported that *C. papaya* leaf powder was more effective in controlling *C. maculatus* and *S. zeamais* when compared with *E. tereticornis* leaf powder.

The highest mortality of *C. maculates* and *S. zeamais* to *C. papaya* was observed in the 10.0 g. This result showed that the more the quantity of the botanical (dose dependent), the more the morality. This result was similar to the work done by Udo (2005) who reported that 5 and 10 g powder of botanicals were significantly toxic to *S. zeamais* and suppressed F_1 progeny emergence compared to 1 g powder. Temitone (2014) also reported that higher dosage of treatment work effectively in the control of *C. maculatus* and *S. zeamais*.

C. Sinensis leaf powder recorded mortality rate of 8.25 ± 5.89 % in *C. maculatus* and 3.05 ± 3.30 % in *S. zeamais.* The highest mortality for *C. Sinensis* leaf powder was also recorded from the 10.0 g and decreased with the quantity from 7.5 to 2.5 g. Reduced biological activities were recorded in the treated maize and beans weevils; the weevils abstain from feeding and this may have led to their death as reported by Ibediugha (2016). This was in agreement with Sharaby (1988) who reported reduced oviposition and egg hatching of potato tuber moth *Phthoridiaea operculella* exposed to 220 µl of orange oil.

P. nitida also showed insecticidal property against *C. maculates* and *S. zeamais*, though it recorded the least mortality, with a mortality rate of 8.10 ± 6.60 % in *C. maculatus* and 2.40 ± 2.70 % in *S. zeamais*. The highest mortality was recorded at 48th hour and by the 96th hour the rate of mortality had decreased. This result was in agreement with the work of Muzemu *et al*. (2013) and Ubulom *et al*. (2012) who stated that the efficacy of botanicals pesticides decreased with time. This may suggest that the botanicals need constant re-application for them to offer continual protection over the grains (Golob, 1981). The findings of this research have shown that *Carica papaya, Citrus sinensis, Picralima nitida* can serve as alternatives to chemical insecticides in the control of *Callosobruchus maculatus* and *Sitophilus zeamais* in stored grains. There is however need to identify and isolate the bioactive chemicals for integration into stored grain programme.

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