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The control of *Sitophilus zeamais* (Motsch) in stored maize using crude bark and wood extracts of *Cedrela odorata* (L. Kennedy) and Pirimiphos-methyl.

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ABSTRACT: A laboratory tests was carried out using aqueous crude ethanol bark and wood extracts of *Cedrela odorata* (L. Kennedy) and a standard synthetic chemical (Primiphos-methyl) as a surface protectant against *Sitophilus zeamais* (Motsch) (*Coleoptera:Curculionidae*) infestation and damage in maize grains. The results of this investigation showed that the bark and wood extracts at 8,000 ppm gave the highest mean mortality of 16% and 24% for both topical application and residual action tests, compared to the pirimiphos-methyl standard formulation which achieved 96-100% mortality at the recommended dosage level of 4ppm. The standard solution, achieved 86-100% mortality of the adult weevils used as invaders of clean protected grains after 90 days storage, while the plant extract gave 32% mortality. The progeny emergence in the infested grains treated with bark extract was almost five times the progeny emergence in similar grains treated with pirimiphos-methyl formulation, and about half the number of progeny which emerged from the control. Subsequent grain damage was reduced from about 4.5% in the untreated control to 2.6% in the bark extract treated grains. The effect of the treatments on controlling the progress of attack in previously infected grains was also similar.

Key Words: Pest control; Insect pests; Maize weevil; *Cedrela odorata*; *Sitophilus zeamais*; Primiphos-methyl.

Introduction

The maize weevil *Sitophilus zeamais Motsch* (*Coleoptera:Curculionidae*) causes extensive damage to corn in storage and is considered the most important insect pest of corn (Okelana and Osuji, 1984). The feeding activities of these weevils may influence among other things the nutritional balance of the grain (protein, carbohydrates, lipids and ash) by removal of portions of kernels. Their larvae live and feed inside grain kernels and adults feed either in the old larval burrows or on the grain.

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Stored product losses resulting from insect pests have been prevented predominantly through the use of insecticides (Haliscak and Beenman, 1983; Horton, 1984). But concern over chemical residues in food dictates that alternative control measures be investigated. Majority of these synthetic chemicals have serious effects in the environment such as the development of resistant strains, toxicity to non-target organisms, environmental degradation and health hazards to farmers as well as increasing the costs of production (Sighamony et al., 1986). The necessity to develop, non-toxic, safe and bio-degradable alternatives to synthetic insecticides has in recent years led to concerted international efforts at developing new sources from the vast store of chemical substances in plants (Olaifa et al., 1987). However, it is estimated that only about 10% of the over 250,000 different plant species in the world today have been examined chemically (Farmsworth, 1990). So there is enormous scope for further studies.

This paper thereforepresents results of an investigation on the effectiveness of a crude ethanol extract from the bark and wood of *Cedrela odorata*, compared to a synthetic chemical as a protectant against *Sitophilus zeamais* infestation and damage in maize grains.

Materials and Methods

The milled dry bark and wood of *Cedrela ododrata* were extracted in a soxhlet apparatus using absolute ethanol as solvent for eight hours (Ofuya et al., 1992). The resulting extracts were concentrated by double distillation using a vacuum pump before they were stored in the refrigerator for subsequent use. Laboratory cultures of the weevils were made and maintained throughout the period in Klinerjar culture bottles.

The insect bioassay tests (topical/residual contact tests) were carried out on ten weevils in each of the Petridishes using various serial dilution of the ethanol extracts (1000ppm, 2000ppm, 4000ppm and 8000ppm) and the synthetic chemical (2ppm, 4ppm, 0.025g and 0.0125g), while the control was treated with distilled water. Each treatment was replicated five times. For the topical application, the treatments were applied topically to the weevils in the respective Petridishes by pipetting with a micro syringe, 5 micro litre of the aqueous crude plant extract solution and 1 micro litre of pirimiphos-methyl solution separately per insect. On the other hand, 250 micro litre of the aqueous plant extracts and 80 micro litre of the standard solution were used for the residual contact tests. For the dust application, 0.025g and 0.0125g were used for both the topical and residual contact tests. Mortality counts of the adult weevils were taken 6hrs, 12hrs and 48hrs after application of the treatments and their respective controls.

The most effective concentrations of the plant extracts and pirimiphos-methyl formulations which were determined from the previous tests were used in the bioassay of the weevils on clean protected stored grains and also to control already infested grains in storage.

Clean and dry healthy maize grains were given cold treatment at –3°C for 3 weeks and left in the laboratory to thaw for 2 days. 50g of the cold-treated seeds were weighed out into the respective kilnerjar bottles. The various treatments (0.5ml plant extract, 0.5ml pirimiphos-methyl solution, 0.025g pirimiphos-methyl dust and 0.5ml distilled water as control) were applied to the respective kilnerjas. Each treatment was replicated five times. The jars were shaken thoroughly (for the grains to mix up well with the "pesticides") and left for 2hrs before 10 adults of *Sitophilus zeamias* of mixed sexes were introduced into each of them. Mortality count of the weevils in each klinerjas was taken after 2 days and on the 14^{th} day, when the weevils were completely sieved out as the females were expected to have mated and oviposited on the grains. The jars were examined on the 40^{th} day and 90^{th} day of storage for adult emergence and build-up of insect infestation. Damage assessment of the grains was carried out using floatation method after the storage period of 90 days. The tests were carried out under ambient room temperature of 25-30°C and relative humidity of 75-88%.

Finally, in a similar test, the grains in the kilnerjars were pre-infested with *Sitophilus zeamais* which were allowed to mate and oviposit for 2 weeks before introducing the extracts and chemical separately to control the progress of the infestation. Similar readings as above were also taken for this test.

Results

Tables 1 – 3 show the effects of topical application and residual action of *Cedrela odorata* extracts (bark and wood) and pirimiphos-methyl formulation (E.C and dust) at various concentrations on the mortality of *Sitophilus zeamais*.

The bark extracts (CBE) at 8,000ppm gave a mean mortality which was significantly different from other concentrations and control, whereas the wood extract (CWE) concentrations were not as effective against the weevils when applied topically. In the residual contact tests, the CBE and CWE each at 8,000ppm gave a mean mortality which was more effective than the control, but the bark extract still maintained a higher mean mortality against the weevils.

The pirimiphos-methyl solution at 4ppm was more effective as a mortality agent for the weevil than its concentrations at 2ppm and this was significant. However, both concentrations were also significantly different from the control on the mortality of the test insect. The 2% dust formulation of pirimiphos-methyl at 0.025g dosage level was also significantly effective than the control. This also goes for the residual contact actions of the synthetic chemical with slightly higher percentage mortality than that of topical application (Table 3).

Table 4 shows the effect of ethanol bark extracts of *C. odorata* and pirimiphos-methyl on *S. zeamais* in clean maize grains, while Table 5 shows the effect of these pesticides on already infested grains.

The pirimiphos-methyl formulations gave a higher mortality of the weevils which was significantly different from the bark extract (CBE) treatment at 8,000ppm and the control All the treatment means on the emergence of the weevil progeny were significantly different from each other and the control. The percentage grain damage by the progeny, which emerged after each treatment, was significantly lower than that recorded in control experiment (Table 4). The effect of the pesticide on the weevil attacking the grains was also similar (Table 5). The pirimiphos-methyl formulations which were not significantly different from each other, caused a significantly higher mean mortality of the weevils than the *C. odorata* back extracts. No mortality was recorded for the control experiments.

Table 1: Effect of topical application of *Cedrela odorata* extracts on mean mortality of *Sitophilus zeamais* (n = 10/replicate).

Concentrations	**Mean Mortality**	
	Bark extract	**Wood extract**
8,000ppm	1.6 ± 1.01a	0.6 ± 0.49ns
4,000ppm	1.2 ± 0.7ab	0.4 ± 0.49ns
2,000ppm	0.6 ± 0.49bc	0.2 ± 0.4ns
1,000ppm	0.4 ± 0.4bc	0.2 ± 0.4ns
0ppm	0 ± 0c	0 ± 0ns

Means with the same letter down the column are not significantly different at P = 0.05 level (DMRT).

Table 2: Effect of action of *Cedrela odorata* extracts on mean mortality of *Stophilus zeamais* (n = 10/replicate).

Concentrations	Mean Mortality	
	Back extract	Wood extract
8,000ppm	2.4 ± 0.49a	1.6 ± 1.02a
4,000ppm	1.6 ± 0.8ab	1 ± 0.89ab
2,000ppm	1 ± 0.89b	0.6 ± 0.49bc
1,000ppm	0.6 ± 0.8bc	0.4 ± 0.49bc
0ppm	0 ± 0c	0 ± 0c

Means with the same letter down the column are not significantly different at P = 0.05 level (DMRT).

Table 3: Effect of tropical application and residual action of Pirimiphos-methyl on mean mortality of *Sitophilus zeamais* (n = 10/replicate).

Concentrations	Mean Mortality	
	Topical Application	Residual Application
4ppm	9.6 ± 0.49a	10 ± 0a
2ppm	6.8 ± 1.33b	9.6 ± 0.49a
0.025g	1.6 ± 1.02c	2.8 ± 1.47b
0.0125g	0.6 ± 0.8d	1.2 ± 1.17c
0ppm	0 ± 0d	0 ± 0d

Means with the same letter down the column are not significantly different at P = 0.05 level (DMRT).

Table 4: Effect of ethanol bark extracts of *Cedrela odorata* and Pirimiphos-methyl on *Sitophilus zeamais* in maize grains after 90 day storage.

Concentrations	Mean Mortality of infesting adults	Progeny	% Grain damage after 90-day storage
(Pirimiphos-methyl)			
4ppm E.C.	10 ± 0a	0.4 ± 49d	1.24 ± 0.50c
0.025g	8.6 ± 1.02a	4.0 ± 1.41c	2.2 ± 0.36bc
(Bark extract)			
8,000ppm CBE	3.2 ± 1.17b	17.4 ± 2.32b	2.56 ± 1.08b
0ppm	0 ± 0c	45.2 ± 6.14a	4.48 ± 1.55a

Means with the same letter down the column are not significantly different at P = 0.05 level (DMRT).

Table 5: Effect of ethanol bark extracts of *Cedrela odorata* and pirimiphos-methyl on maize grains infested with *Sitophilus zeamais* after 90-day storage.

Concentrations	Mean mortality of infesting adults	Progeny	% Grain damage after 90-day storage
(Pirimiphos-methyl)			
4ppm E.C.	9.8 ± 0.4a	1 ± 89d	1.68 ± 0.69c
0.025g	8.4 ± 1.02a	8.2 ± 1.17c	2.22 ± 0.26bc
(Bark extract)			
8,000ppm CBE	2.8 ± 1.33b	21.6 ± 3.14b	2.32 ± 0.63b
0ppm	0 ± 0c	52.8 ± 2.99a	4.84 ± 1.36a

Means with the same letterdown the column are not significantly different at P = 0.05 level (DMRT).

Discussion

The level of significance control achieved by the *C. odorata* bark extracts at 8,000ppm was an indication that the extract contained allelochemicals which were toxic to the weevils. However, the highest mean mortality of 32% achieved by the bark extracts was not high enough when compared to the mean mortalities of 96-100% obtained by the recommended dose of pirimiphos-methyl in both topical and residual contact tests. A higher concentration of the extracts may therefore be needed to give satisfactory level of mean mortality.

The toxicity effects of the plant extracts to the weevils confirms the activity of secondary compounds reported in this tropical plant of family meliaceae (Arnason et al., 1985; 1987; Saxena, 1989; Isman et al., 1990; Koul and Isman, 1992). Similar toxic actions have been reported on plants in the family Piperaceae (Su, 1977; Scott and Mckibben, 1978; Ivbijaro, 1990), Annonoceae (Osisiogu and Agbakwuru, 1978; Lewis, 1992; Lewis et al., 1993) and Zingiberaceae (Pandji et al, 1991). The cedrela plant extracts were toxic, but not very effective at the 8,000ppm concentration in protecting the grains against initiation of infestation nor in deterring progress of attack by *S. zeamais* once it has started. This may probably due to the low concentrations used in this study. Ewete et al (1996) attributed the high larval mortality and growth inhibitation of the European corn-borer *Ostrinia nubilalis* to high concentrations of *Cedrela odorata* extracts containing some allelochemicals. Ofuya et al (1992) also showed that crude extracts from seeds of *Monodora myristica* (Annonaceae) was an effective surface protectant against *C. maculatus* infestation causing damage to legume seeds in storage when applied in high concentrations.

A complete protection of grains in storage for almost 24 months have also been recorded with pirimiphos-methyl formulations at concentrations ranging from 3ppm – 7ppm in Argentina, Australia, Uk and the U.S.A. (Pricket, 1987; I.C.I. hand Book, 1992). The results of the tests with 4ppm concentration of the Pirimiphos-methyl in this study indicate that maize grains could be effectively protected by the synthetic chemical at this concentrations.

Finally, the bark extracts of *C. odorata* merits further investigation as a potential botanical insecticide at higher concentrations. The species are readily available locally and the development of more potent standardized extract of the plant would be cost effective and cheap for resource – poor farmers who produce over 98% of the food consumed.

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