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Full Length Research Paper

The potential of using botanical insecticides for the control of the banana weevil, *Cosmopolites sordidus* (Coleoptera: Curculionidae)

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Crude extracts of chinaberry tree (*Melia azedarach* L.), mexican marigold (*Tagates* spp.), water hyacinth (*Eichornia crassipes*, Martius) and Castor oil (*Ricinus communis* L.) were tested for their effect on weevil mortality, settling responses and oviposition in the laboratory. All extracts of the botanicals did not show significant effects on weevil mortality compared to controls. Weevil settling responses on corms treated with extracts of botanicals compared to controls were statistically similar after 1 h and 72 h of observation. Oviposition was significantly low on corms treated with *M. azedarach*, *Tagetes* spp and *R. communis* compared to controls. Oviposition on corms treated with water hyacinth extracts was not statistically different from oviposition on controls. The data indicates that botanicals possess limited insecticidal properties but the potential of *M. azedarach*, *Tagetes* spp and *R. communis* to control the weevil through preventing oviposition needs further investigation.

Key words: Banana weevil, botanicals, *Cosmopolites sordidus*, insecticidal plants, mortality.

INTRODUCTION

The banana weevil, *Cosmopolites sordidus* (Germar) (Coleoptera: Curculionidae), is one of the major constraints to banana production especially in small scale farming systems (Gold et al., 2001). The weevil lays its eggs singly at the bases of the banana pseudostems less than 25 cm above the soil in holes perforated by the ovipositing female (Abera et al., 2000). Egg production is low with oviposition estimated from 1 to 3 eggs per week (Gold et al., 2001). After hatching, the larvae tunnel into the corm and pseudostem of the plant resulting into stunting, delayed maturation, reduced bunch sizes, snapping and sometimes premature death (Gold et al., 2001). Yield loss due to this has been reported to be up to 100% on farmers fields (Sengooba, 1986) while yield loss of up 50% has been reported in on-station trials (Rukazambuga, 1998; Gold et al., 2004).

Currently, control options available to the farmers in Uganda include pesticides and cultural methods. Chemical control is regarded by farmers as easy to manage, fast acting and effective (Gold et al., 1993). The chemicals are however, costly and are thus not affordable by resource poor farmers in Uganda. Weevil resistance towards these chemicals has recently been reported in some countries (Collins et al., 1991; Gold et al., 1999). Cultural control practices currently in use include crop sanitation and trapping using pseudostem but are of limited application (Gold et al., 2002; Masan- za, 2003). Farmer adoption of this method has also been limited by the availability of trapping material and lack of confidence in the effectiveness (Gold et al., 1993). Alternative control methods especially those that are ecologically sound, less expensive and ethical in safe guarding the well being of non-target species are being sought. Use of botanical extracts thought to have insecticidal properties such as Mexican marigold (*Tage-tes* spp), China berry tree (*Melia azedarach*) water hyacinth (*Eichornia crassi-pes*) and castor oil (*Ricinus communis*) may provide alternatives for the control of this pest.

Botanical insecticides have been reported to have a wide range of biological activities against insects (Beren-

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baum, 1989). These include repellence, feeding or oviposition deterrence, toxicity, sterility and growth regulatory activity (Jacobson, 1989; Schmutterer, 1995; Ascher, 1993). Among the botanicals, extracts from neem tree (*Azadirachta indica* Juss) have been most extensively studied in the last decade (Schmutterer, 1990; Musabyimana et al., 2001). A close relative of neem called China berry tree (*M. azedarach*) has been less investigated, although it also represents a promising source of natural insecticide (Ascher, 1993; Palacois et al., 1993). Insecticidal properties have also been reported to exist in many other plants like water hyacinth (Usha and Jamil, 1990; Nahdy, 1995), Castor oil (Okongkwo and Okoye, 1992) and *Tagetes* spp (Nahdy, 1995). Most of these plant extracts have been studied for storage pests like cowpea weevils, *Callosobruchus chinensis* (Okongkwo and Okoye, 1992; Nahdy, 1995) . The potential of these botanicals for control of *C. sordidus* remains to be exploited.

This study evaluated the potential role of botanical extracts thought to have insecticidal properties for the control of *C. sordidus*. Experiments were conducted to investigate the effect of botanical extracts on adult weevil mortality, weevil settling responses and oviposition.

MATERIALS AND METHODS

The tests were conducted under ambient conditions in a protected roofed-in area at Kawanda Agricultural Research Institute (0^{o}25'N, 32^{o}51'E, 1190 metres above sea level) located 12 km north of Kampala, Uganda. The site has two rainy seasons (March- May and September-November) with average precipitation of 1180 mm per year. Average daily temperatures range between 16 and 29^{o}C.

Insects

Weevils collected from fields at Kawanda Agricultural Research Institute (KARI) using pseudostem traps (Mitchell, 1978) were used. They were maintained in the laboratory at ambient temperature in 10 litre plastic buckets (24 cm diameter and 26 cm depth) and provided with corm pieces as food. Weevil sexes were determined according to Longoria (1968). Female weevils were first kept for three days in all cases on a non-laying substrate to deter them from early oviposition and hence reserve the eggs for the oviposition tests. Each individual was used only once during the experiment to avoid cross contamination.

Plant extracts

Crude extracts of botanicals were used. Ripe seeds of *M. azedarach* were collected from the tree at KARI and sun dried for seven days. The dried seeds were manually crushed in a mortar. A solution was prepared at a rate of 200 g *M. azedarach* to a litre of water (approximately 20% concentration).

Leaves of *E. crassipes* were collected from the showers of Lake Victoria at Luzira landing site, while *R. communis* and *Tagates* spp. were collected from the neighbouring bushes at KARI. All leaves were sun dried for three days. Dry leaves were separately ground in a mortar into finer granules using an electric grinder. They were kept separately in sealed glass jars before use. The extracts for use in tests were prepared by mixing 200 g powder of each botanical with one litre of water.

Effect of botanical extracts on adult mortality

Adult weevil mortality due to botanical extracts was investigated in a no-choice laboratory experiment. The treatments consisted of extracts from i) *M. azedarach*, ii) *Tagetes* spp, iii) *R. communis,* and iv) control. Twenty weevils (females : males = 1:1) were placed in plastic containers (20 cm in diameter and 10 cm in depth) with corm pieces of equal sizes (5 x 5 x 5 cm) in the laboratory. Weevils on corm pieces were sprayed with about 10 millimetres of a solution of botanicals prepared as indicated above. The control corms were sprayed with distilled water. Treatments were replicated 10 times. Weevils were checked after 1, 2, 4, 8, and 16 days and dead weevils were recorded and removed.

Effect of botanical extracts on weevil settling responses

The effect of botanical extracts on weevil settling responses was investigated in a choice laboratory experiment. Treatments were similar to those used in the experiment above. Five corm pieces (quarters from a 42 cm girth corm) each treated with a botanical extract were placed equidistant from each other in a 30-litre basin after spraying four of them with botanical extracts (Figure 1). Control corms were sprayed with distilled water. Twenty weevils (females: males = 1:1) were placed at the centre of the basins. The basins were then covered with black polythene sheets that were perforated to provide adequate ventilation. Basins were checked after 1, 2, 4, 24, 48, and 72 h of treatment and weevils found settling on corms were recorded. The experiment was repeated 10 times.

Effect of botanical extracts on weevil oviposition

The effect of botanical extracts on weevil oviposition was investigated using no-choice tests. Clean paired banana corms (1 – 2 kg) were sprayed with different botanical extracts (treatments) showed above and one corm piece was placed in individual 10 litre buckets. Control corms were sprayed with distilled water and placed in different buckets. The treatments were replicated 10 times. Ten female weevils were released in each bucket that was then covered by perforated lid. The corms were removed after four days and dissected by peeling off thin layers of tissue to expose eggs, which were counted. Each treatment was replicated 10 times.

Statistical analysis

In all experiments, data was analysed using a contingency table test of Statgraphics Plus version 7 statistical package.

RESULTS AND DISCUSSION

There was no significant ($p < 0.05$) difference in adult mortality of weevils treated with botanical extracts compared to control (Table 1). The results indicate that the botanicals tested had limited toxicity to *C. sordidus*. As in previous reports, plants extracts such as neem, castor oil and china berry have limited insecticidal properties but may suppress insect pest populations through affecting

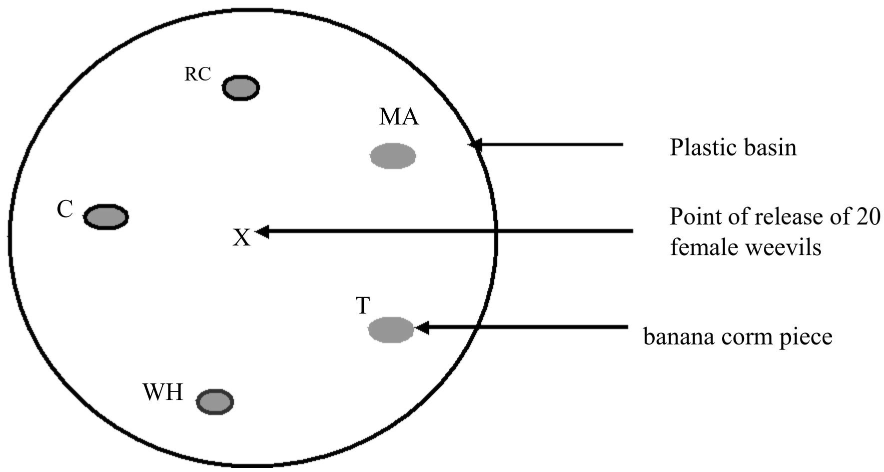

Figure 1. Arrangement of treated corm pieces in a choice test (RC = Ricinus communis, MA = Melia azedarach, T = Tagetes sp. EC = Eichornia crassipes, C = control).

Table 1. Cumulative percentage of dead weevils after sixteen days of treatment with botanicals compared to control.

Treatment	Mean cumulative % percentage mortality (n=10, ± s.e)
Control	0.0±0.0
Ricinus communis	5.5 ±2.2
Melia azedarach	2.0±1.1
Tagetes spp.	0.0±0.0
Eichornia crassipes	0.5±0.1

Numbers of weevils dead due to different treatments were significantly different ($p < 0.05$, contingency table test).

Their orientation and reproductive behaviour (Jacobson, 1989; Schmutterer, 1995; Ascher, 1993; Mostafa et al., 1996; Musabyimana et al., 2001). Although the botanical extracts tested showed limited toxicity to adult *C. sordidus* in this study, these extracts showed great potential for control of storage weevils (*Callosobruchus chinensis* L.) (Nahdy, 1995). Moreover, some of the botanicals tested in the present study are increasingly being investigated for their potential in the management of insect pests (Okongkwo and Okoye, 1992; Nahdy, 1995; Tinzaara et al., 2002).

The mean number of weevils settling on corms treated with botanicals compared to the control corms was not significantly different throughout the sampling period (Table 2). The data generally indicates that the repellence properties of botanical extracts under test were limited.

The numbers of eggs laid on control corms were significantly higher than those laid on corms treated with *Tagetes* ($P > 0.001$, $\chi^2 = 17.8$), *M. azedarach* ($P > 0.001$, $\chi^2 = 31.0$), and *R. communis* ($P>0.001$, $\chi^2 = 99.6$) (Figure 2). The mean number of eggs laid on corms treated with *E. crassipes* was significantly higher than those laid on *Tagetes* ($P > 0.001$, $\chi^2 = 13.5$), *M. azedarach* ($P > 0.001$, $\chi^2 = 26.3$), and *R. communis* ($P > 0.001$, $\chi^2 = 40.0$). These were statistically similar but significantly lower ($p < 0.05$) than those laid on control and water hyacinth treated corms. The mean number of eggs laid on corms treated with water hyacinths was statistically ($p > 0.05$) similar to the eggs laid on controls.

The results indicate that extracts of *M. azedarach*, *Tagetes* spp and *R. communis* could possibly control the weevil through affecting oviposition. Similar results were reported when the effect of neem cake and neem seed powder on weevil oviposition was investigated in the laboratory (Musabyimana et al., 2001). Use of the tested botanical extracts is however, less likely to be successful in Uganda. *M. azedarach* is rare although its propagation is easy. *Tagetes* as well as *R. communis* grows as weeds in most agro-ecological zones in the region. They are easy to use but their propagation would be limiting to their use for *C. sordidus* control.

The water hyacinth showed limited repellence and oviposition deterrence effects to *C. sordidus*. Even if the water hyacinth were to have high potential for weevil control, its use would be limited by its availability. The wa-

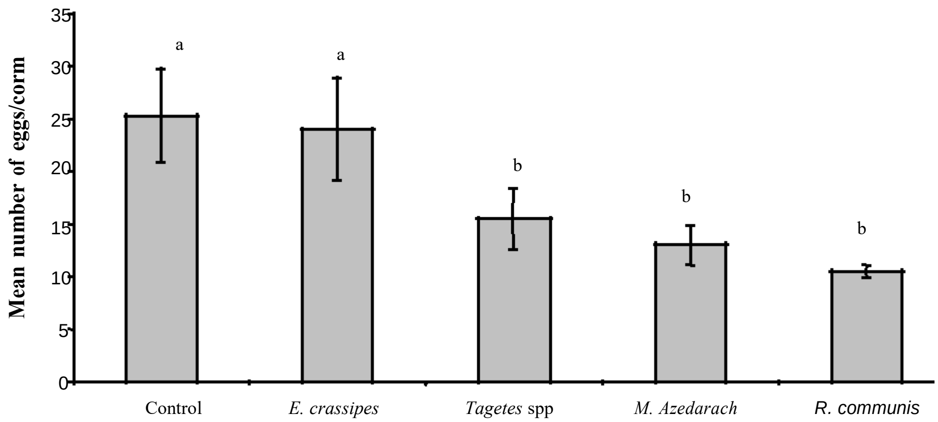

Figure 2. Mean number (n =10, ± s.e) of weevil eggs recovered from treated corms and untreated corms in a no-choice test.

Table 2. Mean number of weevils settling on treated corms compared to control corms at different times (hours) after release.

Treatment	**Mean number of weevils settling on corms after hours of release**					
	1 h	**2 h**	**4 h**	**24 h**	**48 h**	**72 h**
Control	4.4±0.7	4.8±0.8	4.6±0.8	3.4±0.8	4.0±1.1	3.8±0.8
Ricinus communis	3.4±1.4	3.8±1.3	3.4±1.3	3.1±1.3	2.0±0.8	2.3±0.8
Melia azedarach	3.6±1.1	3.3±1.0	3.4±1.0	2.4±0.8	2.9±1.1	2.5±0.8
Tagetes spp.	4.8±1.1	4.3±1.4	4.9±1.4	3.5±1.0	3.5±1.2	2.8±0.9
Eichornia crassipes	3.8±0.5	3.8±0.5	3.8±0.5	3.0±0.8	2.1±1.1	3.0±1.2

In all columns, there was no significant difference between the mean numbers of weevils settling on corms treated with different botanical extracts (n =10, ± s.e).

ter hyacinth is a waterweed occurring only in the major waters of Lake Victoria, Lake Kyoga, and river Nile, and may therefore have little use in banana growing areas far from these waters.

The findings of our study agree to earlier reports that indicated that most plant extracts thought to have insecticidal properties do not have direct toxicity but can control pests through affecting other biological activities (Berenbaum, 1989; Jacobson, 1989; Ascher, 1993; Schmutterer, 1995; Mostafa et al., 1996; Musabyimana et al., 2001). Although the data indicates that botanicals showed limited insecticidal properties but the potential of *M. azedarach*, *Tagetes* spp and *R. communis* to control *C. sordidus* through deterring oviposition needs further investigation.

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REFERENCES

Abera A, Gold CS, Kyamanywa S, Karamura EB (2000). Banana weevil *Cosmopolites sordidus* (Germar) ovipositional preferences, timing of attack and larval survivorship in a mixed cultivar trial in Uganda. In: Craenen K, Ortiz R, Karamura EB, Vuylsteke D (eds) Proceedings of the first International conference on banana and plantain for Africa, Kampala, Uganda, 14-18 October 1996. *Acta Hortic.* 540:487-495.

Ascher KRS (1993). Noncoventional insecticidal effects of pesticides available from the neem tree, *Azadirachta indica*. *Arch. Insect Bioch* Phys. 22:433-449.

Berenbaum RM (1989). North America ethnobotanicals as sources of novel plant based insecticides. In: Arnason JJ, Philogene, BR, Morand P (eds) Insecticides of plant origin, ACS Sympos. Ser. 387: 11-24.

Collins PJ, Treverrow NL, Lamkin TM (1991). Organophosphorus insecticide resistance and its management in the banana weevil borer, *Cosmopolites sordidus* (Germar) (Coleoptera: Curculionidae), in Australia. Crop Prot. 10: 212-221.

Gold CS, Kagezi GH, Night G, Ragama PE (2004). The effects of banana weevil, *Cosmopolites sordidus* (Germar) damage on highland banana growth, yield and stand duration in Uganda. Ann. Appl. Biol. 145:263-269.

Gold CS, Okech SH, Nokoe S (2002). Evaluation of the pseudostem trapping as a control measure against banana weevil, *Cosmopolites sordidus* (Coleoptera: Curculionidae) in Uganda. Bull. Entomol. Res. 92:35-44.

Gold CS, Pena JE, Karamura EB (2001). Biology and integrated pest management for the banana weevil, *Cosmopolites sordidus* (Germar) (Coleoptera: Curculionidae). Int. Pest Manag. Rev 6:79-155.

Gold CS, Bagabe MI, Sendege R (1999). Banana weevil, *Cosmopolites sordidus* (Germar) (Coleoptera: Curculionidae): test for suspected resistance to Carbofuran and Dieldrin in Masaka District, Uganda, Afr. Entomol. 7:189-196.

Gold CS, Ogenga-Latigo MW, Tushemereirwe W, Kashaija I, Nankinga CM (1993). Farmer perceptions of banana pest constraints in Uganda: Results from a rapid rural appraisal. In: Gold CS, Gemmil B (eds) Biological and Integrated Control of Highland Banana and plantain. Proceedings of Research Coordination Meeting, Ibadan, IITA, pp. 3-25.

Jacobson M (1989). Botanical pesticides, past, present and future. In: Arnason JJ, Philogene BR, Morand P (eds) Insecticides of plant origin, ACS Symposium Ser. 387: 1-10.

Longoria A (1968). Diferencias sexuelles en la morphologia externa de *Cosmopolites sordidus* Germar (Coleoptera: Curculionidae). Ciencias Biol. La Habana 1:1-11.

Masanza M (2003). Effect of crop sanaitation on banana weevil Cosmopolites sordidus (Germar) populations and associated damage. Ph.D Thesis, Wageningen University, p. 164.

Mitchell GA (1978). The estimation of banana borer population and resistance levels. WINBAN Research and development Technical bulletin No. 2. pp. 34.

Mostafa TY, Mahgoub SM, Ahmed MS (1996). The efficiency of certain plant powders against cowpea weevil *Callosobruchus maculates* (F.) (Coleoptera: Bruchidae). Egypt J. Agric. Res. 74: 307-319.

Musabyimana T, Saxena RC, Kairu EW, Ogol CPKO, Khan ZR (2001). Effects of neem seed derivatives on behavioral and physiological responses of the *Cosmopolites sordidus* (Coleoptera: Curculioni-dae). *Hort. Entom.* 94:449-454.

Nahdy MS (1995). Biotic and abiotic factors influencing the biology and distribution of common storage pests of pigeon pea. Ph.D Thesis. The University of Reading, UK.

Okongkwo EU, Okoye WI (1992). The control of *Callosobruschus maculatus* (F) in stored cowpea with ground *Ricinus communis* (L) in Niger. Trop. Pest Manag. 38: 237-238.

Palacios SG, Valladares G, Ferreyra D (1993). Preliminary results in the searching of an insecticide from *Melia azedarach* extracts. In: Kleeberg, R (ed) Proceedings of the first workshop on practice oriented results on use and production of neem ingredients and pheromones, Wetbar, Drack and Graphic Giessen, FRG. pp. 91-105.

Rukazambuga ND, Gold CS, Gowen SR (1998). Yield loss in East African highland banana (*Musa* spp., AAA-EA group) caused by the banana weevil, *Cosmopolites sordidus* Germar. Crop Prot. 17:581-589.

Schmutterer H (1990). Properties and potential of natural pesticide from neem tree, *Azadirachta indica*. Ann. Rev. Entomol. 35:272-297.

Schmutterer H (1995). The neem tree *Azadirachta indica* A. Juss and other Maliaceous plant sources of unique natural products of integrated pest management medicine, industry and other purposes. VCH, Weinheim, Federal Republic of Germany.

Sengooba T (1986). Survey of banana pest problem complex in Rakai and Masaka districts, August 1986: Preliminary trip report. Namulonge Research Station Uganda. Unpublished Mss. p. 10.

Tinzaara W, Nankinga C, Kashaija I, Tushemereirwe W (2002). Studies on the efficacy of some biorational insecticides against the banana weevil *Cosmopolites sordidus* Germar. Ug. J. Agric. Sc. 7: 31-35.

Usha R, Jamil K (1990). Chemosensory responses of cowpea weevils *Callosobrucus chinensis* to an aquatic weed, water hyacinth *Eichornia crassipes* Solms. J. Chem. Ecol. 16:1269-1274.