INSECTICIDAL ACTIVITIES OF THREE SELECTED PLANTS AGAINST ADULT *CALLOSOBRUCHUS MACULATUS* FAB (COLEOPTERA: BRUCHIDAE) IN ILORIN, NIGERIA

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ABSTRACT

Experiment was conducted to study the insecticidal activities of three selected plants against the pulse beetle, *Callosobruchus maculatus* Fab. (Coleoptera: Bruchidae) on cowpea, *Vigna unguiculata, seeds*. Four replicates of each of the treatment powders were constituted at 0% (control), 5%, 10% and 20% w/w treatment concentrations as follows: 0.0g (control), 0.5g, 1.0g and 2.0g of the treatment powder samples were added to 10g of equilibrated clean cowpea seeds in 300cm^{3}rearing plastic jars. Thereafter, 10 newly emerged adult *Callosobruchus maculatus* were introduced into each plastic rearing jar including the control jars. The plant powders were evaluated for their direct toxic effect on *C. maculatus*, oviposition inhibition, F1 progeny emergence of *C. maculatus*, and weight loss by the cowpea seeds. Data collected on mortality were analyzed using one-way Analysis of Variance at P<0.05. While data collected for oviposition, F1 emergence and weight loss were analyzed using descriptive statistics. The results revealed that the treatment powders were toxic to *C. maculatus* when compared with the control experiment. But *Azadirachta indica* seed powder significantly performed better in all the parameters measured when compared with the other treatments. Therefore, sustainable use of this biochemical, especially the *Azadirachta indica* seed powder in the control of pulse beetles in the store will enhance better cowpea storage.

KEYWORDS: *Azadirachta*, Bruchidae, Coleoptera, Cowpea, *Khaya*, *Terminalia*, Insecticidal.

INTRODUCTION

Cowpea weevils, *Callosobruchus maculatus* Fab. (Coleoptera: Bruchidae) infest seeds of wild and cultivated legumes to stored beens (Caswell, 1981; Okonkwo and Okoye, 1996; Raja *et al.*, 2000; Park *et al.*, 2003). The larvae bore into the pulse grains and became unsuitable for human consumption, viability for replanting, or for the production of sprouts (Rahman and Talukder, 2006). The pulse beetles (*C. maculatus*) are economically important pests of stored products in Asia and Africa (Ogunwolu and Idowu, 1994; Mulatu and Gebremedhin, 2000; Raja *et al.*, 2000; Ajayi and Lale, 2001).

To improve cowpea production especially on the field and storage, will require the control of the bruchids. Various forms of control have been employed. The most popular being the chemical method which relies heavily on the use of synthetic pesticides. Serious problems of genetic resistance by insect species, pest resurgence, residual toxicity, photo toxicity, vertebrate toxicity, wide spread environmental hazards and increasing costs of application of the presently used synthetic pesticides have directed the need for effective biodegradable pesticides (Ewete *et al.,* 1996; Okonkwo and Okoye, 1996; Talukder and Howse, 2000; Elhag, 2000), which are environmentally safe, specific with broad spectrum bioactivity, no mammalian hazard and non bioaccumulation (Bamaiyi *et al.,* 2007). Plant derived materials are more readily biodegradable. Some are less toxic to mammals, may be more selective in action, and may retard the development of resistance. Their main advantage is that they may be easily and cheaply produced by farmers and small-scale industries as crude, or partially purified extracts (Rahman and Talukder, 2006). It was reported that when mixed with stored grains, leaf, bark, seed powder, or oil extracts of plants reduce oviposition rate and suppress adult emergence of bruchids and also reduce seed damage and weight loss (Onu and Aliyu, 1995; Shaaya *et al.,* 1997; Keita *et al.,* 2001; Wahedi, 2012; Wahedi *et al.,* 2013, Wahedi *et al.,* 2014a, b).This study was carried out to evaluate the insecticidal properties of the powders of *Azadirachta indica*, *Khaya ivorensis*, and *Terminalia catappa* against the pulse beetle, *Callosobruchus maculatus* in Ilorin, Kwara State, Nigeria.

MATERIALS AND METHODS

Experiment on the insecticidal activities of the powders of *Azadirachta indica, Khaya ivorensis,* and *Terminalia catappa* against the pulse beetle, *Callosobruchus maculatus* was conducted in the Entomology Laboratory of the Department of Zoology, University of Ilorin, Nigeria.

Source of test plant materials

Fresh plant leaves of *Azadirachta indica, Khaya ivorensis*, and *Terminalia catappa* were collected from the University of Ilorin campus and neighboring areas during the rainy season (July - September), washed and air-dried in the shade. The dried leaves were then ground to powder using an electric blender. These were stored in dark bottles with screw cap tops.

Source of test insects and maintenance

Adult *Callosobruchus maculatus* used for the experiment was obtained from a culture raised on cowpea using a starter population obtained from the Nigerian Stored Product Research Institute (NSPRI) Ilorin, in the Entomology Laboratory of University of Ilorin. The pulse beetle, *C. maculatus* F. was used for the present experiments.

Initially, 50 pairs of 1-2 day-old adults were placed in 500cm^3 jars containing cowpea seeds. The jars were covered with muslin cloth which was held firmly with the aid of rubber band to prevent the escape of insects, and to allow ventilation. They were allowed to stand for a maximum of 7 days to allow mating and oviposition (Rahman and Talukder, 2006). Then parent stocks were removed and cowpea seeds containing eggs were transferred to fresh cowpea seeds in the breeding jars that were covered with muslin cloth fastened with rubber bands. The subsequent progenies of the beetles were used for the experiments.

Sample preparation of test plants

Powder and dust preparations of leaves were made by separately grinding approximately 500g of leaves of *Azadirachta indica*, *Khaya ivorensis*, and *Terminalia catappa* using electric blender in the laboratory. The resulting powder was passed through a 25-mesh sieve to obtain a fine dust.

Source of cowpea seeds

Clean cowpea seeds were obtained from a farmer around Tanke area of Ilorin. The seeds were further treated to free them from foreign infestation and for constant drying of the seeds using the method described by Wahedi *et al.* (2013).

Bioassay

Four replicates of each of the treatment powders were constituted at 0% (control), 5%, 10% and 20% w/w treatment concentrations as follows: 0.0g (control), 0.5g, 1.0g and 2.0g of the treatment powder samples were added to 10g of equilibrated clean cowpea seeds in 300cm^{3}rearing plastic jars. For the treated jars, the mixtures were stirred vigorously to ensure uniform coating of the cowpea grains by the bryophyte treatment samples. Thereafter, 10 newly emerged adult *C. maculatus* were introduced into each plastic rearing jar including the control jars, and were covered with muslin cloth with the help of rubber band. Each jar was inspected daily for adult mortality over seven days, and the dead *C. maculatus* withdrawn. On the eight day all surviving adults were withdrawn and the weight of each jar content noted. Daily mortality rates (%) were calculated as the proportion of dead insects in the total number of survivors the previous day. Absolute mortality rate (%) was calculated as the proportion of the 10 individual *C. maculatus* that died after 7 days. The number of eggs laid was also noted in the treated jars 14 days after setting up the experiment. Number of eggs laid (oviposition) per jar, was determined using the acid fuschin staining method. Ten cowpea grains from each jar was randomly selected on the 14th day, soaked in warm water for 2-3minutes, drained and subsequently immersed in 0.5% acid fushin stain for 2-5 minutes. The grains were rinsed in water and examined for white gelatinous egg plugs. The number of egg plugs noticed on the ten grains was then extrapolated for the entire jar using an average number of 136 seeds per jar. F1 adult emergence was noted between 7 to 8 weeks of setting up the experiment and recorded. The weight of the content of each jar after F1 emergence was noted. Percentage weight loss by cowpea grains per jar was calculated as the difference between the initial weight and the final weight of the jar content.

Data Analysis

Data collected on daily and absolute mortality of *C. maculatus* was subjected to one-way Analysis of

Variance, and the treatment means were separated using Duncan Range Multiple Test at 5% (P<0.05) level of significance. Data collected on oviposition, F1 adult emergence and percentage weight loss were analyzed using descriptive statistics.

RESULTS

Table 1 shows the effect of different treatments on the mortality of the pulse beetle, *Callosobruchus maculatus* over 7 days of treatment. The mortality was spread across the seven days for the entire treatments, except in *Azadirachta indica* at 2.0g treatment concentration where it recorded 100% mortality at day 5 after treatment. No mortality was recorded throughout the experiment in the control jars, as they were untreated. All the treatment powders recorded conspicuous and significantly higher mean absolute mortality values than the control experiment (0.00±0.00). The least mean absolute mortality value of 6.25±1.71 was recorded with 0.5g of *T. catappa* treatment. *A. indica* recorded 100% mean absolute mortality (10.00±0.00) at 2.0g treatment concentration. The *A. indica* at 2.0g treatment concentration was quick acting, as it recorded significantly (P<0.05) 100% (10.00±0.00) mean mortality at day 5 of treatment.

Figure 1 shows the effect of different treatments on the total number of eggs laid. The lowest (12.1) number of eggs was recorded in the cowpeas treated with *A. indica* at 2.0g concentration; while the highest was recorded in *T. catappa* at 1.0g concentration. Generally, the treatments were effective in reducing oviposition in *C. maculatus* when compared with the control (untreated).

In Figure 2, the effect of different treatments on F1 progeny emergence was shown. From the result, *T. catappa* appeared to have reduced the F1 progeny to the minimum (9.0), at 1.0g concentration; and the highest (27.0) was recorded in *K. ivorensis* at 1.0g concentration. Although, *A. indica* generally reduced the F1 progeny emergence more than the other treatments, when compared.

Similar trend was also noticed in Figure 3, where, *A. indica* treated cowpeas, did not lose much weight when compared with the other treatments. The highest (0.82g) weight loss was recorded in *K. ivorensis* at 1.0 g concentration; while the minimum (0.08g) was recorded in *A. indica* at 2.0g concentration. But the treatments showed some promising effects when compared with the control experiment in protecting the grains from *C. maculatus* feeding, which would have caused the grain weight loss.

TABLE I: Daily and absolute mortality of *C. maculatus* exposed to 0g, 0.5g, 1.0g and 2.0g powders of three selected plants

Treatment	Conc. (g)	Daily Mortality (Mean±SD) 1	2	3	4	5	6	7	Absolute mortality
Control	0.0	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00a	0.00±0.00^{a}	0.00±0.00^{a}
A. indica	0.5	0.50±1.00^{a}	2.00±1.29^{a}	2.75±0.50^{ab}	5.00±0.50^{b}	6.25±1.50^{a}	7.25±0.82^{b}	7.50±0.50^{a}	7.50±2.38^{b}
	1.0	2.00±0.00^{b}	4.00±1.15^{b}	5.25±0.96^{b}	7.50±1.50^{b}	8.25±0.96^{a}	8.25±0.00^{a}	9.00±0.96^{a}	9.00±1.41^{bc}
	2.0	2.50±0.00^{b}	5.00±1.29^{b}	8.25±0.50^{c}	9.25±0.82^{a}	10.00±0.96^{a}	10.00±0.50^{a}	10.00±0.00^{a}	10.00±0.00^{c}
K. ivorensis	0.5	0.75±0.50^{ab}	1.75±1.15^{ab}	3.25±1.29^{ab}	4.50±1.26^{a}	4.75±0.50^{a}	5.50±0.96^{a}	6.50±1.15^{a}	6.50±1.29^{b}
	1.0	0.75±1.50^{ab}	2.25±0.58^{bc}	4.50±1.50^{b}	6.00±1.00^{a}	6.75±0.96^{a}	7.75±0.82^{a}	8.00±0.50^{a}	8.00±1.83^{bc}
	2.0	1.75±0.50^{b}	4.00±0.50^{c}	5.00±0.82^{ab}	5.75±1.50^{a}	6.75±0.82^{a}	7.75±1.15^{a}	9.00±0.96^{a}	9.00±0.82^{c}
T. catappa	0.5	0.00±0.00^{a}	1.00±0.00^{ab}	1.50±1.00^{a}	3.50±0.82^{b}	4.50±0.82^{ab}	5.25±0.96^{a}	6.25±1.15^{ab}	6.25±1.71^{b}
	1.0	0.25±0.50^{a}	1.75±1.00^{b}	2.75±1.41^{a}	5.00±0.58^{b}	6.75±1.26^{b}	7.25±0.58^{a}	8.75±0.96^{b}	8.75±0.96^{bc}
	2.0	1.00±0.82^{b}	2.75±0.96^{b}	4.50±1.71^{a}	6.50±0.82^{b}	8.75±0.96^{b}	9.75±0.82^{a}	9.75±0.00^{a}	9.75±0.50^{c}

Values are means of four replicates (Mean±SD). Means carrying the same alphabet superscript along the columns are not significantly different at $P<0.05$.

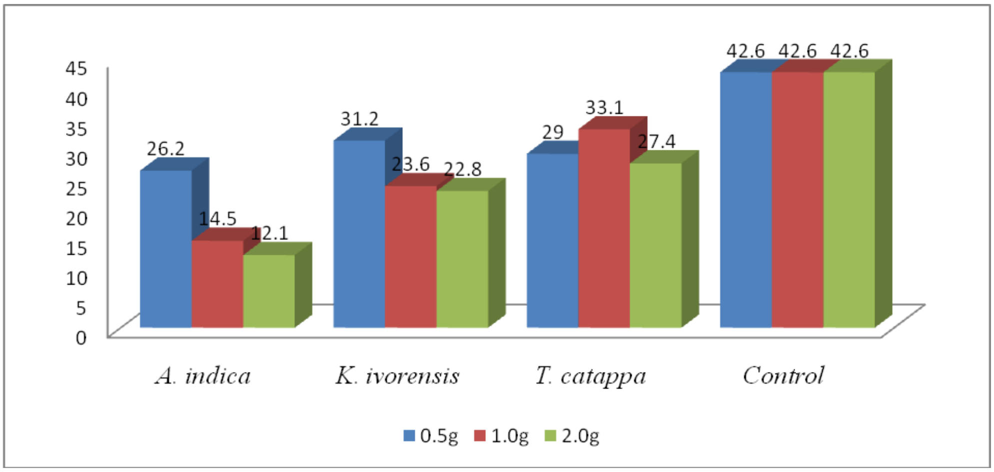

FIGURE 1: Effect of different treatments on oviposition of pulse beetle, *C. maculates*

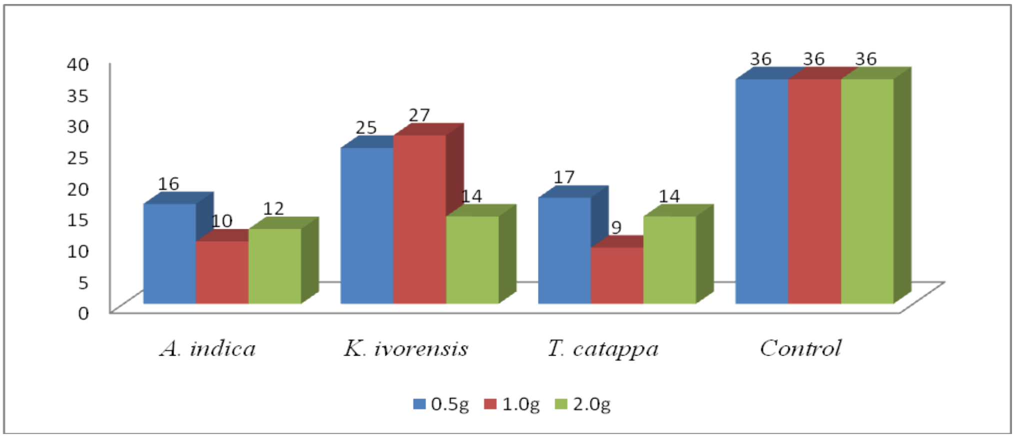

FIGURE 2: Effect of different treatments on F1 progeny emergence of the pulse beetles, *C. maculatus*

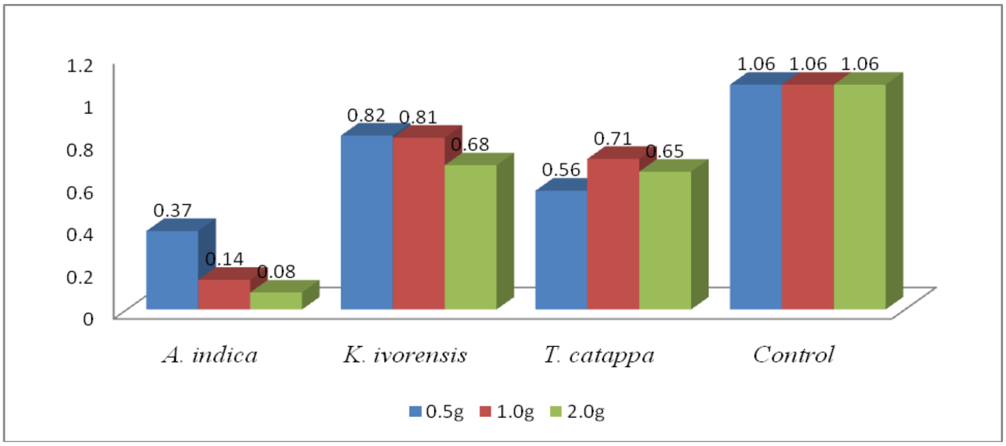

FIGURE 3: Effect of different treatments on the weight loss of the cowpea grains.

DISCUSSION

All the treatment powders were toxic to *C. maculatus* when compared with the control experiment which significantly did not record any mortality throughout the experiment. 2.0g of the three treatments were quick acting as it all recorded higher mortality from the first day of the treatment. This continued throughout the seven days of the treatment. This was also noticeable in the absolute mortality values where mortality increases with increase in the treatment concentrations. There was no significant difference between the treatment concentrations (0.5g, 1.0g and 2.0g) in the absolute mortality, but significantly (P<0.05) different from the control experiment (experiment), when compared. Only *A. indica* at 2.0g recorded 100% absolute mortality. The 100% mortality was achieved in day 5 of treatment which was quite fast. This was also evident in day 1 (24 Hrs) of treatment where *A. indica* at 2.0g recorded the highest (2.50±0.00) mortality value of all the treatments, which further confirmed the insecticidal properties of *A. indica* on *C. maculatus*. This result agrees with Oparaeke *et al* (1998), and Wahedi *et al.* (2013) who reported that *A. indica* significantly caused high mortality in *C. maculatus* on cowpea.

From the result, *A. indica* powder significantly reduced oviposition of *C. maculatus*, more than the other treatment powders when compared. Generally, the plant powders significantly reduced oviposition of the adult pulse beetle (*C. maculatus*) when compared with the control experiment (42.6), which was untreated. *A. indica* at 2.0g treatment recorded the least (12.1) number of eggs. This confirmed the efficacy of the three plants against the pulse beetles. The order of efficacy of the three plants, regarding oviposition deterrent is as follows: *A. indica*>*T. catappa*>*K. ivorensis*. The treatments did not restrain adult F1 progeny emergence of *C. maculatus*. Although, the treatments significantly reduced the number of emergence when compared with the control experiment (36), as shown in Figure 2., *T. catappa* reduced the F1 emergence of *C. maculatus* to the least (9). The plant powders were also effective in protecting the pulse beetles from feeding on the grains, which would have caused weight loss by the grains. This was evident in Figure 3, where the control, significantly recorded higher (1.06) weight loss when compared with the treatments. *Azadirachta indica* at 2.0g again recorded the least (0.08) weight loss. This study agrees with Wahedi *et al* (2013, 2014a) where powders of *A. indica* and *K. ivorensis* respectively, significantly reduced the F1 progeny emergence of *C. maculatus*, and weight loss by the cowpea grains when exposed.

CONCLUSION

In conclusion, the results further confirmed the insecticidal activities of the three plants especially *A. indica*, which showed some promising results in all the biocidal activities tested. Therefore, sustainable use of this biochemical especially in the control of pulse beetles in the store will enhance better cowpea storage, and production, both for domestic and commercial purposes.

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