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Protection of Groundnut (*Arachis hypogaea* L.) against *Trogoderma granarium* Everts (Coleoptera:Dermestidae) using African Bush Tea (*Hyptis suaveolens* Poit.) in the Southern Guinea Savanna of Nigeria

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Abstract

A laboratory experiment was conducted to examine the insecticidal potential of *Hyptis suaveolens* Poit. leaf and seed powders and pirimiphos-methyl dust on fourth instar larvae of khapra beetle, *Trogoderma granarium* Everts. Experiment was conducted at 26±3^0 C and 72±3% r. h. The leaf and seed powders at 1, 2 and 3 g/50 g were tested and then compared with pirimiphos-methyl at 0.1 g/50 g against *T. granarium* in groundnut seeds. Mortality was significantly ($p<0.05$) higher (56.7 and 83.3%) at 12 and 24 h exposure respectively, at 3 g/50 g seeds than at other rates. Treatments with leaf and seed powders applied at 3 g/50 g seeds were less effective in causing larval mortality and reducing adult population but not significantly different when compared to pirimiphos-methyl dust. Treatment of groundnut seeds with *H. suaveolens* leaf and seed powders probably had important practical implication in the southern Guinea Savanna of Nigeria.

Key words: Groundnut, *Hyptis suaveolens*, pirimiphos methyl, protection, *Trogoderma granarium*

1.0. Introduction

Groundnut (*Arachis hypogaea* L.) is grown in most parts of Nigeria, although the northern part has the most suitable soil and climate for its production. Despite the economic importance of groundnut as a source of plant protein for humans and livestock in developing countries, such as Nigeria, profitable protection of this crop is seriously constrained by the attack of khapra beetle, *Trogoderma granarium* Everts. The beetle is receiving attention recently due to its establishment in northern and southern Guinea Savanna zones of Nigeria, where it is causing great losses to oil seeds and other crops in storage. As a pest, the khapra beetle is capable of the complete destruction of stored cereals and cereal products (7).

Synthetic chemicals including fumigants are particularly effective in the control of *T. granarium* in well defined storage condition. However, these chemicals have been reported to cause ecological imbalance manifested by pollution of the environment, which may lead to reduction in the ozone layer that shields the earth from the ultraviolet rays of the sun (8). The success of these chemicals has also been limited by their high mammalian toxicity, hazardous effects on non-target organisms and prohibitive cost. Alternatively, botanicals show insecticidal action and are presumed to contain active components that have less detrimental effects on the environment. African bush tea, *Hyptis suaveolens* Poit., is naturally available in the southern Guinea Savanna of Nigeria where the leaves are traditionally used as mosquito repellents in many homes and villages. The present study is therefore aimed at investigating comparative effectiveness of *H. suaveolens* leaf and seed powders and pirimiphos methyl dust as protectants against fourth instar larvae of *T. granarium*.

2.0. Materials and Methods

2.1. Laboratory culture of *Trogoderma granarium*

Laboratory stocks of the insect were cultured on whole groundnut seeds maintained in three 500 ml Kilner jars at 26±3^0 C and 72±3% relative humidity. Each jar contained varying quantity of the seeds that could sustain the survival of fourth instar larvae of *T. granarium* used for the experiment. These larvae were identified with their morphological traits of robust and hairy body, body length and dark brown colour.

2.2. Collection and preparation of *H. suaveolens*

Hyptis suaveolens plants were collected along walkway at the onset of rainy season beside Nigerian Air Force barracks, Ilorin and the identity of the plant was confirmed at the herbarium of the University of Ilorin, Ilorin, Nigeria. Leaves and seeds of the plant were plucked from the parent plant, dried under shade for 7 days, ground to a uniform particle size of 600 µm in a milling machine to form a fine powder. The leaf and seed powder were immediately used against the insect.

2.3. Preparation of groundnut seeds

Decorticated seeds of the groundnut variety, RRB, were obtained from the Institute for Agricultural Research (IAR), Samaru, Nigeria. The seeds were frozen for 14 days and then allowed to thaw on a laboratory bench for 3 days before they were used for the experiment. The moisture content was computed on a dry weight basis to be 9.2%.

2.4. Experimental design

Hyptis suaveolens leaf and seed powders were admixed at 1, 2 and 3 g/ 50 g groundnut seeds before introduction of ten fourth instar larvae of *T. granarium.* The transparent containers (7 cm diameter) were covered with baft cloth held in place with rubber band to allow ventilation and prevent entry of predators. The pirimiphos methyl dust was applied at 0.1 g/ 50 g groundnut seeds as a standard check. All treatments were replicated three times including the control (seeds not treated with plant powder and chemical dust).

Data collected include larval mortality, adult population 60 days after infestation and percentage weight loss of groundnut seeds. *Trogoderma granarium* larval mortality was examined at 12 h and 24 h post treatment. Live larvae are known to be active especially when disturbed and tend to move away from light source. The dead larvae were removed and discarded. Counts of live *T. granarium* adults over a period of 60 days after infestation were taken and recorded. Powder, frass and exuviae in each container were sieved and discarded. The seeds were then re-weighed and the difference between the initial weight and final weight of the groundnut seeds divided by initial weight were expressed as percentage weight loss.

2.6. Statistical analysis

Data were subjected to analysis of variance (ANOVA) and treatment means with significant differences were separated using Tukey test at p=0.05 significance level.

3.0. Results

Table 1 shows the percentage mortality of *T. granarium* fourth instar larvae, adult population and groundnut seed weight loss. In this study, mortality was significantly ($p<0.05$) higher (56.7 and 83.3%) at 12 and 24 h exposure respectively, at 3 g/50 g seeds than at other rates. Treatment with pirimiphos-methyl dust caused 86.7 and 100% mortality after 12 and 24 HAT respectively. Results show that treatments with seed powders at 3 g/50 g seeds were less effective in causing larval mortality at 24 h compared to pirimiphos-methyl dust. The insecticidal ability of seed powder applied at highest rate did not vary significantly with pirimiphos-methyl dust at 24 h. Groundnut seeds treated with 2 g *H. suaveolens* leaf powder had the lowest larval mortality (13.3%) during the same exposure period. Results showed that African bush tea seed powder at 3 g/50 g groundnut seeds had insecticidal effect not significantly different from pirimiphos-methyl dust applied at 0.1 g/50 g of groundnut seeds. Mortality significantly ($p<0.05$) increased with increase in time of exposure to treatments. The chemical achieved 100% larval mortality within 24 h of exposure.

The percentage of adult population was derived from counts of the number of adults that over a period of 60 days of infestation. More than 40% adults of *T. granarium* occurred at lowest rate of 1.0 g of *H. suaveolens* leaf and seed powders (Table 1). The mean number of adults in the control (123) was taken as 100% adult population. There was however, no significant difference ($P>0.05$) between the insect density at 2 g and 3 g/50 g groundnut seeds for leaf and seed powder treatments. Adult population was significantly reduced in higher rate. No larval mortality was recorded in the lower rate of *H. suaveolens* leaf powder causing higher insect density which was significantly different in comparison with the control. There was 56.9 and 58.5% reduction in the population of *T. granarium* adults at 1 g/50g seeds of leaf and seed powders respectively. Data on the effectiveness of the plant powders against *T. granarium* larvae showed that seed powder exhibited promising protection at 3 g/50g seeds by bringing about 88.6% reduction in adult population.

Seeds treated with *H. suaveolens* seed powder at 3.0 g/50 g groundnut seeds had less weight loss when compared to those treated with 2 g/50 g seed powder, though the difference was not significantly different ($p>0.05$). Seeds treated with higher rates of *H. suaveolens* leaf powder had less weight loss when compared to those treated with 1 g/50 g leaf powder, showing significant differences between them. Weight loss recorded in seeds treated 3 g/50 g *H. suaveolens* seed powder was comparable to weight loss recorded in pirimiphos-methyl dust. All treatments showed significant differences compared to the control except leaf powder at 1 g/50 g groundnut seeds.

4.0. Discussion

The insecticidal potential of the plant powders was dose dependent with higher mortality at high doses and vice versa. Though the rate of treatment of the synthetic chemical was not varied in this study, (6) had earlier observed that the toxicity of pirimiphos-methyl was dose dependent. The leaf and seed powders of *H. suaveolens* caused reduction in adult population with increase in rate of treatment. Findings showed that fewer adults from treated compared to untreated seeds. This might be ascribed to change in behaviour of the insect and reduction in female fecundity caused by the varying rates of the plant part powders. (1) attributed the degree of tolerance of the pest individuals to larval age and rearing condition. There was also less weight loss recorded on treated seeds as a result of their feeding behaviour of the larvae. Results obtained showed that the use of *H. suaveolens* leaf and seed powders at the highest rate of 3 g/50 g seeds against *T. granarium* caused a weight loss of 18.3 and 33.3% respectively. The weight loss of 13.3% recorded in pirimiphos-methyl could be attributed to *T. granarium* adult population in the dust. Though adults do not feed but they move on the seeds in search of mating partner and oviposition site. This suggests that there is the need for complementary use of appropriate strategy to enhance a greater control of the insect pest.

Highest rate of *H. suaveolens* seed powder was the most effective possibly by interfering with the feeding behaviour of the insect. Literature shows the chemical and organic components of *H. suaveolens*. The leaf powder and seed extract have some degree of protection against *Callosobruchus maculatus* (F.) (11) and *T. granarium* (10). It appears that plant materials will not generally control all pests at the same rate. Although these materials do not always control pests as well as commercial insecticides, they may nonetheless be economically worthwhile for the farmer (5). The insecticidal activities of *H. suaveolens* have been attributed to the presence of phenols, steroids, tannins and acids (9)(2)(3). In addition, (12) identified terpene aicohol eucalyptol as the most abundant compound in the essential oil of *H. suaveolens* leaves while (4) isolated hypatadiemic acid from the leaves.

Hyptis suaveolens could not prevent development of larvae to adults which probably multiplied in the second filial generation leading to greater weight loss of the seeds. Apart from availability and the insecticidal activities, *Hyptis* species dispels any fear of environmental pollution associated with synthetic insecticides.

5.0. Conclusion

The findings from this investigation have shown that resource poor farmers can use African bush plant, *Hyptis suaveolens* for *Trogoderma* management in stored groundnut. It may be concluded from the present study that *H. suaveolens* leaf and seed powders were capable of suppressing activities of *T. granarium* fourth instar larvae population in small storage. It shows that it could be very effective if combined with other management strategy. Meanwhile, more work will be carried out to characterize and isolate the active agents in order to obtain insecticidal formulation from it.

Table 1: Comparative effectiveness of *Hyptis suaveolens* leaf and seed powders and pirimiphos methyl dust against *Trogoderma granarium* in stored groundnut

Test material	Rate(g)/50g groundnut seeds	Larval mortality (%) 12 h	Larval mortality (%) 24 h	Adult population (%)	Weight loss (%)
Hyptis suaveolens leaf	1.0	0.0^{f}	13.3^{c}	43.1^{b}	63.3^{a}
	2.0	13.3^{e}	23.3^{c}	23.0^{c}	33.3^{bc}
	3.0	40.0^{c}	63.3^{bc}	11.6^{c}	33.3^{bc}
Hyptis suaveolens seeds	1.0	23.3^{d}	36.7^{c}	41.5^{b}	41.7^{b}
	2.0	23.3^{d}	43.3^{c}	19.8^{c}	28.3^{cd}
	3.0	56.7^{b}	83.3^{ab}	11.4^{c}	18.3^{de}
Pirimiphos methyl	0.1	86.7^{a}	100.0^{a}	6.5^{c}	13.3^{e}
Control	0.0	0.0^{f}	0.0^{c}	100.0^{a}	75.0^{a}
C.V. (%)		17.4	14.3	23.5	19.0

Values with the same superscript(s) in the same column are not significantly different at p=0.05 using Tukey test

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