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Efficacy of Leaf Powders of *Senna obtusifolia* (L.) and *Mitracarpus hirtus* (L.) DC. on the Survival of *Sitophilus zeamais* Motschulsky [Coleoptera: Curculionidae] on Sorghum Grains During Storage

***Suleiman, M. and Suleiman, F. L.**

Department of Biology, Umaru Musa Yar'adua University, Katsina, Nigeria

Correspondence: mymohammed007@yahoo.com

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ABSTRACT

Experiments were conducted in the Biology Laboratory 1 of the Department of Biology of Umaru Musa Yar'adua University (UMYU), Katsina to test the insecticidal effects of leaf powders of Senna obtusifolia (L.) and Mitracarpus hirtus (L.) DC. Doses of 1.0, 2.0 3.0g of each of the leaf powders and 1.0g of Pestox® (cypermethrin) were applied to 50g each of sorghum grains in which five pairs of adult Sitophilus zeamais Motschulsky were released for adult mortality, emergence and grain damage tests. The results showed that the highest (36.67%) mortality of S. zeamais obtained when 3.0g of S. obtusifolia was applied while the least (10.00%) was recorded from the treatments of 1.0g M. hirtus. The findings of this study also showed that adult mortality of S. zeamais was directly proportional to the amounts of the leaf powders applied. The results also revealed that from the highest (114.33) adult emergence of the weevils was obtained when 1.0g of M. hirtus was applied, while the least (40.67) was recorded from the treatment of 3.0g S. obtusifolia. The findings of this study showed that the adult emergence of S. zeamais was inversely proportional to the amounts of the leaf powders applied. Generally, the efficacy of the leaf powders on the survival of S. zeamais was found to be significantly (p<0.05) different between the test powders and the control. Findings of this study showed that the leaf powders of S. obtusifolia and M. hirtus were effective in protecting sorghum grains against S. zeamais infestation in stores. Therefore, more research is recommended on toxicity effect of these plant powders on other insect pests.

Key words: Leaf powders, *M. hirtus*, Sorghum grains, Survival, *S. obtusifolia*, *S. zeamais*

INTRODUCTION

Storage is an important activity, which enhances marketing efficiency by providing the entire ability [1]. Stored grain insect pests, mainly weevil and beetles cause serious damage to cereals, pulses and other stored materials [2]. The loss of food grain during storage due to various insect pests is a very serious problem. Climate and storage conditions, especially in the tropic countries like Nigeria, are often highly favourable for insect growth and development, which leads to their damages to the stored grains that ranges from 5-30% of the world's total agricultural production [3]. In sorghum, the losses incurred through insect damage in store, is estimated to be in the region of 35% of total production [4].

The maize weevil, *S. zeamais* is a small beetle which varies in size with characteristics rostrum which serves as part of the mouth parts. It is a ¼ inch long and varies from dull reddish-brown to nearly black and is usually marked on the back with four light reddish or yellowish spots. The thorax is densely pitted with somewhat irregularly shaped punctures, except for a smooth narrow strip extending down the middle of the dorsal side [5].

The adult weevils and larvae feed on undamaged grains and frequently cause severe powdering, rendering the product unfit for human consumptions partially damaged grains manifest loss in weight, poor marketability, quality deterioration and low viability.

The use of chemical pesticides to protect cereal crops against the attack of grain weevil in storage may cause serious health hazards [6]. In developing countries, the indiscriminate, regular and routine use of synthetic pesticides for the control of insect pest has led to a number of problems, such as insect pests resistance, resurgence, environmental pollution, ecological imbalance and residues in market produce. On the other hand, botanical pesticides are safe, less hazardous and biodegradable [7].

Senna obtusifolia (L.), also called Chinese Senna or sickle pod, is a legume in genus Senna, its green leaves are fermented to produce a high protein food product called *Kawai*, which is eaten by many people in Sudan as a meat substitute. Its leaves, seeds and roots are also used in folk medicine primarily in Asia. It is believed to possess a laxative effect, as well as to be beneficial for the eyes. The seed has also been used as a substitute for coffee. *S. obtusifolia* is also considered a particularly serious weed in many places [8].

Mitracarpus hirtus (L) DC is a plant that belongs to the family Rubiaceae. It is widely naturalized, grows in disturbed places and along roads and tracks through rainforest, Eucalypt forest, deciduous vine thicket and various types of woodland. It is a fide weed of rice in Indonesia [9] and it is used as local medicine in Nigeria to treat a skin disease known as eczema which is caused by fungi.

MATERIALS AND METHODS

Rearing of *S. zeamais*

Adults of *S. zeamais* were cultured in the laboratory at 27^0C – 31^0C and 17.5 – 35% R.H. in the laboratory 1 of the Department of Biology, Umaru Musa Yar`adua University, Katsina (UMYU). Whole sorghum grains (substrate for insects rearing) of local variety (*Kaura*) obtained from Katsina State Central market, were disinfested in the hot air oven at 60^0C for 1 hour [10]. Fifty pairs of adult *S. zeamais* obtained from infested maize grains were introduced into the rearing bottles (50cm^3 capacity) containing 250g sterilized sorghum. The bottles were then covered with muslin cloth and held in place with rubber bands and kept for 2 weeks for oviposition. The parents weevils were then sieved out with the aid of 2mm laboratory test sieve (BS410-1:2000). The rearing bottles were left in the lab drawer until adult emergence.

Collection and Preparation of Leaf Powders

S. obtusifolia and *M. hirtus* leaves were obtained from the bushes around the female hostel and the auditorium in the University (UMYU) Katsina, Katsina state, Nigeria. All the plant materials were washed and rinsed thoroughly, and then dried under the shade for 9 days before grinding into fine powders using laboratory blender (Model number 8010ES) and sieved using 80 µmlaboratory sieve, while electric weighing scale (TP-3002) was used to weigh the different rates of the powders applied. The powders were separately kept in polythene bags and stored at room temperature in the laboratory. The conventional insecticide Pestox® (cypermethrin) was purchased from the same market.

Adult Mortality Test

Fifty (50) gram of clean disinfested sorghum grains was weighed into small plastic bottles. The plant powders were applied at 1.0, 2.0 and 3.0g dosages per 50g sorghum grains with each bottle, while 1.0g of cypermethrin was added to another bottle containing sorghum as check, and zero powder was added to the control. Treatments containing the powders and cypermethrin were thoroughly mixed with the disinfested sorghum grains with the aid of glass rod to ensure thorough admixture. There after five pairs of newly adult weevils were introduced in each of the treated and untreated sorghum in small plastic bottles were then kept in the lab drawer, arranged in a Complete Randomized Design (CRD), and replicated 3 times. Observations were made on adult mortality after 2 weeks of introduction, during which all the weevils were removed and the dead ones were counted and recorded. The plastic bottles were then kept in the laboratory for adult emergence (F1 progeny).

Adult Emergence

The experimental containers were left undisturbed in the laboratory until the emergence of the F1 generation. The emerged adult weevils were allowed to feed from the sorghum grain for another 2 weeks, after which all weevils in each bottle were sieved out, counted and recorded.

Damage Assessment

The level of damage caused by *S. zeamais* on the sorghum grains was studied from the same set-up. Powders from each of the containers were sieved out and the sorghum grain was weighed again and recorded. The grain damage was determined by using the formula:

$$\% \text{ Grain Damage} = \frac{\text{Initial Grain Weight} - \text{Final Grain Weight}}{\text{Initial Grain Weight}} \times 100$$

Statistical Analysis

The data were subjected to analysis of variance (ANOVA) and means were separated using LSD at 5% level of significance ($p<0.05$).

RESULTS

Table 1 shows the effect of leaf powders of *M. hirtus* and *S. obtusifolia* on adult mortality of *S. zeamais* reared on sorghum grains. The Table shows that both of the leaf powders caused adult mortality of *S. zeamais*, even though the chemical check was more effective. Among the leaf powders, *S. obtusifolia* applied at 3.0/50 g sorghum grains resulted in the highest (36.67%) adult mortality, while the least (10.00%) was obtained from 1.0/50 g sorghum grains of *M. hirtus*. The results reveal that as the amount of the powders increased, the adult mortality of *S. zeamais* increased. Hence, the mortality was directly proportional to the amount of the leaf powders applied. There was significant ($p<0.05$) difference between the adult mortality of *S. zeamais* obtained from the treatments and the control.

Table 2 shows the effects of leaf powders of *M. hirtus* and *S. obtusifolia* on adult emergence of *S. zeamais* on sorghum grains. The Table shows that both the leaf powders allowed adult emergence of *S. zeamais*, even though in chemical check there was no adult emergence recorded. Among the plant powders, *M. hirtus* applied at 1.0/50 g sorghum grains resulted in the highest (114.33) adult emergence, while the least (40.67) was obtained from 3.0/50 g sorghum grains of *S. obtusifolia*. This indicates that as the amount of the plant powders increased, the adult emergence of adult *S. zeamais* decreased. Hence, the emergence was inversely proportional to the amount of the plant powders applied.

Table 3 shows the effects of leaf powders of *M. hirtus* and *S. obtusifolia* in reducing sorghum grains damage that might be caused by *S. zeamais*. The Table shows that both of the leaf powders reduced sorghum grains damage by *S. zeamais*, though in chemical check all the weevils died immediately after introduction, and so there was little (0.82%) damage recorded. Among the leaf powders, *M. hirtus* applied at 1.0/50g sorghum grains resulted in the highest (9.31%) grain damage, while the least (1.05%) was obtained from 3.0/50g sorghum grains of *S. obtusifolia*. The results revealed that as the amount of plant powders increased, the grains damage by *S. zeamais* decreased, hence, the grain damage is inversely proportional to amount of plant powders applied.

Table 1: Effect of Leaf Powders of *M. hirtus* and *S. obtusifolia* on Adult Mortality of *S. zeamais*

Test Powders	Mean Adult Mortality (%) ± S. E. Amount of Test Powders Applied (g/ 50 g)		
	1.0	2.0	3.0
M. hirtus	10.00 ± 0.00^b	16.67 ± 4.44^b	23.33 ± 4.44^c
S. obtusifolia	13.33 ± 4.44^b	20.00 ± 4.44^b	36.67 ± 8.89^b
Cypermethrin (1.0 g)	100.00 ± 0.00^a	100.00 ± 0.00^a	100.00 ± 0.00^a
Control (0.0 g)	0.00 ± 0.00^c	0.00 ± 0.00^c	0.00 ± 0.00^d
C. V. (%)	2.34	2.11	4.03

Values within a column followed by different letters are significantly different ($p<0.05$).

Table 2: Effect of Leaf Powders of *M. hirtus* and *S. obtusifolia* on Adult Emergence of *S. zeamais*

Test Powders	Mean Adult Emergence (Number) ± S. E.		
	Amount of Test Powders Applied (g/ 50 g)		
	1.0	2.0	3.0
M. hirtus	114.33 ± 1.78^{b}	90.33 ± 0.44^{b}	58.00 ±1.33^{b}
S. obtusifolia	84.33 ± 2.22^{c}	52.00 ± 2.67^{c}	40.67 ±0.89^{c}
Cypermethrin (1.0 g)	0.00 ± 0.00^{d}	0.00 ± 0.00^{d}	0.00 ± 0.00^{d}
Control (0.0 g)	138.00 ± 2.00^{a}	138.00 ± 2.00^{a}	138.00 ± 2.00^{a}
C. V. (%)	0.74	0.90	0.77

Values within a column followed by different letters are significantly different (p<0.05).

Table 3: Effect of Leaf Powders of *M. hirtus* and *S. obtusifolia* in Reducing Sorghum Grain Damage Caused by *S. zeamais*

Test Powders	Mean Grain Damage (%)		
	Amount of Test Powders Applied (g/ 50 g)		
	1.0	2.0	3.0
M. hirtus	9.31 ± 0.07^{b}	7.07 ± 0.50^{a}	2.11 ± 0.48^{b}
S. obtusifolia	5.55 ± 0.67^{c}	3.27 ± 0.04^{ab}	1.05 ± 0.20^{b}
Cypermethrin (1.0 g)	0.82 ± 0.48^{d}	0.82 ± 0.48^{b}	0.82 ± 0.48^{b}
Control (0.0 g)	12.40 ± 1.28^{a}	12.40 ± 1.28^{a}	12.40 ± 1.28^{a}
C. V. (%)	3.88	17.15	6.46

Values within a column followed by different letters are significantly different (p<0.05).

DISCUSSION

From the results obtained, it can be seen that the plant powders used in this research showed significant effect on mortality and adult emergence of *S. zeamais*, as well as damage caused by *S. zeamais* on sorghum grains. The results confirm that the plant products can be used to protect stored sorghum grains against *S. zeamais*. The use of local plant products and other available materials to protect stored crop grains have been reported by other workers [11, 12]. Both the leaf powders used were observed to have effect on the mortality of adult *S. zeamais* on varying amounts applied (1.0, 2.0 and 3.0g/50 g grains), 14 days after treatment, and this is comparable to the results obtained by other workers [13] where they reported the toxic effect of the leaf powders of *J. curcas* and *L. inermis* used on *S. zeamais* and recorded of up to 100% mortality at all the doses applied (0.5, 1.0 and 2.0 g/20 g grains). It was also observed that as the dose increased the rate of mortality also increased as reported by [14]. Some researchers [10] reported 100% adult mortality of *S. zeamais* when treated with seed crude extract of *J. curcas*. Other scientists [15] reported that 1.5 g of *A. sativum* applied to 25 g of maize grains caused mortality of 85% in adult *S. zeamais*, 14 days after application. The present findings agree with that of [16] who reported 100% mortality of *T. granarius*14 days after application of *C. frutescens*. A scientist [17] also reported that application of 0.4 g of *C. frutescens* caused 75% mortality on adult *S. zeamais* in 20 g maize grains. Cypermethrin applied at (1.0 g/50 g grains) affected the survival of adult weevils with 100.00% mortality during the study period. This was comparable with the previous findings [18], where they showed the toxic effect of permethrin on the survival adult weevils. Literature on the use of *M. hirtus* and *S. obtusifolia* as biopesticides is scarce.

Leaves powders of *S. obtusifolia* and *M. hirtus* resulted in the reduction of adult emergence of *S. zeamais* at all doses applied (1.0, 2.0 and 3.0 g/50 g grains) compared to the control. It was observed that there were significant effects on the emergence of adults reared on the treated and untreated sorghum grains. *S. obtusifolia* powder was found to be more effective in affecting the emergence of adult weevils, while *M. hirtus* was found to be less effective. This is comparable to the previous findings [19] where they reported that the plant powder of *J. curcas* was more effective in affecting the emergence of adult S. zeamais than *L. hastata*. A scientist [13] also reported that the plant powders of *E. balsamifera*, *J.* curcas and *L. inermis* were observed to be effective in reducing adult emergence at all doses applied. The effect on adult emergence was significantly different among both the plant powders tested and between the plant powders and cypermethrin, as well as the control.

Powders of *S. obtusifolia* and *M. hirtus* applied were found effective in protecting the sorghum grains from damage caused by *S. zeamais*. *S. obtusifolia* leaf powder was found to be more effective in reducing grain damage, while *M. hirtus* leaf powder was found to be less effective. The effect on grain damage was significantly different among all the plant powders tested and cypermethrin, as well as the control. Sorghum grains treated with 3.0 g of *S. obtusifolia* leaf powder reveals significant decrease in the grain damage except in 1.0g of *M. hirtus* where the grain damage increased. These plants show exceptional property where the higher concentration was observed to be more effective than the lower doses, this is comparable with the previous findings [19]. *C. frutescens* and *Z. officinale* were found effective in reducing grain caused by *S. zeamais* on maize [20]. The leaf powder of L. inermis was also promising in reducing grain damage and weight loss, unlike other powders [19], its effects had been inversely proportional to the amount used which is not in agreement with the other findings [16] which reported an increase in effectiveness of leaves powder of *L. inermis* with increase in concentration. Plant powders of *C. sinensis* and E. balsamifera were found effective in protecting the sorghum grains from damage caused by *S. zeamais* [14]. Therefore, the weight loss of the grains recorded in cypermethrin might be due to the loss of moisture in the grains.

CONCLUSION

The findings obtained from this study have revealed that the leaf powders of *S. obtusifolia* and *M. hirtus* had significant effects on the mortality, adult emergence and grain damage by *S. zeamais* reared on sorghum grains. The plant products that are traditionally used and produced by the farmers in developing countries appear to be more safety and affordable. Using plants with insecticidal properties is an attractive alternative to the more expensive synthetic pesticides which so often possesses a higher risk of affecting health. The observed differences on mortality and emergence of this pest on treated and untreated sorghum grains indicated that the test powders had effects on the developmental stages. The leaf powders also showed positive protectant ability against *S. zeamais* attacking sorghum grains in the store.

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