TOXICITY OF SOME PLANT POWDERS TO LESSER GRAIN BORER (*RHYZOPERTHA DOMINICA* (FAB.); COLEOPTERA: BOSTRICHIDEA) INFESTING STORED SORGHUM.

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ABSTRACT

Powders of neem seed Kernel (*Azadirachta indica* A. JUSS.), bush tea (*Hyptis suaveolens* L. poit.), Jatropha (*Jatropha curcas* L.), bitter melon (*Momordica charantia* L.) and Mahogany (*khaya senegalensis* Desr.) were applied at 0.5, 1.0. 1.5 and 2.0g per 20g of sorghum grain. Cypermethrin (2.0%) as control check was applied at 0.12g/20g and evaluated for toxicity against *Rhyzopertha dominica* Fab. on stored sorghum grains. Jatropha leaf, Mahogany stem bark and neem seed kernel powders at all concentrations recorded 76.67% and above mortality of adult *R. dominica* as cypermethrin. *A. indica*, *J. curcas* and *K. senegalensis* suppressed oviposition and reduced adult emergence of F_2, offsprings. Sorghum grain damage and weight loss were highly reduced and so protect by *A indica* at 0.5g, while *J.curcas* and *K. senegalensis* were both effective at 1.0g and 2.0g for grain damage and weight loss prevention respectively up to 150 days of storage. Jatropha leaf, Neem seed kernel and mahogany stem bark powders proved significantly more effective compared to cypermethrin dust and other plant leaf powders tested.

Keywords: Lesser Grain Borer, Sorghum pest, Biopesticides, Cypermethrin and *Sorghum bicolor.*

INTRODUCTION

Sorghum bicolor L. Moench is an important cereal crop consumed in the Northern Nigeria (Mohammed *et al*., 2011). Nutritionally, it contributes 73% calories intake and 52.3% per capital protein intake of the Northern Nigeria (Samm, 2009). Sorghum is fifth cereal crop produced in the world following maize, Rice, barley and wheat (Young and Teetes, 1977). Storage pests cause about 20-50% loss to cereal grains annually (FAO, 1985). Lesser grain borer (*Rhyzopertha dominica* F.) is an important pest of sorghum grain which begins the damage of whole grain and also the already damaged grain, causing loss to the quantity and quality of the grains (Amatobi, 2007).

R. dominica (F.) as an important primary consumer of cereal crops (Amatobi, 2007) begins infestation some weeks before harvest from the field and follows the grain to the store to continue the destruction (Lale, 2002). Synthetic insecticides were the measure taken by many small scale farmers to store sorghum up to 4-6/8 months post-harvest (Lale, 2002). This has some side effects such as poisoning mammalian, non-environmental friendly, non-biodegradable, resistance and resurgence by the insects, non-availability of such synthetic or non-functioning as it had expired (Okonkwo, 2004). This ugly scene called for an alternative means of storing sorghum to ensure food security that is safe at all time for human consumption. The use of natural herbs which are edible or medicinal or spices are effective, non-toxic, eco-friendly, biodegradable, cheap, easy to formulate and have been investigated as safe (Okonkwo, 2004). Neem tree is common and known by many farmers as chewing stick and medicinal for oral administration, *Hyptis suaveolens*, *Jatrphpa Curcas*, *Khaya senegalensis* and *Momordica charantia* are used in one way or the other by the farmers as medicine for one ailment or the other. The study is aimed at creating awareness in the farmers of the middle belt and Northern Nigeria that the above mentioned herbs are available and can be used to protect sorghum grain against *R. dominica* that infest them in the store.

MATERIALS AND METHODS

The study was conducted in Zoology Laboratory, Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto (UDUS), located at latitude 13^0 7' 44" North, longitude $5^0$12' 13" East (Sani, 2013). The research was carried out between November, 2012 and July, 2013. The plant materials, *A. indica* (seed) *H. suaveolens* (leaf), *J. curcas* (leaf) *K. senegalensis* (stem bark) and *M. charantia* (leaf) were collected from Lafiagi town except *K. senegalensis* stem bark which was collected from bush near Shonga town. The leaves were shed dried for two to three weeks, the neem kernel seed (NSK) was also shed dried for four weeks while *K. senegalensis* stem bark was sundried for three hours and later shed dried for four weeks to ensure moisture free powders. All plant parts collected were pounded with mutter and pestle and sieved with 0.2mm mesh sieve to obtain 250g powder of each plant. These were separately stored in polythene bags under laboratory conditions prior to use.

The sorghum grain (*S. bicolor*) was obtained from Gbugbu market in Edu L.G.A, Kwara State. The grain supposed to have been infested and or damage were separated from whole grains was disinfested by refrigeration at 0^oC for three weeks (21 days) (Asmanizer and Idris, 2012).

This was later used for the experiment. Stock culture of *R. dominica* was raised by sieving adult *R. dominica* out of the old sorghum grain collected from stores and 100 unsexed *R. dominica* put into a 500ml kliner glass Jar containing 500g of disinfested sorghum grain (Suleiman *et al.,* 2011). After eight days, the adult *R. dominica* introduced to the kliner glass jar containing sorghum grains were sieved out. The sorghum in the Kliner jar was kept on the laboratory table for three to four weeks for eggs to develop, this serve as mother stock for the experiment.

Each plant powders were measured at 0.5, 1.0, 1.5 and 2.0g/20g of grain and 0.12g of control check cypermethrin (2.0%) was measured against 20g of grain in separate petri dishes. They were admixed properly with the grain using glass rod and left on the laboratory table for an hour (Suleiman *et al.,* 2012). After which 5 pairs of newly emerged adults were inoculated into each petri dish (Ewete *et al.,* 2007), these were replicated thrice, labeled accordingly, covered with muslin cloth, tied with rubber band and arranged in a Completely Randomized Design (CRD) on Laboratory tables of Biological Science Department, Usmanu Danfodiyo University, Sokoto. These were left for 12 weeks.

Mortality counts were recorded after 24 hours for seven days. Sorghum pest were sieved out, probed and which ever did not respond to probing needle was considered dead counted and removed, while live insects were returned to the petri dish. On the eight day, the still living insects were removed and the grain left undisturbed on the laboratory table (Danjuma, 2008).

Sorghum grain was observed for possible oviposition on the eighth day with the aid of glass hand lens but was not seen, because of their small size. Perforations made on the grains by the emergent adults were used to estimate the possible oviposition. Adult emergence was counted daily from 4^{th} -8^{th} weeks post infestation by sieving the grain and the emergent adult insects counted and recorded (Asmanizar and Idris, 2012).

Quality loss caused to treated sorghum grain 16 weeks post infestation seed damage was assessed by randomly picking 250 grains from each petri dish and grains with characteristic insect emergent hole was counted (Oparaeke and Daria, 2005). The percentage damage caused to sorghum was calculated using the following formula;

$$\text{Percentage grain damaged} = \frac{\text{Number of bored grain}}{\text{Total number of grain in sample}} \times 100$$

Weight loss caused to sorghum grains 16 weeks post infestation was assessed by count and weigh method (Asmanizar and Idris, 2012) using the formula below;

$$\text{Percentage Weight loss} = \frac{(UNd) - (DNu)}{U\,(Nd+Nu)} \times 100$$

Data obtained was subjected to analysis of variance (ANOVA) and the difference in means was separated by Dunkan Multiple Range Test (DMRT).

RESULTS

Jatropha leaf and mahogany stem bark powder treated at 0.5g/20g of sorghum grain had 100% mortality of adult lesser grain borer within 4.00 and 4.33 days respectively. Bitter guard leaf and neem seed kernel powders caused 80.00 and 76.67% mortality to adult *R. dominica* in 7.00 days respectively. *H. suaveolens* had 60.00% in 7.00 days. Compared to 80.00% mortality caused by cypermethin dust treated sorghum. At 1.0g and 1.5g/20g of sorghum grain, Jatropha still caused 100% mortality of adult *R. dominica*, Mahogany caused 100% and 96.67% insect mortality respectively. At 200g/20g dose Jatropha and mahogany caused 96.67 and 100% mortality to adult *R. dominica* in treated sorghum respectively. Compared to 100% adult mortality caused by cypemethrin dust treated sorghum (Table 1).

Table1: Mortality of adult *R. dominica* Reared on red Sorghum Grains Treated with Varying Amount of Different Plants Powders.

	Amount of powders applied g/20g of grain.			
Test powders	0.5g	1.0g	1.5g	2.0g
	Mean mortality (percent)± SE			
A. indica	76.67^{abc}±8.82	86.67^{b}± 13.33	96.67^{a}±3.33	96.67^{a}d-3.33
H. suaveolens	60.00^{C}± 10.00	76.67^{bc}± 14.53	0.00^{abc}±11.55	66.67^{C}±6.67
J. curcas	100.00^{a}±0.00	100.00^{a} ±0.00	100.00" ±0.00	96.67^{a}±3.33
K. senegalensis	100.00^{a}±0.00	100.00^{a}±0.00	96.67^{a}±3.33	100.00" ±0.00
M. charantia	80.00^{abc}± 11.55	73.33^{hc}± 17.64	63.33^{C}±8.82	93.33^{a}±6.67
Cypermethrin	80.00^{abc} ± 10.00	100.00^{a} ± 0.00	73.33^{abc} ± 8.82	76.67^{bc}± 13.33
Control	16.67^{d}±3.33	16.67^{d}±3.33	13.33^{d}±3.33	10.00^{d}±5.77
$LSD_{(0.50)}$	23.56	30.57	20.58	40.08

Values are mean = standard error of three replicates

Means in a column with different superscripts are significantly different (P<0.05)

Neem seed kernel powder (NSKP) reduced oviposition of adult female *R. dominica* 3.00, 0.33, 1.33 and 0.67% eggs deposition were recorded at 0.5, 1.0, 1.5 and 2.0g/20g of sorghum grain respectively. Mahogany and Jatropha recorded high percentage of egg deposition of 6.38 and 8.00% at 1.5 and 2.0g/20g respectively compared to the control check which had higher egg deposition of 1.00% and untreated control had 45.00% (Table 2).

Table 2: Fecundity of Adult Female *R. dominica* Reared on Red Sorghum Grains Treated with Varying Amount of Different Plants Powders.

	Amount of powders applied g/20g of grain.			
Test powders	0.5g	1.0g	1.5g	2.0g
	Mean fecundity ± SE			
A. indica	3.00^{e}± 1.53	0.33^{d}± 0.33	1.33^{e}± 0.67	0.67^{e}± 0.33
H. suaveolens	49.67^{a}±4.48	58.33^{a}± 13.53	46.67^{a}±6.96	52.33^{a} ± 28.75
J. curcas	4.33^{e}±1.20	5.33^{c}± 2.85	4.33^{d}± 1.86	8.00^{d} ± 1.53
K. senegalensis	17.67^{c}±5.24	3.00^{d}± 1.00	6.33^{d} ± 2.60	5.33^{c} ± 1.76
M. charantia	26.67^{b}±3.48	43.00^{ab} ± 19.55	34.00^{ab} ± 12.12	14.67^{c} ± 4.63
Cypermethrin	7.67^{d}±1.45	11.00^{bc} ± 5.51	10.00^{c}± 1.53	3.67^{e} ± 1.20
Control	15.67^{d}±2.73	15.33^{b} ± 2.60	45.00^{a}± 2.31	22.33^{b} ± 9.53
$LSD_{(0.50)}$	9.80	28.36	16.76	35.26

Values are mean = standard error of three replicates

Means in a column with different superscripts are significantly different (P<0.05)

NSKP had least F1 adult *R. dominica* emergence of 0.00, 0.00 at 1.0 and 1.5g /20g doses, while Jatropha recorded 1.67% at 0.5g dose, compared to 1.33% in cypermethrin and 40.33 in untreated control (Table 3).

Table 3: Emergence of Adult *R. dominica* from the Red Sorghum Grains Treated with Varying Amount of Different Plants Powders

	Amount of powders applied g/20g of grain.			
Test powders	0.5g	1.0g	1.5g	2.0g
	Mean emergence in percent ± SE			
A. indica	2.00^{e}±1.53	0.00^{e}±0.00	0.00^{d}±0.00	0.33^{d} ±0.33
H. suaveolens	33. 00^{a}± 14.53	37.67^{a}± 16.18	37.33^{ab}± 7.22	30.00^{d} ± 14. 1 5
J. curcas	1.67^{e}±1.20	2.67^{e}±2.19	3.67^{d}± 1.20	4.33^{cd} ± 0.88
K. senegalensis	13.00^{cd}±4.04	1.67^{e}±0.88	6.00^{C}±2.3I	3.33^{d} ± 1.45
M. charantia	19.33^{ab}±3.93	31.67^{ab}± 15.50	27.00^{b}±12.17	11.33^{b}±4.67
Cypermethrin	5.67^{d}±1.67	7.33^{de}±3.18	2. 33^{d}±0.88	1.33^{d} ±0.33
Control	10.33^{cd}±4.06	10.67^{cd}±3.7l	40.33^{a}± 1.67	16.67^{ab}±8.09
$LSD_{(0.50)}$	18.69	26.43	16.63	19.55

Values are mean ± standard error of three replicates

Means in a column with different superscripts are significantly different (P<0.05)

Table 4 shows that NSKP, Jatropha and mahogany powders were the most effective out of the five powders tested in protecting the sorghum grains from weight loss where 0.14, 0.39 and 0.36 were recorded respectively, compared to synthetic control and untreated control which recorded 0.80 and 0.97 respectively. Grain damage was prevented most by NSKP 0.27%, mahogany 0.53% and Jatropha 0.93%, cypermethrin and untreated control recorded 2.00 and 1.73% respectively (Table 5).

Table 4: Weight Loss Caused by *R. daminica* to Sorghum Grains Treated with Plant Powders of Varying Amount

	Amount of powders applied g/20g of grain.			
Test powders	0.5g	1.0g	1.5g	2.0g
	Mean weight loss in percent ± SE			
A. indica	$0.14^{d} \pm 0.13$	$0.36^{b} \pm 0.18$	$0.25^{c} \pm 0.13$	$0.15^{b} \pm 0.25$
H. suaveolens	$1.75^{a} \pm 0.20$	$6.29^{a} \pm 2.30$	$8.42^{a} \pm 0.98$	$6.75^{a} \pm 2.34$
J. curcas	$0.43^{cd} \pm 0.11$	$0.51^{b} \pm 0.18$	$0.74^{c} \pm 0.40$	$0.39^{b} \pm 0.38$
K. senegalensis	$0.68^{bcd} \pm 0.28$	$0.40^{b} \pm 0.08$	$1.49^{bc} \pm 0.58$	$0.36^{b} \pm 0.04$
M. charantia	$1.22^{ab} \pm 0.27$	$8.60^{a} \pm 2.09$	$8.62^{a} \pm 3.30$	$2.49^{b} \pm 1.28$
Cypermethrin	$0.80^{bcd} \pm 0.26$	$1.78^{b} \pm 0.79$	$1.93^{bc} \pm 0.22$	$1.25^{b} \pm 0.23$
Control	$0.97^{bc} \pm 0.32$	$1.53^{b} \pm 0.63$	$5.40^{ab} \pm 0.59$	$3.24^{ab} \pm 1.59$

Values are mean ± standard error of three replicates
Means in a column with different superscripts are significantly different (P<0.05)

Table 5. Grain Damage Caused by *R. dominica* to Sorghum Grains Treated with Plant Powders of Varying Amount

	Amount of powders applied g/20g of grain.			
Test powders	0.5g	1.0g	1.5g	2.0g
	Mean grain damage in percent ± SE			
A. indica	$0.27^{c} \pm 0.13$	$1.07^{b} \pm 0.27$	$0.53^{b} \pm 0.35$	$0.67^{b} \pm 0.35$
H. suaveolens	$4.27^{a} \pm 0.93$	$14.27^{a} \pm 4.80$	$16.40^{a} \pm 1.01$	$13.60^{a} \pm 5.50$
J. curcas	$1.47^{bc} \pm 0.13$	$0.93^{b} \pm 0.27$	$1.33^{b} \pm 0.74$	$1.07^{b} \pm 0.87$
K. senegalensis	$1.60^{bc} \pm 0.46$	$0.53^{b} \pm 0.13$	$2.80^{b} \pm 1.15$	$0.67^{b} \pm 1.30$
M. charantia	$3.33^{ab} \pm 0.96$	$15.60^{a} \pm 3.17$	$18.00^{a} \pm 7.71$	$4.93^{b} \pm 2.53$
Cypermethrin	$2.00^{bc} \pm 0.46$	$3.73^{b} \pm 1.48$	$4.42^{b} \pm 0.82$	$2.13^{b} \pm 0.48$
Control	$1.73^{bc} \pm 0.58$	$4.00^{b} \pm 1.20$	$13.87^{a} \pm 2.08$	$6.40^{ab} \pm 2.80$

Values are mean ± standard error of three replicates
Means in a column with different superscripts are significantly different (P<0.05)

DISCUSSION

Jatropha curcas leaf and *K. senegalensis* stem bark powders significantly affect mortality of adult *R. dominica.* Probably because of the presence of total phenol in higher content, tannins and phytic in *J. curcas* and an anti-feeding and growth inhibitory limonoids in *K. senegalensis* as observed by Ewete *et al.* (2012) and Asmanizar and Idris (2012). Similar result was obtained by Suleiman *et al* (2012) who reported that *J. curcas* caused highest adult mortality at 2.0g/ 20g to *S. zeamis* and Asmanizar and Idris (2012) reported that *J. curcas* seed powder caused highest mortality to the insects at 2 per cent concentration. *A. indica and J. curcas* leaf powders reduced female fecundity and adult emergence of F_2 offsprings. The presence of Azadiractin (an active pesticide) in NSKP may be responsible, as observed by Suleiman *et al.* (2011), Adebowale and Adedire (2006) and, Yadhav and Bhargava (2002). Grain weight loss and damage was also prevented by *A. indica* and *J. curcas* leaf powders applied for three months post infestation, this might be because of the presence of anti-feeding properties in the parts of the plants used, as observed by Singh and Singh (2005), Asmanizar and Idris (2012) and Kudachi (2008). The effectiveness of *J. curcas* leaf powder could be attributed to high value of free fatty acid peroxide and iodine (Adebowale and Adedire, 2006). *A. indica*, *K. senegalensis* and *J. curcas* are common trees and shrub respectively in the middle belt and Northern Nigeria where guinea corn (Sorghum) is mostly produced. The weather is also suitable for the production, preservation and use of these plant materials for effective, safe, cheap and easy grain protection, unlike the synthetics currently in use for grain storage. It can therefore be recommended that Neem Seed Kernel Powder (NSKP), *J. curcas* leaf powders and *K. senegalensis* stem bark can be used at 2.5kg/100kg, 7.5kg/100kg and 10kg/100kg respectively for sorghum grain protection against *Rhyzopertha dominica* infestation for four to six months of storage.

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