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EFFECTS OF TEN PLANT MATERIALS IN THE PRESERVATION OF STORED COWPEA AGAINST *Callosobruchus maculatus* F.

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Abstract

The potentials of the pulverized parts of ten locally available plant products compared to a conventional storage insecticide (Actellic 2% dust) as protectants of stored cowpea, Vigna unguiculata (L.) Walp were evaluated under laboratory conditions. Each of the plant materials was tested at four rates (2.5g, 5.0g and 10.0g/100g seed including a control, i.e., 0.0g. Actellic dust was applied at the rate of 1.0g, 2.0g and 3.0g/100g seed. Fifty (50) seeds from each of the treatments were infested with 5 pairs of adult weevils. Assessment was based on the emergence of the F_1 generation and seed damage (mean number of seeds with holes and the number of holes per seed). The seed damage data were used to estimate the weevil perforation index (WPI). All data were analyzed for variance at P=0.05. Although most of the plant materials afforded some measure of control of the insects in this experiment, only three of them, Piper guineense, Moringa oleifera and Ocimum gratissimum in that order, performed comparably well with Actellic dust. Actellic dust treated seeds had the least number of emerged adults (26.2-75.0) over the 7-month storage period, and a WPI of between 0.0 - 26.7%. The cumulative number of emerged adults were also significantly reduced (40.5 86.8 insects) with WPI of between 12.2 and 44.4% and 35.4 90.3 insects with WPI of 16.4 47.8% in seeds treated with Piper guineense and Moringa oleifera, respectivelly. For Ocimum gratissimum, the cumulative number of emerged insects were between 85.6 and 195.0 with only the highest rate (10.0g/100g seed) having protection ability with WPI ranging between 31.7 48.5%. The untreated control had between 104 272.7 emerged insects and an average of 100.0% WPI.

***Key words**: Piper guineense, Moringa oleifera, Ocimum gratissimum,actellic dust, cowpea, bruchids*

Introduction

Worldwide, 2.27 million tonnes of cowpea is produced annually from some 7.7 million hectares with Africa producing 2/3 of the world total in 16 countries. Nigeria produces about 850,000 tonnes annually or 37.5% of world crop (Rachie, 1985).

Unprotected cowpea grain stored over a six-month period may become so riddled with emergence holes made by *C. maculatus* (F.) as to be unusable as human food (Shikaan and Uvah, 1992). Up to 100% damage has been reported in unprotected cowpea after 3-5 months storage (Singh, 1977) due to *Callosobruchus maculatus* (F.). These losses due to produce infestation by storage pests are substantial and pose a real threat to food security in Nigeria and other developing countries in the tropics (Lale, 2001).

At present, synthetic insecticides are employed to control the bruchid (Oparaeke *et al*., 1998). However, despite the apparent "successes" of these toxic synthetic chemicals, fears of problems of toxicity (Olaifa, 1991), pest resurgence and elevation of secondary pests (Stiling, 1985), development of pesticide resistant populations (Golob, 1980); deleterious effects on populations of non-target organisms (White and Sinha, 1990), residues in food (Srivastava, 1980), high cost of most of these chemicals (Adesiyun, 1989), contamination of the environment (Carson, 1962), non-availability and the falsification and adulteration of pesticides (Adesiyun and Apeji, 1983) abound.

The search for alternatives to synthetic insecticides is a current approach world-wide and the use of natural plant products with their array of active components is the focal point (Oparaeke *et al*., 1998).

This study compares the efficacy of ten locally available plants and Actellic 2% dust for the control of stored cowpea seeds, *Callosobruchus maculatus* (F.).

Materials and Methods

Insect Culture

Adult *Callosobruchus maculatus* were collected from infested cowpea seeds from a local market in Ilorin, Kwara State, Nigeria. Insects were introduced into eight (8) breeding containers under ambient temperature of 28±3% and Relative Humidity of75±5%. These were used to establish a laboratory culture.

Cowpea Seeds

Some quantities of untreated cowpea seeds, *Vigna unguiculata* (L) Walp cv TVU 3629, were collected from the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. The seeds were air- dried to avoid mouldiness after which they were sorted, sealed in cellophane bags and put in a deep freezer (for 2 weeks) for thorough disinfestation. The seeds were air-dried in the laboratory for 4 hours prior to use. One hundred (100)g of seeds were weighed out into 250mls translucent plastic tubes, which were covered with clean baft cloth to allow inflow of air and to mimic storage conditions in jute bags. Each treatment was replicated 3 times giving altogether 132 tubes.

Preparation of Test Materials

Fresh leaves of siam weed, *Chromolaena odorata* (L.) king and Robinson; lemon grass, *Cymbopogon citratus* (DC.) Staph, pitanga cherry, *Eugenia uniflora* L; Mango, *Mangifera indica* L; bitter gourd, *Mormodica charantia* L, and basil*, Ocimum gratissimum* L. The seeds of horse radish, *Moringa oleifera* Lam and brown pepper, *Piper guineense* Schum and Thonn and the barks of the cashew tree, *Anacardium occidentale* L. and mahogany, *Khaya senegalensis* (Desr).A. Juss were collected from different locations in Ilorin, Kwara State, Nigeria.

The collected plant materials were air dried until completely dry and pulverized into fine powder, sieved with a 10-micron sieve and sealed in cellophane bags. The ground plant materials were measured out in rates of 2.5g, 5.0g and 10.0g and mixed with 100g of Cowpea seeds in 250 ml plastic tubes and replicated 3 times.

Actellic 2% dust was bought from one of the agro-chemical stores in Ilorin. These were measured at the rates of 1.0g, 2.0g and 3.0g for the three treatment levels.

Treatment

Twenty four (24) hours after, 100g seeds in 250mls plastic tubes were treated with 2.5g, 5.0g and 10.0g of plant materials and 1.0g, 2.0g and 3.0g of Actellic dust respectively, fifty (50\seeds from each of the treated and untreated (control) cowpea seeds were transferred into new 100ml plastic tubes. The treatments were replicated 3 times including the control. Five (5) pairs of male and female *C. maculatus* were introduced into each of the plastic tubes, and covered with baft cloth tied firmly with rubber band.

Data Collection

The total number of adults emerging (dead and living) were counted on the first day emergence was noticed. On this day, all the insects, dead and living were removed from the tubes in order to distinguish them from those that would emerge later, that is at 24 hours and 48 hours. The effect of the experimental materials on emergence was checked on the day of emergence and 24 hours and 48 hours later.

Damage was assessed by the total number and distribution of holes per seed of Cowpea. The number of holes per sample of 10 randomly selected seeds of cowpea and the number of these seeds with holes were recorded for damage assessment. These were checked and recorded on the same date and time the first emerging adults were noticed.

The percentage of perforated grains was calculated as used by Singh *et al.* (1972).

$$\frac{\text{No. of perforated grains in sample}}{\text{Total number of grains sampled}} \times \frac{100}{1}$$

The Weevil Perforation Index (WPI) (Fatope *et al*., 1995), was then calculated thus:

$$\text{WPI} = \frac{\text{\% treated cowpea grains perforated}}{\text{\% control cowpea perforated}} \times \frac{100}{1}$$

Weevil perforation index value exceeding 50 is regarded as enhancement of infestation by the weevil or negative protectant ability of the plant material or insecticide tested.

Residual Test

To assess the residual effect of these plant materials and Actellic dust on stored seeds, the afore mentioned procedures were repeated after the first, second, third, fourth, fifth, and sixth months of storage of the original 100g seeds. Fifty (50) seeds were taken each month from the stock, placed in clean 100mls plastic tubes and 5 pairs of insects introduced as was the case at the commencement experiment.

Results

Adult Emergence

The adult emergence data were collected on the first day emergence was noticed, 24 and 48 hours later. The highest number of emerging insects occurred on the first day. The total cumulative emergence for commencement and months 1-6 were calculated for this analysis (Table 1).

Seeds treated with Actellic dust (26.2 75.0); *Moringa oleifera* (35.4 90.3) and *Piper guineense* (40.5 86.8) had the least number of emerged insects. *Ocimum gratissimum* tagged behind (79.4 195.0). The other materials were not very different, statistically, from the control (104.7 272.7). All the materials used appeared to have had significant effects between the first and fifth months, with the peak performance at the 3rd and 4th months. From the 5th month, the effect of materials seemed to have considerably worn off. The control had the highest numbers of emerging adults. All other rates of application of the different materials were not significantly different.

Damage Assessment

Over the 7-month period under investigation, Actellic dust had the least number of holes per seed with the lowest being at months 3 and 4.

These were followed by *Moringa oleifera* and *Piper guineense,* which had about the same effect. *Ocimum gratissimum* was generally better than the remaining materials especially in months 3 and 4 (Fig 1). The rates of application followed the same pattern with the control having the highest number of holes per seed (Fig 2). The highest rate of application was marginally better than the medium and lower rates which were not particularly different from each other.

Actellic dust had the best index (protection ability) over the 7-month period. The highest damage index occurred at the 7th month. *Piper guineense* came next in performance and was followed by *Moringa oleifera*. Their index fell below the 50% mark for the 7 months under review. Though *Ocimum gratissimum* performed better than the other materials, it was only at the second month that it could be said to have over-all protection ability (Fig 3). The efficacy of the rates of application tended to decrease with time of storage (Fig 4). The highest rate performed better than the medium rate, which was marginally better than the lowest rate.

Discussion

Actellic dust inhibited the emergence of adult C. maculatus in treated samples during the 7 months of storage. As expected, it also had the least damage of cowpea seeds stored over the period, when compared with the untreated control. Actellic dust also gave the best Weevil Protection Index. It should be, however, noted that for all the indexes measured, the efficacy of Actellic dust started decreasing from the 5th month after the commencement of the experiment. The lowest rate used (1.0g/100g seed) was adequate for storage of the seeds within the seven months period. These results are consistent with the earlier works of Ojiako (1990), Oparaeke et al. (1998) and Abdullahi and Mohammed (2004) who variously reported that Actellic dust offered the best control measure and prevented stored grains from damage.

Moringa oleifera consistently gave low cumulative emergence that was statistically the same as the effect of Actellic dust during the 7 months duration of the experiment and performed better than *P. guineense* in months 1, 2 and 3. Throughout the duration of the experiment, *M. oleifera* had statistically the same effect on damage assessment of stored cowpea seeds as *P. guineense* with Weevil Perforation Index of between 16.4 and 47.8%. The efficacy of *M. oleifera* in the experiment is clearly dose related with the highest rate (10.0g/100g seeds) performing better than the lower rates. The effect of *M. oleifera* in inhibiting/suppressing emergence and in damage control of stored cowpea seeds could be as a result of the presence of the steroidal glycoside-strophantidin, which was reported by Olayemi and Alabi (1994) as the bioactive agent. This bioactive agent has been found to completely inhibit the radial mycellial growth of *Aspergillus flavus* for the first 48 hours after inoculation which was comparable to the action of Fernassan D (Balogun *et al.*, 2004). Strophantidin has also been found to inhibit the growth of red flour beetle, *Tribolium castaneum* and tobacco horn worm, *Manduca sexta* (Wissenberg *et al.*, 1998) and *Trypanosoma cruzi* in culture (Chataing *et al*., 1998).

P. guineense gave considerably low numbers of emerged adults which were not statistically different from the action of Actellic dust and *M. oleifera*. There were also few damaged cowpea seeds stored with *P. guineense* with Weevil Protection Index of between 12.2 and 44.4%. The efficacy was dose related as the highest rate (10.0g/100g seed) gave the best protection against damage. Earlier works by Olaifa and Erhun (1988), Ojiako (1990) and Abdullahi and Mohammed (2004) variously showed that *P. guineense seed powder* gave the lowest numbers of F_1 offsprings and protected the stored seeds against damage of *C. maculatus.*. The striking potency of *P. guineense could be attributable to its guineense I component and to its pungent smell which prevents physical contact and caused suffocation among the adult weevils. P. guineense is also said to have high* larvicidal effects whose effects are not clearly understood (Abdullahi and Mohammed, 2004).

Ocimum gratissimum, to some degrees, inhibited the emergence of adult *C. maculatus*. After the initial lull in the commencement of the experiment, *O. gratissimum* picked up and topped the list of the materials after Actellic dust, *M. oleifera* and *P. guineense*. The highest emergence figure (95.0 insects) was significantly lower than that of the untreated control (272. 7 insects). *O. gratissimum* also reasonably protected the seeds when compared with the untreated control.

The efficacy of *O. gratissimum* is dosage related as the lowest rate (2.5g/100g seed) could not protect the treated seeds. The least WPI was 67.8% which was, however, better than the untreated seeds. The medium rate (5.0g/100g seed) could only protect the seeds at the commencement and month 1 of the experiments whereas the highest rate (10.0g/100g seed) protected the seeds all through the 7 months of storage. These reports are consistent with the earlier work of Oparaeke *et al*. (2002) who reported that cowpea seed damage was least on seeds treated with 10.0g leaf powder of *O. gratissimum* per 100g cowpea seed and highest on 2.5g/100g seed (W/W). Earlier, Lajide *et al*. (1998) had found the leaf powders of *O. bascilicum* effective in protecting stored maize grains against *S. zeamais* at the highest dosage rates of 8g/100g and 5g/50g maize grains, respectively. Oparaeke *et al*. (2002) had attributed the protective ability of *O. gratissimum* to some alkaloids. Working on the efficacy of *O. bascilicum* and *O. canum*, Weaver *et al*. (1991) and Regnault and Hamraoui (1994) respectively, had implicated this alkaloid as linalool.

The total cumulative emergence for all the other plant materials *A. occidentale*, *C. citratus*, *C. odorata*, *E. uniflora*, *K. senegalensis* and *M. indica* ranging from 106.9 257.8 insects were basically statistically the same and did not differ significantly from the untreated control (104.7 272.7). *Eugenia uniflora*, however, had the lowest total cumulative emergence for the commencement and for months 1 and 4 and appeared to be better than other materials. It also protected the seeds at the highest and medium rates at the commencement of the experiment. Subsequently, however, *E. uniflora* did not give better protection ability when compared with the untreated

Actellic 2% dust offered the quickest control measure in the first 4 months of storing cowpea seeds. *Piper guineense* seed powder, a local and easily available herb, gave a steady protection of cowpea seeds over the months studied. *Moringa oleifera,* a highly nutritional and medicinal plant gave good protection to the seeds at relatively low concentrations while

Ocimum gratissimum at only the highest rate performed well in effecting adult insect mortality and oviposition. The interactive effect of material type and rate of application was demonstrated by the higher rates of a given treatment material performing significantly better than the lower rates.

Piper guineense, *Moringa oleifera* and *Ocimum gratissimum* could be acceptable, cheap, safe and environmentally friendly alternatives to synthetic chemicals in storage.

It is recommended that the potentials of these products be further explored and that the present effort at finding cheaper, safe and locally available protectants be kept up.

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Table 1: Effects of the Plant Materials and Actellic Dust on the Cumulative Adult Emergence for 7-month period.

Materials	Cumulative emergence							
	Commencement		Month 2		Month 4		Month 6	
Actellic dust	39.8	a	26.2	a	38.5	a	75.0	a
Anacardium occidentale	146.2	cde	95.0	bcd	205.2	c	217.5	c
Cymbopogon citratus	136.5	bcd	128.7	ef	170.8	c	257.8	e
Chromolaena odorata	121.3	bc	140.7	f	189.7	c	237.3	cde
Eugenia uniflora	106.9	b	109.5	cde	165.2	c	237.7	cde
Khaya senegalensis	158.5	de	82.8	b	184.5	c	231.3	cd
Mormodica charantia	134.5	bcd	116.2	def	182.7	c	239.2	cde
Mangifera indica	166.9	e	126.5	ef	189.7	c	244.7	de
Moringa oleifera	56.1	a	35.4	a	49.6	a	90.3	a
Ocimum gratissimum	127.6	bc	85.6	bc	117.9	b	195.0	b
Piper guineense	56.1	a	40.5	a	49.4	a	86.8	a
S.E.M.	9.64		8.15		14.20		7.95	
Rate of Application			.					
0 g (control)	157.0	b	104.7	b	152.7	b	272.7	c
1.0g Actellic; 2.5g plt powder /100g seed	104.5	a	86.6	a	144.3	ab	167.6	ab
2.0g Actellic; 5.0g plt powder /100g seed	101.0	a	86.0	a	138.2	ab	171.3	b
3.0g Actellic 10 g plt powder /100g seed	92.2	a	81.7	a	126.0	a	156.6	a
S.E.M.	5.81		4.92		8.56		4.79	

a,b,c,d,e Means followed by the same letter(s) in each section of the same column are not significantly different at P=0.05

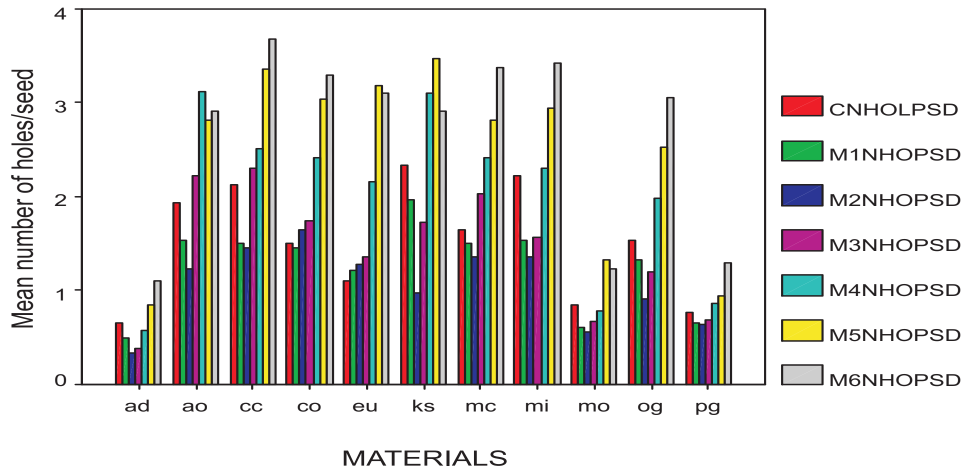

Fig : Comparative mean number of holes per seed under different materials over a 7 month period

Fig 1: Comparative mean number of holes per seed over 7 month period under different materials

C = COMMENCEMENT; M1-M6 = Month 1 through Month 6, NHOPSD= Number of holes per seed,.
ad=Actellic Dust, ao=*Anacardium occidentale*, cc=*Cymbopogon citratus*, co=*Chromolaena odorata*, eu=*Eugenia uniflora*, ks=*Khaya senegalensis*, mc=*Mormodica charantia*, mi=*Mangifera indica*, mo=*Moringa oleifera*, og=*Occimun gratissimum*, pg=*Piper guineense.*

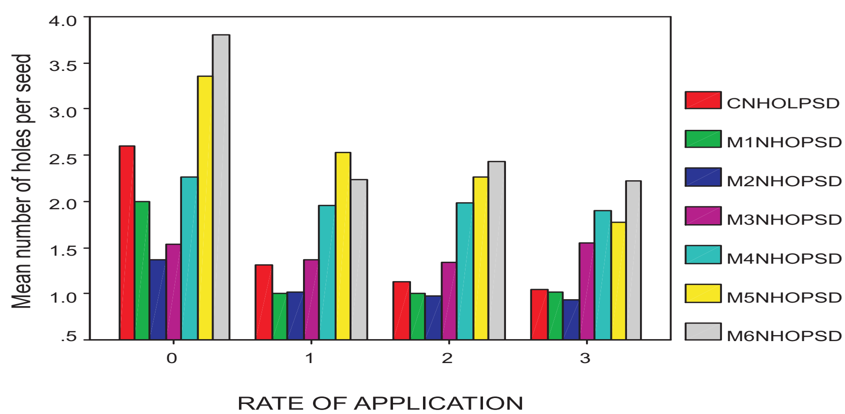

Fig : Comparative mean number of holes per seed under different rates over a 7 month period

C = COMMENCEMENT; M1-M6 = Month 1 through Month 6, NHOPSD= Number of holes per seed.
Rate 0=0g/100g seed, Rate 1=2.5g/100g seed, Rate 2=5.0g /100g seed, Rate 3=10.0g/100g seed.

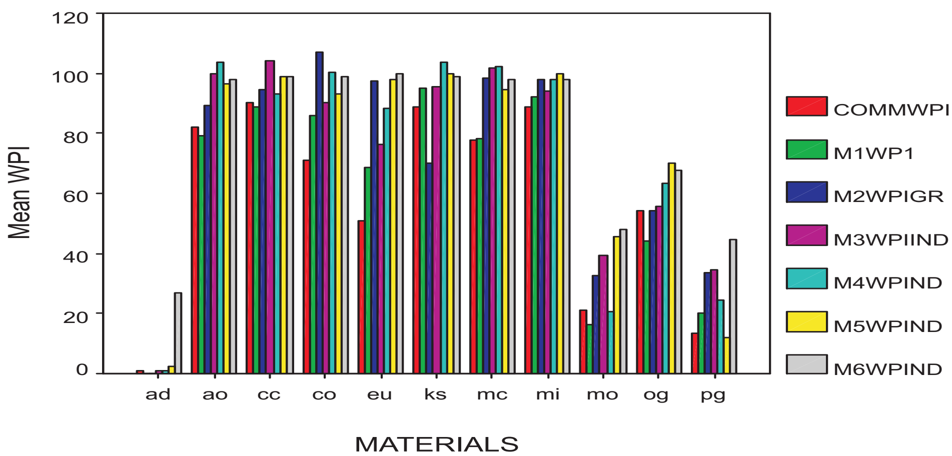

Fig : Comparative mean weevil perforation index over a seven month period under different materials

C = COMMENCEMENT; M1-M6 = Month 1 through Month 6, WPIND= Weevil Perforation Index.
ad=Actellic Dust, ao=*Anacardium occidentale*, cc=*Cymbopogon citratus*, co=*Chromolaena odorata*, eu=*Eugenia uniflora*, ks=*Khaya senegalensis*, mc=*Mormodica charantia*, mi=*Mangifera indica*, mo=*Moringa oleifera*, og=*Occimun gratissimum*, pg=*Piper guineense.*

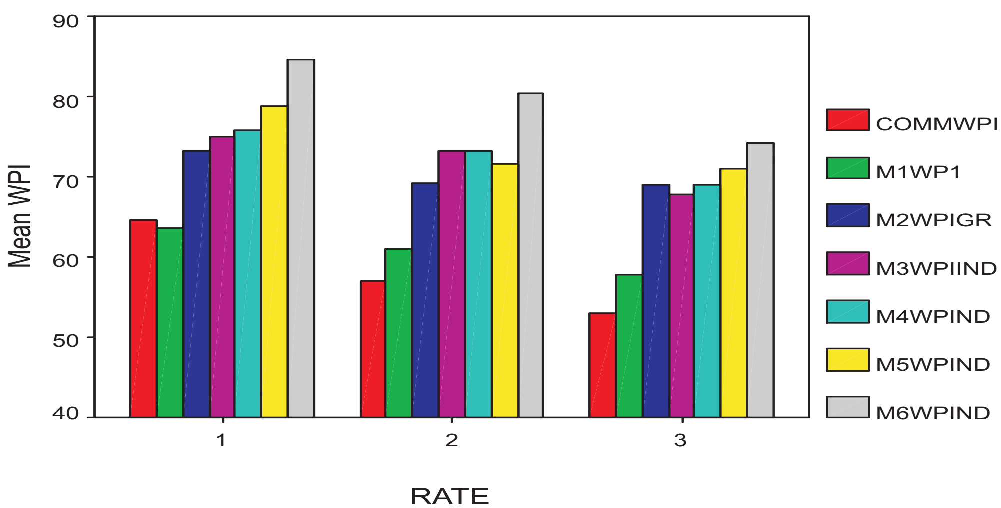

Fig : Comparative mean weevil perforation index over a seven month period under different rates

C = COMMENCEMENT; M1-M6 = Month 1 through Month 6, WPIND= Weevil Perforation Index.
Rate 0=0g/100g seed, Rate 1=2.5g/100g seed, Rate 2=5.0g /100g seed, Rate 3=10.0g/100g seed.