Research Article

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Comparative insecticidal activities of some botanical powders and pirimiphos-methyl against *callosobruchus maculatus* fab.[coleoptera: bruchidae] infesting cowpea seeds

Abstract

Insecticidal activities of powders of *Anacardium occidentale, Momordica charantia, Jatropha curcas*, *Zanthoxylum zanthoxyloides* as well as Pirimiphos-methyl were assessed under ambient atmospheric condition (28±2ºCand 74%r.h) in the laboratory on *Callosobruchus maculatus* Fabricius at four treatment levels of 0.2, 0.4, 0.6, and 0.8 g plant powders per 20g of cowpea seeds. Percentage mortality of insects was observed at 24, 48, 72, 96, 120, 144, and 168h. *Z. zanthoxyloides* had the highest toxicity effect causing up to 100% mortality of adult *C. maculatus* by 168h post treatment with the treatment level of 0.8g followed by the powders of *M. charantia, J. curcas, A. occidentale*, and then Pirimiphos-methyl, causing 84.3%, 83.2%, 82.2% and 72.0% insect mortality respectively. The four botanical powders considerably reduced the number of adults *C. maculatus* that emerged and effectively protected the cowpea seeds during the period of storage for five weeks as against the poor protection offered by Pirimiphos-methyl. From this result, it can be deduced that the insecticide powders from the botanicals used were more effective in protecting *C. maculatus* compared to the chemical insecticide (Pirimiphos-methyl).

Keywords: insecticidal, *anacardium occidentale*, *momordica charantia*, *jatropha curcas*, *callosobruchus*, *maculates*, pirimiphos-methyl, insecticides, mortality

Volume 2 Issue 4 - 2017

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Received: August 15, 2017 | **Published:** December 29, 2017

Introduction

Cowpea, *Vigna unguiculata* [L.] Walp. is a widely planted nutritious grain legume.[1] It is cultivated in many West African countries including Nigeria. Cowpea is a source of dietary protein, vitamins and mineral salts. It has been consumed by human since the earliest practice of Agriculture in developing countries of Africa, Asia, and Latin America.[2] The pulse beetle, *Callosobruchus maculatus* Fab. [Coleoptera: Bruchidae], is a major pest of economically important grain legume such as cowpea, lentils, green gram and black gram.[3–10] Infestation by *C. maculatus* starts in the field, where adult females lay eggs on the green pods of cowpea. The larva bore into the pulse grain which becomes unsuitable for human consumption, viability for replanting, or for production of sprouts.[11,2,3,13] The control of infested stored grains by weevils is primarily achieved by the use of convectional insecticides, such as methyl bromide and phosphine. The shortcomings of these convectional insecticides such as environmental pollution, ozone layer depletion of insecticides containing Chlorofloro carbon, human health hazard, among other has led to the ban or restriction of several chemical insecticides.[14] These chemical insecticides are associated with problems such as, lethal effect on non target organisms, pest resurgence, pest resistance and mammalian toxicity due to residue persistence.[6,14–16,17] These aforementioned problems associated with chemical insecticides has led to the search for ecological friendly and cheap control measures[17–19] which include the use of botanical-derived materials such as plant oil extracts, plant crude extracts, plant powders, wood ash e.t.c. Traditional plant materials are sometimes mixed with legume pod or seed in storage for reducing infestation by weevils.[20,21] This work is aimed at determining the comparative insecticidal activities of some botanical insecticide powders and pirimiphos-methyl against *Callosobruchus maculatus.*

Materials and methods

Insect culture

The adult *C. maculatus* were obtained from Oba market, Ado Ekiti, Ekiti State, Nigeria. Clean, wholesome and uninfested cowpea seeds were also bought from Oba market, Ado Ekiti and was used to rear the insects inside 2 transparent jars covered with muslin cloth. The jars were kept at 28±2°C and 75±5% relative humidity in a woody cage. The culture was maintained by replacing the devoured grains with fresh un-infested ones.

Preparation of insecticide powders

The test botanicals, that is, *Anacardium occidentale, Momordica charantia, Jatropha curcas*, *Zanthoxylum zanthoxyloides* were collected from Ugbo Elu forest in Omuo Ekiti, Ekiti State, Nigeria. The leaves of *Jatropha curca Momordica charantia* and the bark of *Zanthoxylum zanthoxyloides* were air-dried in the laboratory for about one Month. The nuts of *Anacardium occidentale* were sundried for about ten days, after which they were cracked in order to remove the the kernels. The kernels were further air-dried in the laboratory for three weeks. Each of the test plant materials was pulverized separately into fine powders using an electric grinder. The powders were passed through 2.12µm uniform sieve, tied in anylon and placed in a tight- lid glass jar to avoid the loss of active compound in the test plant materials. The Pirimiphos-methyl used for the experiment was obtained from Department of Crop Science, Ekiti State University, Ado Ekiti, Nigeria. These Powders are referred to as the Insecticide Powders.

Response of *C. maculatus* to the INSECTICIDE powders

Twenty grams of clean un-infested cowpea seeds were measured into Petri-dishes of 9cm diameter. Thereafter, 0.2, 0.4, 0.6, 0.8g of each insecticide powder was mixed with the seeds inside each Petri-dish. Another Petri-dish containing 20g of untreated cowpea seed was also prepared to serve as a control. Five pairs of a day old *C. maculatus* adults were introduced into each Petri-dish. Each treatment was replicated 4 times and arranged in a Complete Randomization Design (CRD). The number of adult weevils that died was observed and recorded at 24h interval for a period of 168h(7days). Thereafter, all insects were removed and the experiment was allowed to stay until adults (first filial generation) started to emerge. The number of adults that emerged was counted and recorded. The number of seeds that damaged was also counted, recorded and expressed as a percentage of the total number of seeds in the Petri-dish.[6]

Data analysis

Data Obtained were converted to percentage. Arcsin transformation was carried out on the percentage values. The data were later subjected to one-way analysis of variance (ANOVA) and means were separated using Tukey's test.

Results

Mortality of *C. maculatus* in treated Cowpea Seeds

Table 1-7 show the mortality of *C. maculatus* in cowpea seeds treated with insecticide powders of *Anacardium occidentale, Momordica charantia, Jatropha curcas*, *Zanthoxyllum zanthoxyloides* and Pirimiphos-methyl. It was observed that all the treatments were found to have significant effects on beetle mortality. Mortality of *C. maculatus* increased with increase in dosages of the insecticide powders and the time of exposure to the powders. *Z. zanthoxyloides* was the most potent of all the powders. At a low dosage level of 0.2g by 24h after treatment, *Z. zanthoxyloides* effected 16% mortality which was significantly different from 4.2, 5.9, 4.3, and 4.1% mortality in *A. occidentale, M. charantia, J. curcas* and Pirimiphos-methyl treated cowpea seeds respectively. At the highest dosage of 0.8g*, Z. zanthoxyloides* caused mortality of 62% by 24h after treatment. This trend of mortality was observed in 48, 72, 96, 120, 144 and168h after treatment. There was 100% insect mortality at 168h post-treatment in cowpea seeds treated with 0.8g *Z. zanthoxyloides* powders and this was significantly different from percentage mortality in other treatments. It can be deduced that *Z. zanthoxyloides* was the most toxic to *C. maculatus*, followed by *M. charantia, J. curcas* and *A. occidentale* respectively. The least toxic was Pirimiphos-methyl which is a chemical insecticide.

Table 1 Percentage mortality of *C. maculatus* exposed to insecticide powders at 24hours post-treatment

Insecticide powders	Dosage (G) of insecticides/%mortality at hours post-treatment				
	0	0.2	0.4	0.6	0.6
A. occidentale	0.0±0.0a	4.2±0.7a	8.3±0.2a	12.3±0.4a	15.2±2.2a
M. charantia	0.0±0.0a	5.9±0.4a	9.2±0.5a	13.5±0.4a	16.7±0.8a
J. curcas	0.0±0.0a	4.3±0.7a	6.2±0.3a	10.4±0.4a	12.6±0.4a
Z. zanthoxyloides	0.0±0.0a	16.0±1.2b	24.0±1.2b	45.6±1.2c	62.2±0.4c
Pirimiphos-ethyl	0.0±0.0a	4.1±0.8a	7.2±0.4a	19.3±0.4b	35.6±2.0b

Each value is the mean of four replicates. Means in the same column follow by the same letter(s) are not significantly different (p>0.05) by Tukeys test

Table 2 Percentage mortality of *C. maculatus* exposed to insecticide powders at 48 hours post-treatment

Insecticide powders	Dosage (G) of insecticide/%mortality at hours post-treatmen				
	0	0.2	0.4	0.6	0.8
A occidentale	0.0±0.0a	8.2±0.3a	15.3±0.3a	20.2±0.7b	45.4±0.8c
M. charantia	0.0±0.0a	12.2±0.8b	18.3±0.6a	23.2±2.0b	35.3±0.3b
J. curcas	0.0±0.0a	8.2±0.2a	12.3±0.2a	15.0±0.2a	25.2±o.8a
Z. anthoxyloides	0.0±0.0a	20.3±1.3c	35.2±0.3c	55.2±1.0d	65.2±0.2d
Pirimiphos-methyl	0.0±0.0a	13.3±0.2b	28.2±0.2b	35.3±0.2c	45.2±0.5c

Each value is the mean of four replicates. Means in the same column follow by the same letter(s) are not significantly different (p>0.05) by Tukeys test.

Table 3 Percentage mortality of *C. maculatus* exposed to insecticide powders at 72hours post-treatment

Insecticide powders	Dosage (G) of insecticide/%mortality at hours post-treatmen				
	0	0.2	0.4	0.6	0.8
A occidentale	0.0±0.0a	16.4±0.8a	25.2±0.2a	34.2±0.1a	43.2±0.1a
M. charantia	0.0±0.0a	20.3±0.2	28.3±0.8b	42.2±0.7b	52.0±0.8b
J. curcas	0.0±0.0a	16.1±0.7a	22.4±0.8a	33.3±0.1a	52.0±0.3b
Z. anthoxyloides	0.0±0.0a	26.2±0.2b	35.0±0.2	45.0±0.8b	68.0±0.2c
Pirimiphos-methyl	0.0±0.0a	18.0±0.5a	26.2±0.7a	35.3±0.8a	45.2±0.3a

Each value is the mean of four replicates. Means in the same column follow by the same letter(s) are not significantly different (p>0.05) by Tukey's test.

Table 4 Percentage mortality of *C. maculatus* exposed to insecticide powders at 96hours post treatment

Insecticide poweders	Dosage (G) of insecticide/%mortality at hours post-treatmen				
	0	0.2	0.4	0.6	0.8
A occidentale	0.0±0.0a	23.5±0.8a	34.3±0.8a	42.8±0.8a	52.2±0.2a
M. charantia	0.0±0.0a	30.3±0.2b	42.5±0.7b	55.2±0.2b	68.2±0.2b
J. curcas	0.0±0.0a	25.2±0.2a	32.3±0.4a	43.3±0.3a	52.2±0.4a
Z. zanthoxyloides	0.0±0.0a	36.3±0.7c	45.0±0.7b	54.2±0.2b	73.3±0.5b
Pirimiphos-ethyl	0.0±0.0a	20.2±0.7a	30.1±0.2a	41.7±0.8a	52.3±0.3a

Each value is the mean of four replicates. Means in the same column follow by the same letter(s) are not significantly different (p>0.05) by Tukey's test.

Table 5 Percentage Mortality of *C. maculatus* exposed to insecticide powders at 120hours post-treatment

Insecticide powders	Dosage (G) of insecticide/%mortality at hours post-treatmen				
	0	0.2	0.4	0.6	0.8
A occidentale	0.0±0.0a	32.3±0.4b	42.5±0.5b	53.5±0.2a	60.4±0.2a
M. charantia	0.0±0.0a	38.2±0.8b	50.3±0.2c	58.3±0.7b	75.2±0.8b
J. curcas	0.0±0.0a	35.3±0.2b	40.8±0.8b	52.8±0.2a	60.2±0.2a
Z. zanthoxyloides	0.0±0.0a	46.2±0.5c	55.8±0.5d	62.3±0.5c	74.3±0.8b
Pirimiphos-methyl	0.0±0.0a	28.2±0.2a	35.8±0.7a	48.3±0.2a	60.2±0.2a

Each value is the mean of four replicates. Means in the same column follow by the same letter(s) are not significantly different (p>0.05) by Tukey's test.

Table 6 Percentage mortality of *C. maculatus* exposed to insecticide powders at 144hours post-treatment

Insecticide powders	Dosage (G) of insecticide/%mortality at hours post-treatmen				
	0	0.2	0.4	0.6	0.8
A occidentale	0.0±0.0a	40.4±0.7a	51.2±0.2a	64.3±0.5b	68.4±0.8b
M. charantia	0.0±0.0a	47.4±0.3b	62.1±0.5b	65.2±0.3b	73.2±0.4c
J. curcas	0.0±0.0a	42.2±0.7a	48.2±0.7a	62.5±0.4a	68.2±0.7b
Z. zanthoxyloides	0.0±0.0a	54.8±0.2c	63.2±0.5b	71.5±0.2c	85.8±0.2d
Pirimiphos-methyl	0.0±0.0a	39.3±0.5a	46.2±0.0a	58.2±0.8a	60.2±0.8a

Each value is the mean of four replicates. Means in the same column follow by the same letter(s) are not significantly different (p>0.05) by Tukey's test.

Table 7 Percentage Mortality of *C. maculatus* exposed to insecticide powders at 168 hours post-treatment

Insecticide powders	Dosage (G) of insecticide/%mortality at hours post-treatmen				
	0	0.2	0.4	0.6	0.8
A occidentale	0.0±0.0a	55.4±0.8b	62.4±0.3b	74.2±0.6b	82.2±0.2b
M. charantia	0.0±0.0a	56.6±0.5b	73.4±0.1c	73.4±0.4b	84.5±0.5b
J. curcas	0.0±0.0a	54.8±0.4b	57.6±0.0a	74.8±0.5b	83.2±0.4b
Z. anthoxyloides	0.0±0.0a	62.2±0.4c	75.3±0.4c	82.2±0.6c	100.0±0.0c
Pirimiphos-ethyl	0.0±0.0a	50.2±0.6a	58.4±o.5	62.3±0.4a	72.0±0.4a

Each value is the mean of four replicates. Means in the same column follow by the same letter(s) are not significantly different (p>0.05) by Tukey's test.

Effect of insecticide powders on adult emergence of *C. Maculatus*

Table 8 revealed that the treatments had significant effect on adult emergence. The number of adults that emerged decreased with increase in dosages of the insecticide powders. There was no adult emergence in cowpea seeds treated with 0.8g of all the botanical insecticide powders six weeks after treatment except for Pirimiphos-methyl caused 4.2% adult emergence.

Effect of botanical insecticide powders and pirimiphos-methyl on seed damage

The ability of the powders to protect the cowpea seeds from damaging increased with increase in dosages of the powders as revealed by (Table 8). Almost all the cowpea seeds in the control experiment were damaged with the degree of damage ranging from 94 to 100%. All the Botanical insecticides powders offered better protection of the cowpea seeds *Z. zanthoxyloides* was observed to be the best protectant of cowpea seeds.

Table 8 Mean adult emergence of *C. maculatus* at six weeks post-treatment with insecticide powders

Insecticide Powders	Dosage (G) of Insecticide / % Mortality at Hours Post-Treatment				
	0	0.2	0.4	0.6	0.8
A occidentale	102a	16.40b	7.40b	1.50a	0.00a
M. charantia	98a	18.20b	6.50b	1.20a	0.00a
J. curcas	100a	13.00b	5.20b	0.00a	0.00a
Z. anthoxyloides	105a	6.00a	0.00a	0.00a	0.00a
Pirimiphos-ethyl	103a	70.20c	58.30c	24.20b	4.20b

Each value is the mean of four replicates. Means in the same column follow by the same letter(s) are not significantly different (p>0.05) by Tukey's test.

Discussion

The toxicity effect of some botanical insecticide powders and Pirimiphos-methyl against *Callosobruchus maculatus* infesting cowpea seeds in storage were evaluated, using mortality, adult emergence and seed damage as indices. The various results obtained from the present findings revealed that there was a significant effect of the botanical insecticide powders and the Pirimiphos-methyl on *C. maculatus* mortality, adult emergence and seed damage during the period of storage. It can be deduced from the results obtained that *Z. zanthoxyloides* was the most potent against *C. maculatus* because it effected the highest beetle mortality, suppressed adult emergence and drastically reduced seed damage. The high toxicity of *Z. zanthoxyloides* insecticide powders may be due to its peppery characteristic. Also the powder may block the spiracles of the insects, thereby, leading to suffocation and death of the insects.[6] The efficacy of plant may also be due to the presence of phytochemicals such as alkaloid, glycocides, saponin, tannins, phenolic among others. Since most of these compounds had been reported to cause insect mortality, therefore, the high mortality of *C. maculatus* in insecticide powder of *Z. zanthoxyloides* can be associated to the presence of one or more of these compounds.[22] *A. occidentale, M. charantia and J. curcas* are also very effective in the control of *C. maculatus* as a result of their ability to evoke between 82 to 84% *C. maculatus* mortality, low adult emergence and low seed damage.

Comparing the test botanical insecticide powders with Pirimiphos-methyl, it was observed that Pirimiphos-methyl is not as effective in protecting grains compared to *A. occidentale, M. charantia and J. curcas and Z. zanthoxyloides*. The comparatively lower mortality, higher adult emergence, higher seed damage and survival by the beetle in Pirimiphos-methyl have confirmed this. This is because it has been a common practice by people to use a particular convectional insecticide over a long period of time. Due to this reason, some insects developed resistance to Pirimiphos-methy.[23] This present work agreed with the findings of Ravinder[24] who compared the insecticidal activities of plant powders with PMP and discovered that citrus leaf powder was as effective as PMP in exhibiting insecticidal actions. He discovered that the synthetic insecticide PMP was superior to the other plant insecticide powders used (except CLP) in reducing oviposition and insect mortality. Onu and Ajayi (1995) worked with African nutmeg, clove, garlic, Oparaeke[25] worked with chilli pepper, black pepper and they both obtained positive results of their insecticidal effectiveness. The result from this study revealed that powders from the four test plants are more effective than Pirimiphos-methyl for the protection of cowpea against *C. maculatus C. maculatus* found it difficult to develop resistance to plant powders due to the presence of several active insecticidal compounds and this has given botanical powders the potency to solve the problems caused by insect pest.[25,26] Since the botanical species are cheap, ecologically friendly and readily available it is recommended that the powders of the test botanicals be used in the control of adult *C. maculatus*, most especially the powders of *Z. zanthoxyloides*.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

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Citation: Obembe OM, Ogungbite OC. Comparative insecticidal activities of some botanical powders and pirimiphos-methyl against *callosobruchus maculatus* fab.[coleoptera: bruchidae] infesting cowpea seeds. *MOJ Biol Med.* 2017;2(4):305–309. DOI: 10.15406/mojbm.2017.02.00063

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