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Evaluation of Insecticidal Activity of Some Oils and Clay against *Callosobruchus Maculatus* (F.) (Coleoptera:Chrysomelidae) On Stored Cowpea

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Abstract

The efficacy of clay, *Jatrophacurcas* (L.) seed oil and palm oil in the control of cowpea bruchid, *Callosobruchus maculatus* (F.) on stored cowpea was studied in the laboratory of the College of Crop and Soil Sciences of Michael Okpara University of Agriculture, Umudike. Five pairs of male and female *C. maculatus* (1-2 days old) were introduced into each experimental unit of 250ml plastic vials containing 20 grams cowpea seeds of Ife Brown cultivar, which had been thoroughly admixed with formulations of clay, *J. curcas* seed oil and palm oil. These formulations and a synthetic insecticide permethrin dust (0.6%) were applied at the rates of 0g (control), 0.1g, 0.2g, 0.3g, 0.4g, 0.5g and replicated three times. This experiment was laid out in a Completely Randomized Design (CRD) and data were collected on the percentage adult mortality at 24 hours, 48 hours, 5 days, and 7 days post infestation, oviposition, and adult emergence of *C. maculates* and percentage seed germination after three months of storage. The results obtained showed that all the treatments had significantly higher adult mortality ($P \leq 0.05$) than the control, significant lower oviposition and adult emergence with higher seed germination. Applications of these formulations at 0.4g and 0.5g per 20g of cowpea seeds were not significantly different ($P \leq 0.05$). Clay at all levels had a higher efficacy than the synthetic insecticide ($P \leq 0.05$). Therefore clay at the rate of 20g per kilogram of Cowpea could be recommended for use in the control of cowpea storage pest *C. maculatus*.

Key words: Clay, plant oils, cowpea, *Callosobruchus maculatus*, control.

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is a legume belonging to the family Fabaceae. Among the major tribes in Nigeria, it is known as "Wake" or "Tsarrariya" (Hausa), "Akidi" or "Agwa" (Igbo) "Ewa" or "Ewe" (Yoruba) (Dales, 1996).

All varieties of cowpea are heat loving and drought tolerant (Abudulai, 2003). Due to its high protein content (25%), cowpea has been referred to as the poor man's meat, since it serves as a rich source of protein in the absence of animal protein e.g. meat, fish and egg,

especially in developing countries, like Nigeria. (Aykrody and Doughty, 1982; IITA, 1990).

Cowpea may be boiled and cooked into porridge to be eaten alone or with other foods such as rice, yam, corn, garri, or even bread. In some parts of southern Nigeria, they are milled into flour or paste for delicacies such as "Akara" (Bean cakes) or Moi-moi, (Ene-Obong, 1984). Nutritionally, Cowpea is considered very nutritious, with protein content of 25%, fat of 1.3%, fibre of 1.8%, carbohydrate content of 67%, and 8.7% water (IITA, 1990), with amino acid profile which compliments that of cereal grains.

Economic storage of cowpea in developing countries particularly Nigeria is currently being hampered by insect pests of which the major insect pest is the cowpea bruchid, *Callosobruchus maculatus* (Singh, 1978; Ivbijaro, 1983; Ohiagu, 1986; NRI and ODA, 1996). Serious damage done by this pest results to food shortage and threatens food security Emeasor and Emosairue (2002). Most of the chemicals used to protect cowpea in storage are environmentally disruptive, have adverse effect on non-target organisms and have high mammalian toxicity e.g. organophosphates and Organochlorines, many of which have been banned in several countries. (Hassal, 1990; Clarkson, 1995; Gordon, 1998; Kovacic, 2003; Costa, 2006).

There is now a renewed interest in the use of pesticides of plant origin in order to reduce the problems of environmental pollution and risk to non-target species (e.g. bees) and humans. Powders and oils of parts of plants species such as *Piper guineense, Carica papaya* and *Ageratum conyzoides* have been reported to be effective alternatives to the use of synthetic insecticides in the storage of cowpea (Duke, 1985; Dales, 1996; Ogunwolu and Odunlami, 1996; Rajapakse and van Emdem, 1997; Lale and Abdulrahman, 1999; Ofuya, 2001; Emeasor and Emosairue 2002; Ofuya and Dawodu, 2002; Quain *et al*., 2009).

Objectives of the study include:

- To evaluate the potentials of the use of clay, *J. Curcas* seed oil and Palm oil as a dust formulation.
- To determine the insecticidal activity of clay on *C. maculatus*.
- Compare the effect of clay, *J. curcas* seed oil and palm oil formulated into dust, with a synthetic insecticide,

permethrin, for the control of *C. maculatus*.

Materials and Methods

Naturally occurring white clay was obtained and ground into fine powder. Pods of *J. curcas* were opened and the seeds were extracted and air dried. The seed coat was removed and the cotyledons and embryo were ground, and then soaked for 24 hours in petroleum ether. The seed oil was then separated using Soxhlet apparatus in the Animal Science laboratory of the Michael Okpara University of Agriculture Umudike. Fresh palm oil was obtained as a finished product and both oils were formulated into dust using clay as a carrier in the ratio of one part of oil to five parts of clay (i.e. 1:5). The cowpea bruchids used for the study were reared from infested cowpea seeds purchased from Umuahia (Abia State, Nigeria) main market, contained in jute bags and maintained at room temperature until the insect population needed for the experiment was obtained. Small 250ml capacity cylindrical vials were used for the study. Holes were made in the lids to ensure ventilation and muslin cloth was placed over the containers before they were closed to prevent the escape of the insects. Cowpea of Ife brown variety, a variety popularly consumed in Nigeria was used for the study. The treatments i.e. clay, *J. curcas* seed oil and palm oil (using clay as carrier) were applied at five levels i.e. 0g, (control), 0.1g, 0.2g, 0.3g, 0.4g and 0.5g per 20g of cowpea seeds. Permethrin was applied at the same rates for comparison. All the treatments including the permethirn were replicated three times. The treatments were placed in the plastic vials described previously and thoroughly admixed with the seeds by manual agitation. Ten freshly emerged cowpea seed bruchids (1-2 days old), 5 females and 5 males were introduced into each vial and placed on the laboratory bench at room temperature. Sexing was done following the methods of Halstead (1963). The control vials had neither permethrin nor any natural product added.

The following data were collected

- Adult mortality after 24 hours
- Adult mortality after two days
- Adult mortality after five days
- Adult mortality after seven days
- Oviposition
- Adult emergence
- Percentage seed germination

Statistical Analysis

The resulting data were analysed using "Analysis of Variance" (ANOVA) method, at 5% level of significance. Separation of the means was done with "Fishers Least Significant Difference" (FLSD) at 5% level of significance.

Results and Discussion

Analysis of variance showed that the treatments and interactions were significantly different. Table 1 shows mean percentage mortality of adult *C. maculatus* exposed to some plant oils, clay and permethrin 24 hours; 48 hours, 5 days, and 7 das post infestation. After 24 hours of infestation, Clay significantly (P≤0.05) caused the highest mean percentages mortality of *C. maculates* among the treatments, including permethrin, even at the lowest dosage (0.1g of clay per 20g of cowpea seeds). Also, among the dosage means 0.5g caused the highest mean percentage adult mortality of *C. muculatus* although this was not significantly different (P≤0.05) from mortality caused by 0.3g and 0.4g per 20g cowpea seeds. Within 48 hours, apart from palm oil at 0.1g and 0.2g per 20g of cowpea seeds and also permethrin at 0.1g, all the treatments caused significantly (P≤0.05) higher mortality of adult *C. maculatus* than the control (P≤0.05). It was also observed that clay caused the highest mean mortality among the treatments including the permethrin even at the lowest dose (P≤0.05). However, the dosage means showed no significant difference and Clay at 0.3g, 0.4g and 0.5g had the highest mean percentage mortality of *C. maculatus*.

After five days all the treatments except palm oil at 0.1g per 20g cowpea seeds significantly caused a higher mean percentage mortality of adult *C. maculatus* than the control (P≤0.05)(Table 1). Among all the treatment means, clay significantly caused the highest mean percentage mortality of adult *C. maculatus*, although it was not significantly different from permethrin (P≤0.05). Among the dosage means, 0.3g, 0.4g and 0.5g caused the highest mean percentage mortality of *C. maculatus*(P≤0.05). Clay significantly caused the highest mean percentage mortality of *C. maculatus* at all dosage (P≤0.05). After observation for seven days(Table 1), all the treatments except palm oil at 0.1g significantly caused a higher percentage mortality of adult *C. maculatus* than the control (P≤0.05). However, mortality recorded in vials containing Clay, *J. curcas* and permethrin were not significantly different (P≤0.05), with clay

recording the highest percentage mortality.

Table 1: Mean percentage mortality of adult *C. maculatus* exposed to some plant oils, Clay and permethrin dust 24 hours, 48 hours, 5 days and 7 days post infestation.

		Treatments				
Duration after infestation	**Dosage g/ 20g Cowpea Seeds**	***J. curcas***	**Palm Oil**	**Clay**	**Permethrin**	**Mean**
24 hours	0.0	12.30	11.85	12.53	12.40	12.27
	0.1	12.27	6.15	59.00	12.27	22.42
	0.2	12.27	12.27	59.71	26.56	27.70
	0.3	23.85	23.85	74.73	26.07	37.13
	0.4	23.85	23.85	74.73	28.78	37.56
	0.5	28.78	28.78	80.61	28.78	41.74
	Mean	18.89	15.66	60.18	22.37	
	LSD = Treatment : 9.65	Dosage : 4.40	Interaction: 23.65			
48 hours	0.0	21.92	20.51	21.60	20.46	21.15
	0.1	35.01	23.85	83.31	26.07	42.06
	0.2	34.92	23.85	83.31	41.15	45.81
	0.3	39.15	32.30	89.19	43.07	50.93
	0.4	39.15	41.07	89.19	57.29	56.68
	0.5	48.85	41.07	89.19	59.22	59.58
	Mean	36.37	30.54	75.97	41.33	
	LSD = Treatment : 7.22	Dosage : 8.84	Interaction: 17.67			
5 days	0.0	28.63	27.55	28.92	28.03	28.29
	0.1	48.93	30.99	87.19	50.77	54.97
	0.2	52.86	41.15	89.19	63.93	61.78
	0.3	53.07	53.15	89.19	77.44	68.21
	0.4	59.18	61.71	89.19	83.31	73.35
	0.5	77.44	72.02	89.19	83.31	80.49
	Mean	53.29	47.89	79.15	64.51	
	LSD = Treatment : 6.46	Dosage : 7.91	Interaction: 15.82			
7 days	0.0	28.75	27.55	29.25	27.61	28.29
	0.1	57.00	37.22	89.19	57.00	60.10
	0.2	57.29	48.93	89.19	63.93	64.84
	0.3	60.00	62.71	89.19	7.74	54,91
	0.4	69.19	61.71	89.19	83.31	75.85
	0.5	89.19	77.44	89.19	89.19	86.25
	Mean	60.16	52.72	79.20	54.91	
	LSD = Treatment : 7.41	Dosage : 9.08	Interaction: 18.16			

Effect of treating cowpea seeds with some natural products and permethrin dust on oviposition, adult emergence of *C. maculatus* and on cowpea seed germination, after three months of storage is presented in Table 2.

The results showed that all the plant oils significantly reduced oviposition (P≤0.05). Palm oil had lower oviposition than *J. curcas* and permethrin at 0.1g, 0.2gand 0.3g per 20g of cowpea seeds. However, at higher dosages of 0.4g and 0.5g *J. curcas* and Clay had the lowest oviposition of *C. maculatus* than permethrin and Palm oil (P≤0.05). Also, comparing the dosage means, 0.4g and 0.5g of treatment per 20g of cowpea seeds had no significant difference (P≤0.05).

Furthermore, the treatment means showed that *J. curcas* seed oil impregnated on clay and Clay gave the lowest percentage adult emergence of *C. maculatus*. The dosage means were significantly different (P≤0.05) with 0.5g per 20g of cowpea seeds having the lowest adult emergence of *C. maculatus*. *J. curcas* seed oil impregnated on clay and Clay also gave the highest percentage germination of cowpea seeds at 92 days post infestation. The dosage means were significantly different (P≤0.05) with 0.4g and 0,5g per 20g of cowpea seeds having the highest percentage germination of cowpea seeds.

Table 2: Effect of treating cowpea seeds with some natural products and permethrin dust on the Ovipostion and Adult emergence of *C. maculatus* and on cowpea seed germination after three months of storage.

		Treatments				
	Dosage g/ 20g Cowpea Seeds	***J. curcas***	**Palm Oil**	**Clay**	**Permethrin**	**Mean**
Oviposition	0.0	6.15	6.15	6.15	6.15	6.15
	0.1	3.92	3.33	3.66	3.67	3.65
	0.2	3.53	3.13	3.19	3.58	3.36
	0.3	3.44	3.08	2.66	3.44	3.16
	0.4	2.48	3.13	2.41	3.34	2.84
	0.5	2.42	3.03	2.11	3.19	2.69
	Mean	3.66	3.64	2.44	3.90	
	LSD 0.05 = treatment	0.22:	Dosage : 0.27	Interaction : 0.55		
Adult emergence	0.0	86.65	86.65	86.65	86.65	86.65
	0.1	52.96	78.23	63.65	66.73	65.39
	0.2	52.98	74.72	61.95	64.96	63.65
	0.3	47.20	70.56	46.30	64.89	57.24
	0.4	22.22	67.30	32.22	62.43	46.04
	0.5	6.67	61.58	15.00	51.85	33.78
	Mean	44.78	73.17	50.90	66.25	
	LSD 0.05 = Treatment	6.37 :	Dosage : 7.80	Interaction : 15.60		
Percentage germination	0.0	13.33	13.33	13.33	13.33	13.33
	0.1	36.67	23.33	46.67	26.67	33.34
	0.2	43.33	26.67	53.33	26.67	37.50
	0.3	63.33	33.33	73.33	36.67	51,67
	0.4	96.67	43.33	96.67	50.00	71.67
	0.5	100	56.67	100	73.33	82.5
	Mean	58.89	32.78	63.89	37.78	
	LSD 0.05 = treatment : 6.20		Dosage : 7.60	Interaction : 15.19		

Adebowale and Adedire (2006) reported that the oil significantly reduced the number of eggs laid by *C. Maculates* and suggested that the results obtained were probably due to suffocation and/or lethal poisoning of the immature forms by the oil. These observations are also in agreement with that of Jadhau and Jadhau (1984) who reported that 0.2% (v/w) of *J. curcas* seed oil reduced oviposition of *C. maculatus* and

totally prevented eggs from hatching even after 33 days of treatment. This present study, in agreement with the foregoing, shows that *J. curcas* seed oil impregnated on clay is able to inhibit oviposition of *C. maculates* to an economic extent, at a concentration of 0.4g and 0.5g per 20g of cowpea seeds ($P \leq 0.05$).

The clay when applied alone caused mortality of the *C. maculatus*, a phenomenon in agreement with those published by EPA (2008) which stated that clay is environmentally friendly and has asphyxiation and prophyxiation effects against all insects. It also forms a barrier film over seeds, fruits and leaves, making the site uncomfortable for the insects which then seek alternative sites. However, clay had higher potency when applied alone but showed lower efficacy when mixed with *J. curcas* seed oil or palm fruit oil.

The results obtained with respect to percentage mortality of *C. Maculates* showed that the insecticidal potential of clay was the highest followed by the synthetic pesticide (permethrin), *J. curcas*, palm oil and the control, in that order.

Conclusion and Recommendation

The Cowpea bruchids, *C. Maculates* (F.) (Coleoptera; Chrysomelidae) is a threat to the availability of grains for consumption and seeds for planting. It has been observed that many Nigerian farmers and traders indiscriminately apply pesticides of high mammalian toxicity to grains, thus exposing unsuspecting buyers to chronic toxicity. There is renewed interest in the development of environmentally friendly insecticides with low mammalian toxicity. Also, in the preservation of grains, dust preparations are easier to handle more appropriately.

Clay at 0.5g per 20g of cowpea seeds significantly caused the highest mean percentage mortality of adults and the lowest oviposition of *C. maculatus*. However, *J. curcas* and clay had similar results ($P \leq 0.05$) at 0.4g and 0.5g per 20g of cowpea seeds. Generally, the Clay gave better results than the permethrin. There was no synergy between the clay carrier and the oils (*J. curcas* and Palm fruit oil), since the results obtained from the mixtures proved poorer than those obtained from the clay alone. Therefore, other carriers including those without pronounced insecticidal activity should be screened as possible carriers for these plant oils, since such carriers tend to reveal the true insecticidal potential of such oils. Also, since 0.4g of clay per 20g cowpea seeds gave good results which were similar to those obtained with 0.5g of clay per 20g of cowpea seeds, clay at the rate of 20g

per kilogramme of cowpea seeds can be recommended for the control of *C. maculatus* on cowpea seeds in storage.

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