Journal of

Entomology

ISSN 1812-5670

Academic
Journals Inc.

www.academicjournals.com

Journal of Entomology 4 (3): 194-201, 2007
ISSN 1812-5670

Reduction of Post-Harvest Loss Caused by *Callosobruchus maculatus* (F.) in Three Varieties of Cowpea Treated with Plant Oils

K.E. Law-Ogbomo
Department of Agriculture,
Faculty of Basic and Applied Sciences,
Benson Idahosa University, PMB 1100,
Benin City 300001, Nigeria

Abstract: The efficacy of three plant oils (rubber seed oil, palm oil and palm kernel oil) in reducing post harvest loss caused by *Callosobruchus maculatus* (F.) in three cowpea varieties (Ife white, Ife brown and Kano white) was determined in the laboratory at 30+0.30°C and 61+0.32% r.h. Each of the plant oils was tested by exposing adult weevils to various levels of 0, 2.5, 5.0, 7.5 and 10 mL kg^{-1} admixed with cowpea grains in four replications. Each experimental unit had fifteen sexed adult insects. All the plant oil treatments recorded significantly high ($p<0.05$) mortality of adults (70-96%) at 7 Days After Treatment (DAT). Percentage weevil mortality in treated grain was significantly higher than in control. The plant oils gave appreciable percentage reduction in percentage weight loss (0.1-1.7%) when compared with the untreated control (48.2%). Significant reduction in percentage punctured grain (0-32%) versus 93.2% in control and has no adverse effects on seed viability. However, among the treatments, rubber seed oil at 10 mL kg^{-1} grain was the most effective in reducing post harvest weight loss (0.1%). The Ife brown was more resistant to *Callosobruchus* infestation than Ife white and Kano white. A combination of rubber seed oil with Ife brown at the rate of 10 mL kg^{-1} grain gave the most effective reduction in Callosobruchus population and damage.

Key words: Plant oils, *Callosobruchus maculatus*, weight loss, punctured grain, mortality

INTRODUCTION

The loss of food grains during storage due to pests has long been a serious problem to growers. In my tropical countries, cowpea is a staple crop and *Callosobruchus maculatus,* the major pest in storage (Mital, 1971). Percentage weight losses in storage have been estimated to be 60% without control (Pereira, 1983). Loss of cowpea grain caused by *Callosobruchus maculatus* means that the resources such as time, labour, land and fund spent in cultivating the crop are wasted. Control of the pest through the use of conventional insecticides has serious adverse effect, such as the development of resistant strains, toxic residues, increasing costs of production, pollution of the environment and hazards from handling toxic compounds. As a result of these serious drawbacks, there is a need to develop alternative, cheap and safe methods of insect control. In ancient times, oils were used to protect stored grains from insect attack especially in India (Su, 1977).

In recent years, many workers have given greater attention to the control of stored grain pests using vegetable, essential and mineral oils. Jadhav and Jadhav (1984) used some vegetable oils, plant extracts and synthetic insecticides as protectants for stored grains.

Su (1977) studied insecticidal activity of black pepper on *Sitophilus oryzae* and *Callosobruchus maculatus.* Pereira (1983) also evaluated six vegetable oils as protectants for cowpea and bambara nuts. While Enobakhare and Law-Ogbomo (2002) study the use of some plant products which include groundnut cake, palm kernel cake, soybean meal, bitter leaf and fever plant as grain protectants for reduction of post harvest losses caused by *Sitophilus* in three selected maize varieties.

Naik and Dumbre (1984) succeeded in keeping *Callosobruchus maculatus* under control by admixing cowpea with oils of coconut and palm kernel. While Onolemhenhen (1991) treated cowpea grains with rubber seed oil and the grains remain unattacked and undamaged by *Callosobruchus maculatus* for six months.

This trial focus on the potential use of rubber seed oil, palm oil and palm kernel oil as grain protectants for reduction of post harvest losses caused by *Callosobruchus maculatus* in three selected cowpea varieties.

MATERIALS AND METHODS

The trial was conducted at the laboratory unit of Benson Idahosa University, Benin City in 2004. The three cowpea varieties used for this study were Ife white, Ife brown and Kano white. The cowpea varieties were sun dried to a constant weight for four weeks and then placed in large transparent polythene bags. Grain moisture content was determined for all the varieties after moisture equilibration at 61.00±0.32% r.h by the method of Dobie (1984). The three cowpea varieties were sterilized before they were used for the trial by cleaning the grains in 70% ethanol solution to free them from any pre-infestation (1983). Oils of rubber seed, palm and palm kernel was added to the cowpea grains at the rate of 0, 2.5, 5.0, 7.5 and 10 mL kg^{-1} in a kilner jar and mechanically shaken for 5 min. Each treatment, including the control comprised four replicates to each of which was added batches of fifteen 1-3 days old (sex ratio 2:1 i.e., 10:5) weevil taken from a laboratory culture maintained on Ife brown.

Mortality assessment was done everyday until the 7th day after exposure to treatment. Dead adult weevil being those which showed no visible movement after 20 sec observation time, were removed and recorded. Following 7 days assessments, all adult weevils were removed from the jars and corrections for mortality in control were computed using Abbott's formula as cited in Enobakhare and Law-Ogbomo (2002).

At the end of 7 days, the effect of vegetable oils on the reproductive capacity was determined by careful observation of each grain from each treatment on daily basis until, the adult start emerging from the seeds. The ovicidal and lawicidal properties of the plant oils were determined by computing the emerging F_1 adult weevils with the number of eggs laid with the number of eggs laid after 180 DAT.

At the end of 180 DAT, the contents of each container were sieved to remove the dust, frass and any insect present in the grains. The grains were re-weighed and the percentage loss in weight was computed thus:

$$\%\text{Wt. loss} = \frac{(W_i - W_f)100}{W_i}$$

Here W_i = initial weight, W_f= final weight (Enobakhare and Law-Ogbomo, 2002). After re-weighing, the grains were sorted into wholesome and damaged grains and the proportion of damaged grains was computed as:

$$(X/Y)100$$

Where X = Number of punctured grains per treatment, Y = Total number of grains per treatment (Enobakhare and Law-Ogbomo, (2002).

Viability of the grain was tested in petric dishes (9 cm diameter) lined with moist filter paper. Fifty grains were randomly selected from every treatment and placed in the petric dish for 96 h. The dishes were watered after 48 h. The grains used for viability test were those previously exposed to weevils (Enobakhare and Law-Ogbomo, 2002).

Data collected were analysis of variance and means were separated using Tukey's procedure. Before analysis of variance was carried out, the data collected on percentage mortality weight loss and punctured grain was transformed using Arc sine transformation while data collected on emerging F_1 progeny was transformed using $\log_{10}$ transformation. Geometric means was used to obtain the original treatment means from the $\log_{10}$ transformation while Arc sine was transformed back into percentages before presentation in the result.

RESULTS

All plant oils caused weevil mortality as showed in Table 1 The mean percentage mortality ranges from 70 to 96 and was significantly higher than that on the untreated control (0%). Grains treated with

Table 1: Mortality (%) of adult *Callosobruchus maculatus* as influenced by cowpea variety, plant oil treatments and their application rates

Cowpea variety	Plant oil	Dosage (mL kg^{-1})	Means (%) mortality ($n = 4$; $p<0.001$)	Varietal means
Ife white	Rubber seed oil	0.0	0c	
		2.5	79c	
		5.0	82bc	
		7.5	93ab	
		10.0	96a	
	Palm oil	0.0	0c	
		2.5	75cd	78cd
		5.0	79c	
		7.5	89b	
		10.0	93ab	
	Palm kernal oil	0.0	0c	
		2.5	71d	
		5.0	76cd	
		7.5	84b	
		10.0	90b	
Ife brown	Rubber seed oil	0.0	0c	
		2.5	80c	
		5.0	88b	
		7.5	98a	
		10.0	100a	
	Palm oil	0.0	0c	85a
		2.5	78c	
		5.2	85b	
		7.5	96a	
		10.0	98a	
	Palm kernal oil	0.0	0c	
		2.5	76c	
		5.0	82bc	
		7.5	90b	
		10.0	94ab	
Kano white	Rubber seed oil	0.0	0c	
		2.5	75cd	
		5.0	78c	
		7.5	91ab	
		10.0	92ab	
	Palm oil	0.0	0c	72c
		2.5	70cd	
		5.0	73cd	
		7.5	80c	
		10.0	89b	
	Palm kernal oil	0.0	0c	
		2.5	70d	
		5.0	72d	
		7.5	81c	
		10.0	88b	

Treatment mortality, Control = 0%, CV: 4.8%, = 85.3%, Mean followed by a common letter(s) are not significantly different at 0.1% probability level (Comparison made vertically) plant oils gave no appreciable mortality at 7 DAT but higher mortality was found with higher dosages of these plant oils (Table 1). The oils of palm and palm kernel recorded lower mortality than rubber seed oils but the later was not significantly more superior. All treatment showed significance in two way ANOVA ($p<0.05$).

Varietal effects on mortality were significant (Table 2) Ife brown had the highest mortality (85%) followed by Ife white (78%) and then Kano white (72%). There were significant interaction between plant and dosage since the interaction of plant oils and rates of application results in differential percentage mortality.

Table 2: Oviposition and emergency (%) by Callosobruchus infestation as influenced by cowpea variety, plant oil treatments and their rates of application

Maize variety	Plant oil	Dosage mL kg^{-1}	No. of egg laid (N = 4 p<0.001)	Means % adult emergency (N = 4 p<0.001)	Variety mean
Ife white	Rubber seed oil	0.0	90.5a	85.8a	
		2.5	25.3b	10.5b	
		5.0	14.3b	6.2c	
		7.5	7.5c	3.6c	
		10.0	4.2a	84.6a	
	Palm oil	0.0	90.3b	11.1b	21.5b
		2.5	23.4b	6.4c	
		5.0	11.8b	3.2c	
		7.5	7.5c	0.7c	
		10.5	4.6a	85.5a	
	Palm kernal oil	0.0	90.6a	11.4b	
		2.5	24.3b	6.5c	
		5.0	12.5b	3.6cd	
		7.5	6.5c	1.2d	
		10.0	4.8c	85.3a	
Ife brown	Rubber seed oill	0.0	91.6a	8.3b	
		2.5	18.2	3.4c	
		5.0	8.2b	0.4c	
		7.5	6.4c	0.4c	
		10.0	3.4	0.0c	
	Palm oil	0.0	92.3a	86.4a	19.2c
		2.5	23.1b	9.4b	
		5.0	11.5b	4.7c	
		7.5	7.3c	2.2cd	
		10.0	4.1c	2.2cd	
	Palm kernal oil	0.0	92.9a	86.4a	
		2.5	24.1b	9.5b	
		5.0	12.3b	5.1c	
		7.5	6.3c	2.7cd	
		10.0	4.5c	0.3d	
Kano white	Rubber seed oil	0.0	92.3a	86.9a	
		2.5	26.7b	10.5b	
		5.0	15.2b	6.4c	
		7.5	7.8b	3.5c	
		10.0	5.1c	1.5d	
	Palm oil	0.0	92.3a	88.1a	24.3a
		2.5	26.7b	11.7b	
		5.0	15.2b	6.9c	
		7.5	8.2b	3.9c	
		10.0	6.1c	1.7d	
	Palm kernal oil	0.0	92.4a	88.3a	
		2.5	26.5b	12.5b	
		5.0	15.6b	6.9c	
		7.5	8.5b	3.9c	
		10.0	6.3c	1.4d	

Treatment number of egg laid = 8.2% Treatment adult emergence = 5.2%, Control number of egg laid = 96.3% control adult emergence = 88.2% CV: 4.3%, Mean followed by a common letters are not significantly different at 0.1% probability level (comparison made vertically)

The treated grains had lower ovipositions which range from 3.4 to 26.5% than the untreated control 96.3% (Table 2). The plant oils also had a tremendous effect on adult emergence of *Callosobruchus maculatus* which range from 0 to 12.5% as against untreated grains 88.2% for untreated control (Table 2). At 10 mL kg^{-1} application of rubber seed oil and palm oil for Ife brown, no adult weevil emergence was observed.

Overall percentage weight loss was lower in value treated trains (0.1-1.7%) than that of the untreated control (43.2%) (Table 3). Grains treated with rubber seed oil, palm oil and palm kernel oil gave appreciable reduction in weight in that order as compared with control. All the plant oils were

Table 3: Weight Loss (%) by *Callosobruchus* infestation as influenced by cowpea variety, plant oil treatments and their rates of application

Cowpea variety	Plant oil	Dosage mL kg^{-1}	Means % weight loss (n = 4; p<0.001*)	Variety mean
Ife white	Rubber seed oil	0.0	48.6a	
		2.5	1.2b	
		5.0	0.9b	
		7.5	0.6b	
		10.0	0.3b	
	Plam oil	0.0	48.5a	2.8b
		2.5	1.4b	
		5.0	1.1b	
		7.5	1.0b	
		10.0	0.4b	
	Plam kernal oil	0.0	48.1a	
		2.5	4.6b	
		5.0	1.2b	
		7.5	1.0b	
		10.0	0.6b	
Ife brown	Rubber seed oil	0.0	48.1a	
		2.5	1.0b	
		5.0	0.7b	
		7.5	0.3b	
		10.0	0.1b	
	Plam oil	0.0	48.1b	2.1a
		2.5	1.1b	
		5.0	0.9b	
		7.5	0.5b	
		10.0	0.2b	
	Plam kernal oil	0.0	48.3a	
		2.5	1.8b	
		5.0	1.0b	
		7.5	0.6	
		10.0	0.4b	
Kano white	Rubber seed oil	0.0	48.1	
		2.5	1.4b	
		5.0	1.2b	
		7.5	1.1b	
		10.0	0.3b	
	Plam oil	0.0	48.2a	3.4c
		2.5	1.6b	
		5.0	1.4b	
		7.5	1.3b	
		10.0	0.5b	
	Plam kernal oil	0.0	48.3a	
		2.5	1.7b	
		5.0	1.5b	
		7.5	1.0b	
		10.0	0.7b	

Treatment weight loss = 1.2%. Control weight loss = 48.2% CV: 5.2%, Mean followed by a common letter(s) are not significantly different at 0.1% probability level (comparison made vertically) more effective at the higher application rates than the lower rates. All the plant oil treatments were also significantly different ($p<0.05$) from control in terms of weight loss. Cowpea varieties showed different degrees of susceptibility to weevil infestation in terms of weight loss. The Ife brown recorded the least percentage of weight loss of 2.1% (Table 3). Kano white recorded the highest weight loss of 3.4%. There were significant interaction (variety x plant oils; variety x application rates and plant oils x application rates x variety).

The percentage punctured grain of treated grains (0-32%) was lower than that of the untreated control (93.2%). All plant oil treatments were significantly different from untreated control at ($p<0.05$). Ife white had the least punctured grain (28.5%) followed by Ife brown (31.5%) and Kano white (37.7%) (Table 4).

Table 4: Effect of plant oil treatments and variety on damage done by *Callosobruchus maculates* as expressed in percentage punctured grain and on viability of cowpea grains

Cowpea variety	Plant oil	Dosage nL kg^{-1}	Mean% punctured grain (n = 4; $p<0.001$*)	Varietal mean	% viability	Variety mean
Ife white	Rubber seedoil	0.0	94		30	
		2.5	20		48	
		5.0	10		58	
		7.5	4		64	
		10.0	0		74	
	Plam oil	0.0	92		32	
		2.5	30		48	
		5.0	12		54	
		7.5	6		60	
		10.0	4		70	
	Plam kemal oil	0.0	92	28.5	36	52.5
		2.5	32		44	
		5.0	14		48	
		7.5	14		54	
		10.0	6		68	
Ife brown	Rubber seed oil	0.0	92		32	
		2.5	18		50	
		5.0	6		62	
		7.5	2		70	
		10.0	0		76	
	Plam oil	0.0	96	31.5	34	54.7
		2.5	34		46	
		5.0	20		60	
		7.5	18		62	
		10.0	8		68	
	Plam kemal oil	0.0	94		74	
		2.5	38		28	
		5.0	20		46	
		7.5	18		52	
		10.0	10		60	
Kano whiye	Rubber seed oil	0.0	92		68	
		2.5	40		30	
		5.0	24		40	
		7.5	20		50	
		10.0	16		58	
	Plam oil	0.0	92	37.7	60	43.2
		2.5	44		38	
		5.0	28		44	
		7.5	28		48	
		10.0	20		60	
	Plam Kernal oil	0.0	46		30	
		2.5	32	5.0		34
		7.5	30		40	
		10.0	24		46	

Treatment damaged grain = 9.3%. Control damaged grain = 93.2% Overall mean = 40.2% CV: 5.1%. E. = 0.52%, Treatment germination = 52.8% Control germination = 28% overall mean = 42% CV: 5.0% S.E = 0.51%

Studies on the effect of variety and plant oils on seed viability (Table 4) revealed that the plant oils did not hamper seed viability. The untreated control had the least percentage germination (28±0.51%). Ife brown treated with rubber seed oil at the rate of 10 mL kg^{-1} was observed to have the highest seed viability of 76%.

DISCUSSION

This trial has revealed that all the plant oils applied to cowpea grains significantly reduced weight in the grain when exposed to *Callosobruchus maculatus.* Despite their different properties and origin apart, all the plant oils tested in this trial were equally effective and they caused adult weevil mortality. The mortality may be attributed to physical barrier to aspiration as it blocks the spiracles and thereby impaired respiration (Hall and Harma, 1991), toxicity, repellence by constituents (Don-Pedro, 1990) and starvation (Onlemhenhen, 2001).

In terms of reduction of percentage weight loss caused by weevils (Table 3), all the plant oils used had appreciable effects. This could be attributed to the reduction in F_1 progeny (Table 2) and to certain nutritional inhibitors in the plant oils (Dales, 1996). The reduction in F_1 progeny could have resulted from ovicidal and larvicidal properties of plant oils and this could have arisen from the form interference with normal respiration resulting in suffocation (Hall and Harma, 1991) Among the cowpea varieties, Ife brown was observed to have the least percentage weight loss (Table 3) indicating that it is more resistant to weevil damage than Ife white and Kano white.

The Kano white was found to be the most susceptible to weevil infestation as it was observed to have the highest weight loss. Punctured grain is a symptom of damage as the grain will have reduced market value and germination. This is in conformity with the observation of Enobakhare and Law-Ogbomo (2002). All grains treated with plant oils had reduced percentage punctured grains than the untreated control (Table 4). This reduction could be attributed to high adult weevil mortality and low adult weevil emergence in the treated grains.

Plant treatments of grains have no effect on the viability of seeds. Therefore, such plant oils could reduce the infestation of stored grain pests without causing any adverse effect on grain quality. It is economically reasonable to use plant oil highlighted above to control *Callosobruchus maculatus* as these products are relatively available and cheap when compared with conventional pesticides as possible protectants of stored grains (Enobakhare and Law-Ogbomo, 2002).

Plant oils have no adverse effect after storage, on cooking and taste. It also eliminates the possibility of food contamination when insecticides are mixed with grains in storage. Although plant oils have proved to be effective against stored grain weevils as minimizing the susceptibility of grains to cowpea weevils, the most effective strategy to prevent the post harvest loss of the small-scale farmers could be obtained by integrating the tested plant oils with other pest management procedures.

REFERENCES

Dales, M.J., 1996. A review of plant materials used for controlling insect pests of stored products. NRI Bulletin 65, Chaltham, UK., pp: 84.

Dobie, P., 1984. Biological methods for integrated control of insects and motes in tropical stored products. V1: The use of resistant varieties. Trop. Stored Prod. Infor., 48: 4-8.

Don-Pedro, K.N., 1990. Insecticidal activity of fatty acid constituents of fixed vegetable oils against *calloso bructus*. *Chinensis* (F) on cowpea. Pest. Sci., 20: 295-302.

Enobakhare, D.A. and K.E. Law-Ogbomo, 2002. Reduction of pest harvest loss caused by *Sitophilus zeamais* (Motsch) in three varieties of maize treated with plant products. Pest Harvest Sci., 1: 1-6.

Hall, J.S. and G.E. Harman, 1991. Protection of stored legume seeds against attack by storage fungi and weevils: Mechanism of action of Lipodal and oil seed treatments. Crop Prot., 10: 375-380.

Jadhav, K.D. and L.D. Jadhav, 1984. Use of some vegetable oils, plant extracts and synthetic products as protectants from pulse beetle, *Callosobruchus maculatus* in stored grain. J. Food Sci., Technol., 14: 110-113.

Mital, H.C., 1971. Protection of cowpea from insect infestation with the aid of fixed oils. J. West African Sci. Assoc., 16: 45- 48.

Naik, R.R. and R.E. Dumbre, 1984. Effect of some vegetable oils used in protecting stored cowpea in biology of pulse beetle, *Callosobruchus maculatus* Fab. Bull. Grain Technol., 22: 25-31.

Onolemhenhen, O.P., 1991. Use of rubber seed oil in the control of *Sitophilus zeamais* Motsch infestation of stored maize. Nig Ann. Nat. Sci., 1: 11-16.

Onolemhenhem, O.P., 2001. Evaluation of rubber seed oil for the control of the rice weevil, *Sitophilus oryzae* L. J. Agric. Fis., 2: 23-26.

Pereira, J., 1983. The effectiveness of 6 vegetable oils as protectants of cowpea and bambaranut against infestation by *Callosobruchus maculatus* (F). J. Stored Prod. Res., 19: 57-62.

Su, H.C.F., 1977. Insecticidal properties of black pepper to rice weevil and cowpea weevils. J. Econ. Ento., 70: 18-20.