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EFFICACY OF SELECTED SEED OILS AGAINST THE FECUNDITY OF CALLOSOBBRUCHUS MACULATUS(F.) (COLEOPTERA: BRUCHIDAE)

ABSTRACT

Efficacy of admixing traditionally extracted oils from five different plants to two varieties of cowpea (Vigna unguiculata L. WaIp) seeds; Sokoto local and Kananado during storage, against the fecundity of cowpea bruchid (Callosobruchus maculatus F.) was investigated under ambient laboratory conditions. Oils from seeds of neem, cotton, groundnut, castor and desert dates were extracted and ten oil mixtures pair- wise were formulated in five dosages (0.5, 1.0, 2.0, 3.0 and 4.0ml). Each was used to treat 50g seed of the cowpeas, and then infested with 10 pairs of adults' C. maculatus in petri-dishes alongside untreated seeds. Fecundity of the females was determined 14 days post infestation by calculating number of eggs laid per female in each petri-dish. Effect of the oils on females' fecundity was observed to be indirectly proportional to the dosage used for treating both cowpeas. Neem kernel oil applied as straight and in mixtures proved to be more efficacious than the remaining oils. Significant differences ($p>0.05$) for reduced fecundity on treated and untreated seeds were observed. Comparatively, fewer eggs per female were laid on Kananado, implying that in addition to the effect of oils this variety is resistant to bruchid attack.

KEYWORDS: Callosobruchus maculatus; fecundity; seed oil efficacy; cowpea varieties.

1. INTRODUCTION

The cowpea (V. unguiculata) is one of the most important grain legumes throughout the tropical belt covering Asia, the far East, Africa, Southern Europe, Central and South America and in the Southern United State of America[1]. Nigeria alone produces over 2 million tonnes of cowpea annually[2] which was estimated at 70% of the total world production[3]. However, the most widely grown variety has a rough white seed coat with a black eye locally known as farin wake. Various species of weevil (Callosobruchus spp.) attack and damage cowpeas in storage in Nigeria, but the Callosobruchus maculatus (cowpea bruchid) was described as the primary pest of stored cowpea in the semi arid regions of Africa[4,5]. Ranked as the most damaging pest of stored legumes in Nigeria[6,7]. This bruchid was responsible for over 90% of the damage done to cowpea seeds by insects[8]. Against the insect species that attack the pods of cowpeas in the field, only the bruchids survive in the store and among the later only C. maculatus thrive[9].

Cowpea seeds are demeaned upon bearing eggs deposited by the female bruchids and or windows left by the emerged adults from the seeds. The egg is whitish, oval in shape and measures about 0.4-0.75 mm[10]. The anterior end is rounded and the tapering posterior end has a micropyl and a small appendix like structure[11]. Female bruchids lay eggs on 10-15% of pods in the field with only 1-2 per female[9], but during storage the number varies from 35-100 per female[10,11]. A one per cent field infestation of pods at the harvest time resulted in 80% damage of seeds after a few months of storage[12].

Of the several measures of control adapted against the menace of bruchids, pesticides have provided rapid curative action in minimizing damage, flexibility in usage and a more practical measure. But due to environmental contamination and residue in food, potential chronic toxicities, disruption of non-target organism; resurgence of pests or potential pests; and steady increase in cost of pesticides[13], alternative measure is sought for. Peasant farmers in rural Africa admixed plant oils with stored product presumably to drive away insects or deter them from feeding. The present effort is aimed at investigating such local practices of admixing cowpea with seed oils as a measure of pest management.

2. MATERIALS AND METHODS

3. Oils tested for efficacy

The oil types used are obtained from the kernels of the following plants:

- Neem oil: extracted from kernels of Azadirachta indica (A. Juss).
- Cotton oil: extracted from kernels of Cossypium hirsutum (L.)
- Groundnut oil: extracted from kernels of Arachis hypogea (L.)
- Castor oil: extracted from beans of Ricinus communis (L).
- Desert Dates oil: extracted from kernels of Balanites aegyptiaca (L. Del.)

In each case, the seeds were decorticated to separate the kernels which are then pan grilled on fire and pound to form a paste. This paste was hand pressed to give off the oil. Mixtures of the oil extracts were also prepared in 1:1 ratio to obtain ten separate combinations which were also screened.

4. Cowpea varieties used

Two cowpea varieties were selected; the Sokoto local that has small seeds with rough white seed coat and a brown eye, one hundred seeds weigh 13.9g and Kananado having large seeds with rough white seed coat, black eye and weigh 16.7g for hundred seeds. Adequate amount of seeds for each variety was sterilized in a deep freezer for two weeks to disinfest any prior infestation by cooling[13]. The seeds were then dried under ambient laboratory conditions for another two weeks and kept as stock.

5. Rearing of C. maculatus

The adults of C. maculatus were obtained from reared cultures in the laboratory maintained on cowpea at 30±2^{0}C and 80±5% RH. They were fed on sterilized cowpeas in four glass jars (each measuring 350ml) till a new generation of adults emerged. The new generation adults were then reared as mother stock for experimental purpose.

6. Experiments conducted

150g of sterilized seeds of Sokoto local variety were obtained from the stock and thoroughly mixed with 1.5ml neem oil. The seeds were then divided into 3 separate petri dishes, each containing 50g seeds treated with 0.5ml oil. The fourth petri dish with 50g untreated seeds was also obtained as control. Ten pairs of approximately 2-day-old adult bruchids were obtained from the mother stock using camel hair brush and released in each petri dish containing seeds. All the petri dishes containing seeds were kept under laboratory conditions while the insects were allowed to feed till they died (14 days later). The number of eggs laid on seeds in each petri dish was counted. Similar experiments were conducted by applying increased dosage (1.0, 2.0, 3.0 and 4.0ml) of the same and other extracted oils, as well as when Kananado variety was used. Likewise when applying the ten combinations of the oils for each 50g of seeds. The results obtained were analysed using ANOVA and comparison of treatment means was based on Duncan's Multiple Range Test.

7. RESULTS AND DISCUSSION

Efficacy of plant oils on reducing fecundity of females C. maculatus maintained on Sokoto local variety of cowpeas is shown in Table 1. It was observed that, even the lowest dosage of each oil used (0.5ml/50g seed) to treat seeds reduced the number of eggs laid per female bruchid. However, the minimum fecundity was on seeds treated with neem kernel oil (32.23±0.8 eggs per female) while the maximum was on those treated with cotton seed oil (42.28±1.2 eggs per female). The reduction in the number of eggs laid by each

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INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY
ISSN-2319-2119
RESEARCH ARTICLE
Yahaya, M.M et al, The Experiment, Mar. 2013 Vol. .8(4), 513-521

female on treated seeds remained consistent with each increase of oil dosage used (1.0-4.0ml/50g seed). Moreover, the bruchids were unable to lay eggs on seeds treated with the highest dosage of neen kernel oil but each female laid maximum of 2.7±1.4 eggs on seeds treated with cotton oil as the highest observed on treated seeds. Similarly, it was on seeds treated with the combination of neem + desert dates oils that the bruchids laid minimum number of eggs and the maximum on those treated with the combination of cotton + castor oils (Table 2). Though, significant differences (p>0.05) in reduced fecundity among females maintained on oil treated seeds were observed, those maintained on untreated seeds showed no such significant reductions in fecundity.

As shown in Table 3, the bruchids maintained on Kananado variety of cowpeas treated with the lowest dosage of the same individual oils, laid minimum number of eggs on seeds treated with neem oil (20.07±0.2 eggs per female) and maximum on those treated with cotton oil (33.07±0.3 eggs per female). When the dosage of oils was increased to 3.0ml/50g seed, neem, groundnuts and desert dates oils completely inhibited female bruchids from oviposition while same was achieved at 4.0ml/50g seed by the remaining oils. Likewise, the bruchids laid fewer eggs on all seeds treated with any oil combined with neem kernel oil (Table 4). However, all the oil combinations used to treat the cowpeas significantly reduced the fecundity of the bruchids at dosage of 0.5ml/50g seed and above as compared to untreated seeds. But no eggs were laid by the bruchids when maintained on seeds treated with the highest dosage of each oil combination.

All the oils used to treat the cowpeas either singly or in different combinations affected the fecundity of females' C. maculatus. The neem kernel oil applied as straight or in combination with the other oils was more efficacious for reducing the bruchids fecundity than those of cotton, groundnut, castor and desert dates either as straight or in combinations. Reductions in the fecundity of C. maculatus on cowpeas treated with vegetable oils, were earlier reported[14,15,16] where repellence due to odour was commonly attributed as being responsible. Moreover, neem oil possesses extraordinary gastotory repellent properties against the desert and migratory locust[17,18]. Similarly, azadirachtin and salanin compounds isolated from neem oil possessed activity as feeding deterrent against striped cucumber beetle Diabrotica undecimpunctata[19,20]. There was evidence of growth disruption, feeding inhibition, deterrence and outright mortality associated with neem based products on certain insect species[21].

The effect of cotton seed oil on reducing the fecundity among females' C. maculatus indicates the presence of certain compounds in the oil which might be responsible for this activity. When applied on beans, the crude oils of cotton seed, soya beans and coconut palm were very effective in reducing the oviposition of Zabrotes subfasciatus[22,23]. Oil from cotton seed contains aromatic sesquiterpens dimmer and gossypol compounds[24,25]. Gossypol compounds are believed to cause male sterility among many species of insects including bruchids[26]. Toxicity of these compounds against tobacco budworm (Heliothis virescence), pink bollworm (Pectinophora gossypiella) and boll weevil (Anthonomus grandis) has been established[27]. Thus, the compounds might have played roles in affecting the fecundity of females' C. maculatus.

Groundnut seed's glycerides contain certain allelochemicals comprising phytohaemagglutinins, protease inhibitors, and saponins[28,29] all of which were reported toxic to C. chinensis[30] and C. maculatus[31]. It could be possible that the compounds might be present in the groundnut oil used in the present experiment and had an effect on reducing the bruchids fecundity. The foliage of castor plant possesses insecticidal properties and the meals from its beans proved toxic to livestock[32]. Presumably, the oil extracted from them may be toxic and that females' C. maculatus are vulnerable to it thereby caused reduced fecundity.

Though, admixture of desert dates oil with stored cowpeas to ward-off insect pests is not a common practice, the results obtained from the present study indicated it a promising agent for reducing the fecundity of C. maculatus. However, different extracts of desert dates (including the oil) contain saponins[33] that the bruchids are unable to hydrolyzed[34]. Moreover, the ovicidal and molluscicidal activities of desert dates oil have been reported[35]. Generally, the female bruchids were more fecund on Sokoto local variety of cowpeas than on Kananado variety. Owing to the larger seeds of Kananado it would be assumed to provide more surface area for oviposition and the coating of oils on the seeds would be less. The variety has moderately combined resistance to root-knot nematodes, aphids and

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Yahaya, M.M et al, The *Experiment, Mar. 2013 Vol. .8(4), 513-521*

bruchids[20,31]. But the food on which insects are bred influences the number of eggs laid[32,34,3536]. Though, the efficacy of seed oils against the bruchids' fecundity is quite variable, they should work well in combination with resistant cultivars.

8. CONCLUSIONS

All the seed oils used in this study significantly reduced the bruchids fecundity right from the lowest dosage applied (0.5ml/50g seed) and inhibited egg laying when highest dosage (4.0ml/50g seed) was used. Neem oil was however, more efficacious in this respect when applied either as straight or in combination with other oils used. Fewer eggs were laid on kananado seeds which might indicate resistant of the variety to the bruchid attack. The activity of seed oils against bruchids fecundity can be well-utilized, while planning for more alternative control measures for the bruchid.

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ISSN-2319-2119

RESEARCH ARTICLE

Yahaya, M.M et al, The *Experiment, Mar. 2013 Vol. .8(4), 513-521*

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THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Yahaya, M.M et al, The *Experiment, Mar. 2013 Vol. .8(4), 513-521*

Oil treatments	Mean fecundity ± S.E Concentration of oils (ml/50g seed)				
	0.5	1.0	2.0	3.0	4.0
Neem	$32.23^{a} \pm 0.8$	$24.97^{a} \pm 0.8$	$16.7^{a} \pm 0.6$	$4.13^{a} \pm 0.3$	0.0
Cotton	$42.28^{b} \pm 1.2$	$39.93^{b} \pm 0.6$	$27.8^{b} \pm 0.5$	$13.57^{b} \pm 0.5$	$2.7^{a} \pm 1.4$
Groundnut	$39.97^{b} \pm 0.3$	$32.73^{c} \pm 1.7$	$19.73^{ac} \pm 1.2$	$9.13^{cd} \pm 0.8$	$1.03^{ab} \pm 0.2$
Castor	$42.0^{b} \pm 0.5$	$34.57^{c} \pm 0.8$	$20.07^{c} \pm 0.8$	$11.2^{c} \pm 1.1$	$1.87^{ab} \pm 0.1$
Desert dates	$40.37^{b} \pm 0.9$	$32.33^{c} \pm 1.8$	$19.23^{ac} \pm 1.8$	$8.9^{d} \pm 0.8$	$0.8^{b} \pm 0.4$
Control (untreated)	$72.63^{c} \pm 1.6$	$67.3^{d} \pm 0.4$	$59.83^{d} \pm 0.4$	$70.37_{e} \pm 0.3$	$57.53^{c} \pm 0.5$
L.S.D.	2.89	3.52	3.08	2.14	1.92

Means with the same letter (s) are not significantly different ($p>0.05$)

Table 1: Fecundity of females' C. maculatus maintained on Sokoto local variety of cowpeas (Vigna unguiculata L. Walp) treated with seed oils

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Yahaya, M.M et al, The *Experiment, Mar. 2013 Vol. .8(4), 513-521*

Oil treatments (1:1)	Mean fecundity ± S.E Concentration of oils (ml/50g seed)				
	0.5	1.0	2.0	3.0	4.0
Neem + Cotton	$35.33^{ab} \pm 0.2$	$26.23^{a} \pm 2.8$	$17.43^{a} \pm 0.2$	$8.1^{ab} \pm 1.3$	0.0
Neem + Groundnut	$34.3^{ab} \pm 0.3$	$25.13^{a} \pm 1.2$	$16.0^{a} \pm 2.0$	$6.87^{ab} \pm 3.7$	0.0
Neem + Castor	$35.1^{ab} \pm 0.2$	$25.77^{a} \pm 0.9$	$16.5^{a} \pm 1.5$	$7.87^{ab} \pm 0.7$	0.0
Neem + Desert dates	$33.9^{a} \pm 0.2$	$24.6^{a} \pm 0.2$	$15.97^{a} \pm 1.2$	$6.57^{a} \pm 0.4$	0.0
Cotton + Groundnut	$43.9^{c} \pm 1.3$	$35.87^{b} \pm 2.0$	$27.6^{b} \pm 0.5$	$13.07^{cd} \pm 2.6$	$2.9^{a} \pm 0.2$
Cotton + Castor	$45.87^{c} \pm 0.7$	$37.33^{b} \pm 1.4$	$29.03^{a} \pm 3.0$	$13.73^{d} \pm 0.4$	$4.5^{b} \pm 1.0$
Cotton + Desert dates	$43.27^{c} \pm 1.3$	$34.9^{b} \pm 1.8$	$26.4^{b} \pm 0.7$	$11.47^{acd} \pm 1.4$	$1.57^{c} \pm 0.3$
Groundnut + Castor	$36.8^{b} \pm 1.3$	$28.3^{a} \pm 1.4$	$19.93^{a} \pm 0.0$	$8.6^{acd} \pm 1.4$	$2.17^{ac} \pm 0.4$
Groundnut + Desert dates	$36.1^{ab} \pm 0.3$	$27.13^{a} \pm 0.6$	$18.13^{a} \pm 2.1$	$8.33^{ab} \pm 0.4$	$1.37^{c} \pm 0.4$
Castor + Desert dates	$36.6^{b} \pm 0.9$	$27.87^{a} \pm 1.2$	$20.87^{c} \pm 2.7$	$8.73^{abc} \pm 0.7$	$1.63^{c} \pm 0.4$
Control (untreated)	$60.3^{d} \pm 0.5$	$54.57^{c} \pm 1.1$	$71.87_{d} \pm 1.3$	$59.37_{e} \pm 0.7$	$62.87^{d} \pm 0.2$
L.S.D.	2.60	4.29	5.23	4.64	1.13

Means with the same letter (s) are not significantly different ($p>0.05$)

Table 2: Fecundity of females' C. maculatus maintained on Sokoto local variety of cowpeas (Vigna unguiculata L. Walp) treated with mixed seed oils (1:1)

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Yahaya, M.M et al, The *Experiment, Mar. 2013 Vol. .8(4), 513-521*

Oil treatments	Mean fecundity ± S.E Concentration of oils (ml/50g seed)				
	0.5	1.0	2.0	3.0	4.0
Neem	20.07^{a} ±0.2	14.17^{a} ± 0.3	3.13^{a} ± 0.3	0.0	-
Cotton	33.07^{b} ± 0.3	22.77^{b} ± 0.5	9.57^{b} ± 0.4	1.13^{a} ± 0.2	-
Groundnut	28.87^{c} ± 0.2	16.6^{c} ± 0.4	6.9^{b} ± 0.1	0.0	-
Castor	29.77^{bc} ± 0.6	17.77^{d} ± 0.4	7.63^{b} ± 0.2	0.6^{a} ± 0.4	-
Desert dates	28.67^{c} ± 0.3	16.5^{c} ± 0.4	6.67^{b} ± 0.4	0.0	-
Control (untreated)	42.83^{d} ± 2.8	46.0_{e} ± 0.1	44.8^{c} ± 2.3	41.73^{b} ± 3.3	42.73 ± 1.5
L.S.D.	3.68	1.16	2.99	4.12	-

Means with the same letter (s) are not significantly different ($p>0.05$)

Table 3: Fecundity of females' C. maculatus maintained on Kananado variety of cowpeas (Vigna unguiculata L. Walp) treated with seed oils

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Yahaya, M.M et al, The *Experiment, Mar. 2013 Vol. .8(4), 513-521*

Oil treatments (1.1)	Mean fecundity ± S.E Concentration of oils (ml/50g seed)				
	0.5	1.0	2.0	3.0	4.0
Neem + Cotton	$22.83^{a} \pm 0.2$	$14.5^{ab} \pm 0.2$	$5.27^{abc} \pm 0.4$	0.0	-
Neem + Groundnut	$22.23^{a} \pm 0.4$	$13.63^{b} \pm 0.2$	$3.77^{ac} \pm 0.3$	0.0	-
Neem + Castor	$22.50^{a} \pm 0.3$	$14.07^{ab} \pm 0.1$	$4.7^{abc} \pm 0.2$	0.0	-
Neem + Desert dates	$22.03^{a} \pm 0.2$	$13.23^{b} \pm 0.7$	$3.33^{a} \pm 0.4$	0.0	-
Cottol + Groundnut	$30.93^{b} \pm 1.2$	$23.83^{c} \pm 0.3$	$10.43^{e} \pm 0.9$	$1.4^{ab} \pm 0.4$	0.0
Cotton + Castor	$31.57^{b} \pm 1.4$	$25.0^{c} \pm 0.6$	$10.67^{e} \pm 0.7$	$2.37^{b} \pm 0.5$	0.0
Cotton + Desert dates	$30.57^{b} \pm 1.9$	$22.93^{c} \pm 1.7$	$9.27^{de} \pm 0.3$	0.0	-
Groundnut + Castor	$24.20^{a} \pm 1.3$	$16.7^{a} \pm 1.3$	$7.1^{bd} \pm 0.6$	0.0	-
Groundnut + Desert dates	$23.60^{a} \pm 0.4$	$15.8^{ab} \pm 0.3$	$6.5^{bcd} \pm 0.4$	0.0	-
Castor + Desert dates	$23.73^{a} \pm 1.0$	$16.03^{ab} \pm 1.0$	$6.93^{bd} \pm 0.2$	0.0	-
Control (untreated)	$43.2^{c} \pm 1.0$	$43.33^{d} \pm 2.0$	$41.7^{f} \pm 2.8$	$41.67^{c} \pm 2.3$	43.5 ± 2.4
L.S.D.	2.91	2.90	2.80	2.13	

Means with the same letter (s) are not significantly different ($p>0.05$)

Table 4: Fecundity of females' C. maculatus maintained on Kananado variety of cowpeas (Vigna unguiculata L. Walp) treated with mixed seed oils

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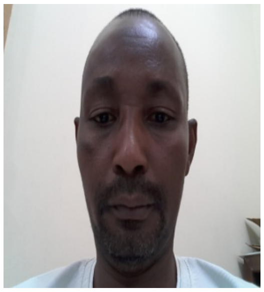

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