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Efficacy of the Seed Powder and Oil of *Jatropha Curcas* in the Control of *Acanthoscelides obtectus* in Stored Cowpea

Samuel Femi Babatunde[1,*], Abdulrasak Kannike Musa[1], Lukman Idowu Gambari[2]

[1]Department of Crop Protection, Faculty of Agriculture, P.M.B. 1515, University of Ilorin, Ilorin, Nigeria

[2]Federal University of Agriculture, College of Agronomy, Department of Crop Production, Makurdi, Benue State, Nigeria

HIGHLIGHTS

- It is important to protect and preserve the cowpea for human and animal consumption.
- It is important to control post-harvest losses caused by cowpea weevil using non synthetic chemicals.

Abstract

A study was carried out to evaluate the efficacy of seed powder and oil of *Jatropha curcas* in controlling post-harvest losses caused by cowpea weevil, *Acanthoscelides obtectus* (Say) on cowpea. 100 g of *J. curcas* powder were put in 300 ml of n- hexane used as the solvent. The Jatropha seed powder was tested at dosages of 0.1g, 0.2g and 0.3g and Jatropha seeds oil at the rate of 0.05ml, 0.1ml and 0.2ml were applied to 20g cowpea seeds in petri dishes. The different rates of treatment recorded significant differences (P=0.05) in causing adult mortality compared to the untreated control. The different rates of treatment also recorded significant differences (P=0.05) in oviposition of each treatment compared to the control. The percentage weight loss and seed damage were also suppressed as a result of treatment with the plant material compared to the untreated control. However, among the treatments Jatropha seeds oil at 0.2ml/20g cowpea recorded the highest adult mortality rate and lowest oviposition while control had the lowest mortality rate and highest oviposition. The study shows that Jatropha had bio pesticides effect in controlling *A. Obtectus.*

Keywords: Soxhlet apparatus; *Acanthoscelides obtectus; Jatropha curcas;* cowpea; n-hexane; pirimiphos methyl; oviposition

1. Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) originated in West and Central Africa before spreading to Latin America and Southeast Asia (Edeh and Igberi 2012; Karadaş and Ceyhan 2023). As a legume, cowpea plays a crucial role in nutrient cycling due to its tolerance to drought and soil acidity, as well as its ability to fix

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***Correspondence:** samfemmy2002@gmail.com

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nitrogen from the air. This makes it particularly well-suited for regions experiencing declining soil fertility and drought (Sert and Ceyhan 2012; Ibrahim et al. 2016; Ceyhan and Karadaş 2023). Cowpea seeds serve as a major source of plant proteins and vitamins, animal feed, and a source of income (Ibrahim et al. 2016; Jou-Nteufa and Ceyhan 2022). In Nigeria, cowpea (*Vigna unguiculata*) is an important source of dietary protein, particularly because its edible seeds are a cost-effective alternative to more expensive protein sources (Adedire et al. 2011; Jou-Nteufa and Ceyhan 2025). Cowpeas are also a valuable addition to the diets of resource-poor farmers, providing supplementary nutrition alongside their primary staples, such as roots, tubers, and cereals (Ileke et al. 2013). Cowpea is a significant staple food and cash crop in Nigeria, with the potential to greatly reduce malnutrition among resource-poor farmers while improving food security, productivity, and the sustainability of crop-livestock systems (IITA 2009). A study by Ibrahim et al. (2016) found that low-income individuals tend to rely more on cowpea-based food products as their primary source of protein, rather than animal protein. Research conducted in Nigeria by Dugje et al. (2009) highlighted the economic benefits for farmers who cut and store cowpea fodder for sale during peak dry seasons, which can increase their annual income by 25%. When incorporated into crop rotation, cowpea contributes nitrogen to the soil, benefiting cereal crops such as maize, millet, and sorghum, particularly in areas struggling with poor soil fertility (Tijjani et al. 2015).

However, cowpea production faces numerous challenges, including damage from insect pests, parasitism by Striga gesnerioides, diseases, drought, low and unpredictable rainfall, and extended dry seasons (Singh et al. 2002). *Acanthoscelides obtectus* (Say) (Coleoptera: *Chrysomelidae*: *Bruchinae*) originates from Mesoamerica and is a significant post-harvest and field pest of both wild and cultivated common beans (*Phaseolus vulgaris* L., *Fabaceae*) in tropical regions (Paul et al. 2010; Thakur 2012). *Acanthoscelides obtectus* and *Zabrotes subfasciatus* (Boheman) are two species of beetles that often coexist in bean storage areas, sharing the same habitat and geographical range. Among these two species, *Acanthoscelides obtectus*, which has a wide distribution in eastern and southern Africa (Mutungi et al. 2015), is economically significant. Many small-scale farmers in this region rely on bean production and sales as a crucial source of household income. When infested, these farmers often sell their beans immediately after harvest, when market prices are at their lowest. Infestations can lead to substantial dry weight losses of 10% to 40% in less than six months, with damage rates potentially reaching up to 70% in the same time frame (Paul et al. 2009). The post-harvest damage caused by *A. obtectus* results in significant financial losses for African small-scale farmers; Mishili et al. (2011) estimated a 2.3% decrease in price for each insect emergence hole in 100 beans. All larval instars of *A. obtectus* are voracious feeders, consuming legume proteins, often reducing heavily infested beans to empty shells. *A. obtectus* has a short life cycle of three to four weeks and a high reproductive potential, allowing for the emergence of multiple generations per year under favorable conditions (Soares et al. 2015). Female *A. obtectus* lay eggs in clusters inside pods in the field or on shelled stored bean seeds (Godrey and Long 2008). Although typically one larva infests each seed, multiple infestations can occur, with late instar larvae entering the same seed through the burrow made by the first. The final instars then excavate a chamber just below the seed testa for pupation. The presence of a final instar or pupa can be visually detected by a small window in the seed coat. After emergence, the adult chews a hole in the seed coat to exit and is ready to mate. As with many other post-harvest pests of stored grain, *A. obtectus* infestations begin in the field, where adults lay eggs in dried bean pods. By late harvest, damage to the beans can be so severe that there might be little to no harvest at all (Velten et al. 2007). There is an urgent need to educate farmers about safer and effective pest control measures that have minimal side effects.

2. Materials and Methods

2.1. Study Area

This study was conducted in the Department of Crop Protection laboratory of the University of Ilorin. The study location falls within the southern Guinea Savannah agro-ecological zone of Nigeria between latitude 8°25'N and longitude 4°67'E.

2.2. Source of Seeds

The cowpea seed variety used for this study is RSH 256 and was sourced from the International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria. The seeds were wrapped in a polyethylene bag and were kept in the freezer at the Crop Protection laboratory, University of Ilorin, to kill any immature stages of insects. The seeds were removed 10 days after freezing and then spread on a laboratory desk to unthaw.

2.3. İnsect Culture

A culture of cowpea weevil, *A. obtectus,* was prepared at laboratory ambient temperature (30 ± 3°C) and relative humidity (68 ± 3%) respectively. The weevils were collected from already existing stock in the Crop Protection laboratory, University of Ilorin, Nigeria. Fifty (50) unsexed adults of *A. obtectus* were used to infest cowpea seeds in a transparent plastic container which was covered with muslin cloth held tightly by perforated lid to ensure aeration and prevent escape of the insects. Freshly emerged adults were used for the study.

2.4. Apparatus and Equipment

The apparatus, equipment and materials used include transparent plastic containers, cowpea seeds, water, n-hexane, measuring cylinder, conical flasks, *Jatropha Curcas* seeds, muslin cloth, a pair of scissors, a razor blade, paper tape, a hairbrush, digital weighing balance, spatula, Soxhlet apparatus, a plastic sieve, electric blender, rubber band, laboratory desk, freezer, petri dish, foil paper and beakers.

2.5. Collection and Preparation of Plant Material

Jatropha Curcas seeds were collected from the parent plant at the University of Ilorin Jatropha plot between latitude 8°29'N and longitude 4°35'E in the morning. *J. Curcas* seeds were cracked and the shells were carefully removed to get the kernel. The kernels were dried at 30^0C to get constant moisture content after which they were ground with the aid of an electric blender, and sieved to obtain uniform particles. The powder was stored in a vial until required for use.

2.6. Soxhlet Extraction

100 g of *J. Curcas* powder was wrapped in a muslin cloth and tied with a rubber band before introducing into the thimble of a Soxhlet extractor. 300 ml of n-hexane was introduced into a round bottom flask. The electric cooker served as the source of heat (b.p. 68^0C) which lasted for 6-7hrs. The excess solvent was separated from the oil with the aid of rotary evaporator and was collected in the receiving flask.

2.7. Experimental Procedure

Experiment was conducted on four (4) main areas, namely Toxicity bioassay, Oviposition deterrence, Seed damage and Germination test

2.7.1. Toxicity bioassay

In this experiment, Jatropha seed powder at the rates of 0.1g, 0.2g and 0.3g and Jatropha oil at the rates of 0.05ml, 0.1ml and 0.2ml were applied to 20g cowpea seeds in petri dishes. A single rate of Pirimiphos methyl 0.4ml was added as a check. An untreated control was also added as part of the treatments making a total of eight (8) treatments. Cowpea seeds treated with Jatropha oil and pirimiphos methyl were air dried. Ten (10) unsexed *A. obtectus* were introduced into the treated cowpea seeds. All treatments were replicated three times. Mortality count was taken after 1, 3 and 7 days.

2.7.2. Ovipositon deterrence

This experiment was conducted in two phases namely: Choice test and No Choice test.

Choice Test: For this setup, 20g cowpea seeds in petri dishes were treated with highest and lowest concentration of Jatropha seed powder 0.3g and 0.1g, highest and lowest concentration of Jatropha seed oil and Pirimiphos methyl 0.4ml and untreated control was also added as part of the treatments making a total of six (6) treatments. After air drying, one seed from each treated cowpea seeds was picked and placed inside glass petri

dish which contained melted paraffin wax to hold the seed in place. There were three (3) replicates for the experiment. The number of eggs laid on each cowpea seed was counted after the death of the insects.

No Choice test: For this setup, 20g cowpea seeds in petri dishes were treated with only highest concentration of Jatropha seed powder 0.3g and highest concentration of Jatropha seed oil 0.2ml and Pirimiphos methyl 0.4ml and untreated control were added as part of the treatments making a total of four (4) treatments. Six (6) seeds were selected at random from the treated cowpea seeds and placed carefully inside glass petri dishes which contained melted paraffin wax to hold the seed in place. A pair of adult day old of *A. obtectus* was introduced. The insects were not given choice of which treated cowpea seeds to lay their eggs as only seeds of the same treatment were represented in each petri dish. The treatments were replicated three (3) times, the number of eggs laid was counted after the death of the insects.

2.7.3. Seed damage

In this experiment, 20g of cowpea seeds were treated with 0.1g, 0.2g and 0.3g of Jatropha seed powder and Jatropha seed oil of 0.05ml, 0.1ml and 0.2ml and Pirimiphos methyl 0.4ml in transparent plastic containers. An untreated control was also added as part of the treatments making a total of eight (8) treatments in all. Cowpea seeds treated with Jatropha seed oil and pirimiphos methyl were air dried after which two (2) pairs of adult *A. obtectus* were introduced. Treatments were replicated three times. The plastic containers were covered with muslin cloth and the setup was placed in the laboratory for 45 days after which the number of undamaged seed (seeds without holes) and number of damaged seeds (seeds with holes) was counted and recorded. The weight of seeds in each cup was also taken and recorded.

2.7.4. Germination test

In this experiment, 20g of cowpea seeds were treated with 0.1g, 0.2g and 0.3g of Jatropha seed powder and Jatropha seed oil of 0.05ml, 0.1ml and 0.2ml and Pirimiphos methyl 0.4ml in transparent plastic containers. An untreated control was also added as part of the treatments making a total of eight (8) treatments in all. Cowpea seeds treated with Jatropha seed oil and pirimiphos methyl were air dried. Treatments were replicated three times and no insect was introduced to the seeds placed in a transparent plastic containers covered with muslin cloth and the setup was placed in the laboratory for three (3) months after which ten (10) seeds were randomly selected from each plastic container and placed in a petri dishes whose inside have been laid with tissue paper. Distilled water was used to moisten the tissue paper. Observations were taken on the following

I. The number of seeds with radicles at 24, 48 72 and 96 hours after set up
II. The number of seeds with radicles and root hairs at 96 hours after set up
III. The number of seeds with hypocotyl at 96 hours after set up
IV. The number of seeds with primary leaves at 96 hours after set up

2.8. Data Collection

Data were collected on various parameters including adult mortality, Oviposition, Seed damage and Germination. The percentage seed mass loss was computed following the method of Haines (1991) as follows:

$$\frac{initial\ weight - final\ weight}{Initial\ weight} X100 \quad (1)$$

2.9. Statistical Analysis

All data collected were subjected to analysis of variance and in a Completely Randomized Design (CRD) model using GenStat 2017 version and significant differences. Treatment means were separated using Duncan`s Multiple Range test (DMRT) at 5% level of significance.

3. Results and Discussion

The results of this experiment shows that the various treatments used in this study had effects on mortality with increase of dosages of Jatropha seed oil caused adult mortality of *A. obtectus* at the high rates of 0.2ml after 1 day, 3 days and 7 days when compared to the untreated control. (Table 1) after the same period. This

indicates that Jatropha seed powder and Jatropha seed oil has the ability to cause mortality of *A. obtectus* when compared with Pirimiphos methyl that was added as check. This support the findings of Babatunde and Musa. (2020) who reported that *E. globulus* plant extracts can be another source of insecticides/pesticides against stored grain pests.

There was considerable mortality of *A. obtectus* in cowpea seeds treated with the highest rate of (Table 1). Jatropha seed powder of 0.3 g which could be compared with the lowest concentration of Jatropha seed oil 0.05 ml.

Table 1. Effects of different rates of treatments on percentage mortality of adult

Percentage Adult mortality of *A. obtectus* (DAT)			
Treatments	**Day 1**	**Day 3**	**Day 7**
Jatropha powder 0.1g	0.0a	16.7a	93.3a
Jatropha powder 0.2g	10.0ab	20.0a	93.3a
Jatropha powder 0.3g	36.7bc	76.7b	100.0a
Jatropha Oil 0.05ml	63.3cd	90.0b	100.0a
Jatropha Oil 0.1ml	86.7de	100.0b	100.0a
Jatropha Oil 0.2ml	100.0e	100.0b	100.0a
Untreated control	0.0a	13.3a	90.a
Pirimiphos methyl 0.4ml	100.0e	100.0b	100.0a
SEM	8.9	9.6	3.9

Values with the same letter in the same column are not significantly different at P=0.05

For the Choice test, no egg was laid on cowpea seeds treated with Pirimiphos methyl, Jatropha seed oil both at lowest 0.05ml and highest 0.2ml rates compared with untreated control (Table 2a). This can be attributed to the fact that the introduced insects died within 24hrs after treatment suggesting that the treatment had effect on contact with the insects thereby hindering egg laying. This was in agreement with (Babatunde et al., 2021) who indicated that cashew nut extract reduced progeny emergence as well as reducing the damage on cowpea seeds by *C. maculatus*. For no choice test, eggs were laid on the cowpea with seeds treated with pirimiphos methyl when compared with untreated control (Table 2b). In the no choice test, eggs were laid on cowpea seeds treated with Jatropha seed oil 0.2ml but not as much as Jatropha seed powder 0.3g and untreated control (Table 2b).

Table 2a. Effects of different rates of treatments on oviposition of *A. obtectus* choice test

Treatments	**Mean number of eggs Laid**	**Mean number of seeds oviposited**
Jatropha powder 0.1g	1.7b	0.7b
Jatropha powder 0.3g	1.0ab	0.7b
Jatropha Oil 0.05ml	0.0a	0.0a
Jatropha Oil 0.2ml	0.0a	0.0a
Untreated control	1.7b	1.0b
Pirimiphos methyl 0.4ml	0.0a	0.0a
SEM	0.5	0.2

Values with the same letter in the same column are not significantly different at P=0.05

Table 2b. Effects of different rates of treatments on oviposition of *A. obtectus* (no choice test)

Treatments	**Mean number of eggs Laid**	**Mean number of seeds oviposited**
Jatropha powder 0.3g	38.0bc	6.0a
Jatropha Oil 0.2ml	14.3ab	4.0a
Untreated control	52.7c	6.0a
Pirimiphos methyl 0.4ml	0.0a	0.0a
SEM	9.2	0.8

Values with the same letter in the same column are not significantly different at P=0.05

Table 3a shows that cowpea seeds treated with pirimiphos methyl 0.4ml and Jatropha seed oil 0.2ml had the highest percentage of undamaged seeds (zero damage) when compared with untreated control. Jatropha powder also offered some measure of protection against *A. obtectus* on stored cowpea seeds as Jatropha seed powder 0.3g had the lowest percentage number of seeds with holes and therefore offered the highest protection followed by as Jatropha seed powder 0.2g and 0.1g as compared with control. This indicates that at high rate, Jatropha seed powder was more effective and reduction in damage may be due to fact that fewer eggs were laid on cowpea seeds giving a few population of next generation, hence damage was reduced. This corroborate (Musa and Sulyman 2014) who reported aqueous peel extracts of grapefruit and lime reduced number of eggs, progeny emergence and the seeds were not riddled with holes and also believe that applications demonstrated inhibitory effects on *C. maculatus* development.

There was weight reduction in all cowpea seeds treated with the three rates of Jatropha powder 0.1g, 0.2g and 0.3g and their weight were compared with control which shows that Jatropha powder was not as effective as Jatropha oil in protecting cowpea seeds against *A. obtectus.*

There was no weight reduction for the cowpea seeds treated with Jatropha oil as compared with control indicating that Jatropha oil was very effective in protecting cowpea seeds against damage (Table 3b)

Table 3a. Effects of different rates of treatments on seed damage on percentage seeds with and without hole.

Percentage Number of seeds with and without hole					
Treatments	**0 Hole**	**1 Hole**	**2 Holes**	**3 Holes**	**4 Hole and above**
Jatropha Powder 0.1g	53.5a	29.8b	11.3bc	4.3b	1.1a
Jatropha Powder 0.2g	72.2a	19.8ab	5.1ab	1.8ab	1.1a
Jatropha Powder 0.3g	74.0a	18.4ab	5.8ab	1.5ab	0.4a
Jatropha Oil 0.05ml	99.6b	0.4a	0.0a	0.0a	0.0a
Jatropha Oil 0.1ml	100.0b	0.0a	0.0a	0.0a	0.0a
Jatropha Oil 0.2ml	100.0b	0.0a	0.0a	0.0a	0.0a
Untreated Control	53.1a	27.3ab	13.9c	3.6a	2.1a
Pirimiphos Methyl 0.4ml	100.0b	0.0a	0.0a	0.0a	0.0a
S.E	6.3	3.5	2.1	1.1	0.7
Control S.E	7.8	4.1	2.6	1.4	0.8

Values with the same letter in the same column are not significantly different at P=0.05

Table 3b. Effects of different rates of treatments on weight of cowpea seeds after damage by *C. maculatus*

Treatments	**Initial Weight**	**Current Weight**	**% Weight Loss/Weight Gain**
Jatropha Powder 0.1g	20.0	17.7ab	11.5
Jatropha Powder 0.2g	20.0	16.9a	15.5
Jatropha Powder 0.3g	20.0	16.9a	15.5
Jatropha Oil 0.05ml	20.0	21.3c	6.7
Jatropha Oil 0.1ml	20.0	22.0c	10.0
Jatropha Oil 0.2ml	20.0	20.1bc	0.5
Untreated Control	20.0	17.0a	15.0
Pirimiphos Methyl 0.4ml	20.0	20.0abc	0.0
S.E	0.0	0.9	
Control S.E	0.0	1.1	

Values with the same letter in the same column are not significantly different at P=0.05

On the whole, germination was hindered for Pirimiphos methyl and Jatropha oil 0.2ml indicating that Jatropha oil to be used in preservation must be of low concentration because high concentration may lead to reduced germination. Jatropha powder did not affect germination of seeds. Germination was prolonged for the oils than the powder and more prolonged for the powder than the untreated control (Table 4a and 4b).

Table 4a. Effects of different rates of treatments on germination of cowpea seeds after 3 months of storage

Percentage Number of Seeds with Radicle				
Treatments	**@ 24 Hours**	**@ 48 Hours**	**@ 72 Hours**	**@ 96 Hours**
Jatropha powder 0.1g	6.7ab	43.3cd	83.3c	93.3cd
Jatropha powder 0.2g	6.7ab	33.3bcd	76.7bc	96.7d
Jatropha powder 0.3g	3.3a	40.0cd	66.7bc	86.7bcd
Jatropha Oil 0.05ml	0.0a	23.3abc	56.7b	66.7b
Jatropha Oil 0.1ml	3.3a	30.0bc	56.7b	70.0bc
Jatropha Oil 0.2ml	0.0a	6.7a	53.3b	66.7b
Untreated control	16.7b	53.3d	83.3c	96.7d
Pirimiphos methyl 0.4ml	0.0a	16.7ab	30.0a	33.3a
S.E	3.3	7.1	7.2	8.0

Values with the same letter in the same column are not significantly different at P=0.05

Table 4b. Effects of different rates of Treatments on Germination of Cowpea Seeds after 3 months of Storage

Percentage Number of Seeds with Radicle, Root Hairs, Hypocotyl and Primary leaves @ 96 Hours			
Treatments	**Percentage Radicle and Root Hairs**	**Percentage Hypocotyl**	**Percentage Primary leaves**
Jatropha powder 0.1g	60.0bc	60.0bc	16.7bc
Jatropha powder 0.2g	66.7bc	53.3abc	3.3ab
Jatropha powder 0.3g	53.3bc	53.3abc	6.7bc
Jatropha Oil 0.05ml	53.3bc	50.0abc	10.0abc
Jatropha Oil 0.1ml	53.3bc	53.3abc	10.0abc
Jatropha Oil 0.2ml	43.3ab	36.7ab	0.0a
Untreated control	76.7c	76.7c	20.0c
Pirimiphos methyl 0.4ml	23.3a	23.3a	0.0a
S.E	8.5	9.1	4.1

Values with the same letter in the same column are not significantly different at P=0.05

4. Conclusions

Numerous researchers have undertaken investigations to identify plants with insecticidal properties that can effectively manage pests impacting food crops. This approach seeks to reduce dependence on synthetic insecticides, which may contribute to pest resistance, pose health risks, and lead to environmental degradation. One study specifically assessed the efficacy of seed powder and oil from Jatropha curcas in controlling post-harvest losses caused by the cowpea weevil, Acanthoscelides obtectus. The findings revealed that both Jatropha curcas seed powder and oil significantly reduce populations of Acanthoscelides obtectus. When applied at higher doses—0.3 grams for the seed powder and 0.2 milliliters for the oil—these treatments notably diminished beetle infestation and seed damage, demonstrating effectiveness comparable to that of the synthetic insecticide Pirimiphos-methyl. Consequently, products derived from Jatropha curcas offer a sustainable and environmentally friendly alternative for protecting stored cowpea from insect pests. The study recommends further research into the formulation and large-scale application of these treatments.

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