

# Efficacy of aqueous leaf extracts and synthetic insecticide on pod-sucking bugs infestation of cowpea (*Vigna unguiculata* (L.) Walp) in the Guinea Savanna Region of Nigeria

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## ABSTRACT

Pod-sucking bugs (PSBs) infestation by *Anoplocnemis* sp./*Riptortus* sp./*Clavigralla* sp./*Nezara viridula* (Linnaeus) greatly limits cowpea (*Vigna unguiculata* (L.) Walp) production throughout sub-Saharan Africa. The efficacy of aqueous leaf extracts (ALEs) (5 percent weight/volume concentration) of three botanicals and one synthetic insecticide against PSBs infestation was thus evaluated. The botanicals tested include *Azadirachta indica* A. Juss, *Chromolaena odorata* (L.) and *Ricinus communis* (L.), whilst the synthetic insecticide was Uppercot 500 EC (Lambda cyhalothrin 30 g + Dimethoate 250 g). The effects of these treatments on the number of PSBs/pods/seeds, pod/seed weight and grain yield were assessed during 2008 and 2009 rainy seasons in Bayo, Borno State, Guinea Savanna region, Nigeria. The number of PSBs was lower on crops treated with Uppercot 500 EC (0.00 - 0.31). This was followed by crops treated with the ALEs of *A. indica*/*C. odorata* (0.31 - 1.33) and *R. communis* (0.72 - 3.72) than the untreated (3.06 - 5.64) ones. The number of pods/pod weight per plant, seeds/seed weight per pod and total grain yield were generally higher on cowpea crops treated with Uppercot 500 EC (26/17 g, 14/19 g and 1618 kg). This was followed by crops treated with the ALEs of *A. indica*/*C. odorata* (23 - 25/14 - 15 g, 12 - 13/15 g and 1268 - 1310 kg) and *R. communis* (21/13 g, 11/14 g and 972 kg) than the untreated (16/9 g, 7/10 g and 312 kg) ones. Although Uppercot 500 EC was most effective in protecting cowpea against PSBs attack, the ALEs

of *A. indica* and *C. odorata* appreciably protected treated crops against infestation, giving relatively high total grain yield. Both botanicals can thus serve as alternatives to synthetic insecticides for managing PSBs attack on cowpea.

**Keywords:** Cowpea; Pod-Sucking Bugs; Infestation; Aqueous Leaf Extract; Synthetic Insecticide; Grain Yield

## 1. INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important leguminous crops widely grown in the tropics, especially in the savanna zones of West Africa and other drier regions of the world [1,2]. Cowpea is a primary source of plant protein for humans, as well as fodder for livestock. It also serves as a cover crop, important for nitrogen fixation [3].

Majority of people in the developing countries including Nigeria are engaged in cowpea production, but with low productivity mainly due to insect pest attack at flowering and post-flowering (podding) stages [4-6]. Attacks by post-flowering insect pests contribute greatly to low cowpea production in the savanna region of northern Nigeria [5-9]. Damage arising from flowering and podding insect pests such as the pod borers and pod-sucking bugs (PSBs) often leads to severe losses of cowpea grains in the field [10,11]. The control of infestation by these pests should therefore improve or raise cowpea production by several folds in the northern savanna regions of Nigeria.

Due to the generally high cost of synthetic insecticides and their hazardous impact on the environment and human applicators, biopesticides are much more preferred

for insect pest control [12,13]. Plant extracts effective in managing insect pest attacks can therefore serve as alternatives to synthetic insecticides application [5,6]. This study therefore evaluated the efficacy of aqueous leaf extracts (ALEs) of three plant species including neem (*Azadirachta indica* A. Juss), Siam weed (*Chromolaena odorata* (L.)) and castor bean (*Ricinus communis* (L.)) in controlling PSBs infestation of cowpea in Bayo, Borno State, Guinea Savanna Region, Nigeria.

## 2. MATERIALS AND METHODS

### 2.1. Location

Field studies were carried out during 2008 and 2009 rainy seasons at the Borno State Agricultural Development Programme (BOSADP) research sub-station in Briyel, Bayo Local Government Area (11°51'N and 13°15'E), Borno State, situated in the Guinea Savanna region of Nigeria.

### 2.2. Collection of Materials and Preparation of Extracts

Seeds of the early maturing cowpea variety, Banjiram, with red seed coat colour were purchased from BOSADP. Fresh and clean leaves of the botanicals neem, Siam weed and castor bean were obtained from different farms in Briyel, Bayo Local Government Area. The synthetic insecticide, Uppercot 500 Emulsifiable Concentrate (EC) (Lambda cyhalothrin 30 g + Dimethoate 250 g), used in this study was obtained from the agro-chemical distributor, African Cotton Company Limited (AFCOTT), in Maiduguri, Borno State.

The fresh and clean plant leaves obtained were pounded into a paste using pestle and mortar. Five gram (g) paste of each plant material (neem, Siam weed and castor bean) was weighed and poured into a 5000 milliliters (ml) conical flask containing one liter of distilled water. The mixture (paste and water) was manually stirred vigorously for ten minutes and then sieved after two hours using a Muslin cloth to get the 5 per cent (%) weight (w) of paste per volume (v) of water concentration (w/v) extract [14,15].

### 2.3. Experimentation

The field was cleared, ploughed, harrowed and ridged at 0.75 meters (m) apart, and afterwards divided into plots separated by an alley of 2.0 m apart. Each plot was 4.0 m × 3.0 m (12.0 m<sup>2</sup>). Cowpea seeds were sown at 2 - 3 centimeters (cm) depth, and also at 30 cm intra row and 75 cm inter row spacing. Each treatment was replicated four times and the entire field laid out in a randomized complete block design. Weeding was done using hand hoe, and carried out at three weeks interval.

Uppercot 500 EC (1.5 g active ingredient/hectare) and the ALEs (5% w/v concentration) of *A. indica*, *C. odorata* and *R. communis* were applied fortnightly using the Knapsack sprayer, CP 15. Application of the above test materials commenced with the onset of podding, and was maintained fortnightly when the previous application(s) must have waned off. Each plot was sprayed with a single designated test material. The number of PSBs found on ten randomly selected plants per plot was counted at two, four, six and eight days after application (DAA). The number of pods harvested per plant were counted, and then weighed (g) with a Mettler balance. Following the shelling and winnowing of harvested pods, the number of seeds per pod were also counted and weighed as described above.

### 2.4. Data Analysis

Data collected on the number of PSBs, pods and seeds, as well as the weight of pods, seeds and total grain yield were subjected to the analysis of variance (ANOVA). The means of the treatments were separated using the least significant difference (LSD) at 5% level of probability as described by Gomez and Gomez [16].

## 3. RESULTS AND DISCUSSION

The number of PSBs found attacking cowpea crops per plot during the podding stage are presented in **Table 1**. The results showed that at two, four, six and eight DAA, the mean numbers of PSBs per plot was higher on untreated (3 - 6) cowpea crops. This was followed by those treated with the ALEs of *R. communis* (1 - 4), *A. indica* or *C. odorata* (0 - 1) and lower on those treated with Uppercot 500 EC (0). Also, the mean number of PSBs at two to eight DAA was 1 - 6/2 - 4/4 - 5/4 - 10 times higher on cowpea treated with the ALEs of *A. indica*, *C. odorata* and *R. communis* than the untreated crops. Furthermore, the mean number of PSBs was 4 - 10

**Table 1.** Effect of three aqueous leaf extracts and Uppercot 500 EC on the mean number of pod-sucking bugs per plot at different days after application.

Treatment	Number of pod-sucking bugs/plot			
	2 DAA <sup>1</sup>	4 DAA	6 DAA	8 DAA
<i>Chromolaena odorata</i>	0.36	0.67	0.67	1.32
<i>Azadirachta indica</i>	0.31	0.67	0.88	1.33
<i>Ricinus communis</i>	0.72	0.78	2.67	3.72
Uppercot 500 EC <sup>2</sup>	0.01	0.00	0.00	0.31
Control	3.06	3.09	3.82	5.64
Standard Error (±)	0.03	0.02	0.03	0.04
Least Significant Difference (0.05)	0.05	0.04	0.06	0.08

<sup>1</sup>Days after application; <sup>2</sup>Emulsifiable Concentrate.

and 2 - 3 times less at different DAA on cowpea crops treated with *A. indica* and *C. odorata* than with *R. communis* and also untreated crops. Though, the ALEs of all three botanicals contributed in reducing the number of PSBs on treated cowpea, the extracts of *A. indica* and *C. odorata* were relatively more effective against crops infestation. The ALEs of the two botanicals, therefore, seem to have potent insecticidal properties for checking PSBs infestation and population increase. Botanical insecticides contain compounds with properties that repel, deter or disrupt the growth, feeding or reproductive activities of insect pest on crops [5,6,10]. Azadirachtin, a triterpenoid substance from the *A. indica* plant has been generally reported to have repellent, antifeedant, growth inhibitory and toxic or insecticidal activities against a number of insect pests [17]. [18], for instance, found that 1% and 3% oil emulsion spray of *A. indica* on rice respectively reduced the incidence of *Cnaphalocrocis medinalis* and protected developing grains against *Leptocorisa acuta*. Oil (5%) sprays of *A. indica* plus its kernel extracts (39%) have been reported to effectively reduce the population of *Helicoverpa armigera* in chickpea [19]. The usage of Nemidin-9, an *A. indica* (70%)-based formulation, also inhibited larval development of *H. armigera* in chickpea [20]. Phytochemical studies by Matur and Davou [21] showed that the insecticide, Chlopyrifos, and also ALEs of *C. odorata* (<1 mg/mL) recorded 100% larval mortality of *Simulium* spp. Similarly, the mortality of *Sitophilus zeamais* Motsch. on maize due to dried and pulverized leaves of *C. odorata* (66% - 75%) compared appreciably to that caused by the insecticide, Actellic dust (75%) [22]. In evaluating the bioactivity of *C. odorata*, [23] found that its ALEs was very strongly positively correlated with the progeny production of *S. zeamais* and grain weight loss in maize. Insecticidal or acaricidal and antimicrobial agents including quercetin, gallic acid, flavone or kaempferol responsible for pest repellence, deterrence or toxicity have specifically been isolated from the *R. communis* plant [24,25]. Ingestion and contact of the oil emulsion (10%) of *R. communis* by *P. xylostella* larvae on cabbage resulted in 100% mortality, and also strongly deterred oviposition (<20 total eggs) 5 DAA [26]. Sorghum seeds treated with hydraulic and ethanolic seed extracts of *R. communis* (0.1 - 0.5 ml/5g seed) repelled 80% of *Tribolium castaneum* Herbst adults and also caused 100% larval mortality 3 DAA [27]. Also, in killing 48% - 60% diazinon, deltamethrin and multi-acaricide resistant cattle ticks, *Rhipicephalus microplus*, the leaf extract of *R. communis* proved to be considerably effective against organophosphate and pyrethroid resistant ticks [25]. Similar to our results, however, other studies have also found the extracts of *R. communis* to be slightly efficacious against certain insect pests. Egg hatchability of *Brontispa longissima* Gestro, 7

DAA of *R. communis* extracts was higher (70%) than when treated with *Celosia argeneae* L. and *Mikania micrantha* H.B.K. (44% - 54%) [28]. The treatment of *Agave tequilana* Weber with hydroethanoholic extracts (0.1 - 100,000 ppm) of the leaves/seeds of *R. communis* against *Scyphophorus acupunctatus*, likewise showed no significant effects on adult mortality and weight loss changes [29]. Altogether, these suggest that the efficacy of *R. communis* at least varies with insect species or the developmental stage, and also the formulation type or combination and concentration tested.

Results of the number of pods harvested and pod weight per plant are presented in **Table 2**. The number of pods and pod weight produced were higher from cowpea treated with Uppercot 500 EC (26 and 17 g). This was followed by those treated with the ALEs of *A. indica* or *C. odorata* (23 - 25 and 14 - 15 g), *R. communis* (21 and 13 g), and lower on untreated (16 and 9 g) crops. The results of the number of seeds obtained or seed weight per pod and total grain yield are presented in **Table 3**. Similar to the above trend, the number of seeds and seed weight per pod was greater from cowpea treated with Uppercot 500 EC (14 and 19 g). This was followed by crops treated with the ALEs of *A. indica* or *C. odorata* (12 and 15 g), *R. communis* (11 and 14 g) than those from untreated (4 and 10 g) ones. Total yield obtained was three (*R. communis* (972 kg)), four (*C. odorata* (1310 kg) and *A. indica* (1268 kg)) and five (Uppercot 500 EC (1618 kg)) times higher from treated than untreated (312 kg) cowpea crops. The overall, lower number and weight of pods/seeds and total grain yield obtained from untreated cowpea crops indicate greater damage due to attack by the PSBs. Greater general yield of cowpea pods/seeds/total grains obtained from crops treated with both synthetic and botanical insecticides was attributed to the reduction of PSBs infestation or population and feeding activities on these crops [11,30]. PSBs feeding during the early podding stages of cowpea often lead to pod abortion/shriveling or seed damage [31], that culminates in poor pod or -seed set and decreased crop yield. Taken together, the results show that the PSBs remain very

**Table 2.** Effect of three aqueous leaf extracts and Uppercot 500 EC on the mean number of pods and pod weight per plant.

Treatment	Number of pods/plant	Pod weight (g)/plant
<i>Chromolaena odorata</i>	23.33	14.30
<i>Azadirachta indica</i>	25.02	15.29
<i>Ricinus communis</i>	20.88	12.52
Uppercot 500EC <sup>1</sup>	26.08	17.33
Control	15.67	8.85
Standard Error (±)	0.04	0.05
Least Significant Difference (0.05)	0.08	0.10

<sup>1</sup>Emulsifiable Concentrate.

**Table 3.** Effect of three aqueous leaf extracts and Uppercot 500 EC on the mean number of seeds and seed weight per pod, and total grain yield of cowpea.

Treatment	Number of seeds /pod	Seed weight (g)/pod	Grain yield (kg/ha)
<i>Chromolaena odorata</i>	12.08	14.61	1267.96
<i>Azadirachta indica</i>	12.67	15.33	1310.41
<i>Ricinus communis</i>	10.62	14.38	971.85
Uppercot 500EC <sup>1</sup>	14.02	19.33	1617.62
Control	6.84	10.17	311.70
Standard Error (±)	0.06	0.31	16.74
Least Significant Difference (0.05)	0.12	0.67	36.48

<sup>1</sup>Emulsifiable Concentrate.

important insect pests of the reproductive structures of cowpea crops in the savanna region of Northern Nigeria [5,6,8,11,14]. As such, it is imperative to protect the reproductive structures of cowpea crops with, *i.e.*, insecticides (synthetic or botanical) to aid obtain favorable crop yield. Without which, as in this study, cowpea crops may incur PSBs infestation and destruction severe enough to threaten good crop yield. The impact of insecticide spray regimes on insect abundance in cowpea crops grown in North Eastern Nigeria was for instance assessed by [9]. Findings obtained pointed out that the spraying of insecticides at the onset of the podding stage generally reduced insect pests infestation and pod or seed damage, and ultimately increased grain yield. The number of PSBs recorded was 2 - 3 and 4 - 9 times much less on cowpea crops treated with the ALEs of *A. indica* and *C. odorata* than with *R. communis* and untreated crops. The total grain yield of cowpea treated with the ALEs of *A. indica* or *C. odorata* and Uppercot 500 EC were 4 and 5 times respectively higher than those of untreated crops. Also, the total grain yield of cowpea crops treated with the ALEs of *A. indica* and *C. odorata* was 1.3 times higher than those treated with *R. communis*. Having performed better than *R. communis*, the ALEs of *A. indica* and *C. odorata* have proven to be appreciably effective against PSBs infestation, and as a result, can sustain greater crop yield. Both botanicals can therefore serve as alternatives to synthetic insecticides usage for managing the populations of PSBs on cowpea. Advantageously, these botanicals are readily available in the savanna region of Northern Nigeria. Also, being bio-degradable the bio-insecticides should be friendly or safe to the applicators, farmers, consumers and environment.

#### 4. CONCLUSION

In conclusion, the application of the ALEs of *A. indica* and *C. odorata* from the onset of podding and at fort-

nightly intervals, greatly reduced PSBs infestation of cowpea crops. This, in consequence, supported increased total grain yield, which was appreciably close to that from cowpea crops protected with the synthetic insecticide, Uppercot 500 EC. With better general performance than the ALE of *R. communis*, extracts of the above two botanicals can serve as alternatives to synthetic insecticides in checking PSBs infestation and destruction of cowpea crops.

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