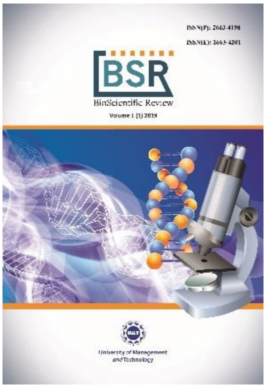

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Evaluation of Plants Extracts from *Capsicum annum* and *Allium sativum* against *Aphis craccivora* Attacking Cowpea Plant in Kano, Nigeria

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Abstract

The efficacy of *Capsicum annum* fruits and *Allium sativum* cloves methanolic crude extracts were evaluated on field for the control of *Aphis craccivora* attacking cowpea plants. Two cowpea genotypes (IAR-48 and IT97K-499-35) were planted separately in a randomized block design, for a cowpea genotype an experimental plots measured 5m x 3m with 1.5m space between plots was demarcated. The plot contained four subplots each measured 1.67m x 3m and replicated three times, given the total of twelve subplots. Within a subplot are three pairs of ridges (70cm apart) tallied with the three different concentrations (200, 600 and 1000ppm) for the plant extracts treatments application. Plant extract treatments along side with synthetic chemical insecticide (Magic force) as positive control were applied to the subplots using Knapsack sprayer 15 days after sowing. The results showed that the population scores of *A. craccivora* after treatments application on susceptible genotype IAR-48 was reduced significantly ($p < 0.05$) when compared with untreated control subplot. The least population scores of this insect on genotype IAR-48 was recorded in plants treated with *A. sativum* at 600ppm concentration level which was effective over positive control (synthetic chemical). The genotype IT97K-499-35 recorded no population aphid in plants treated with *A. sativum* at 200ppm concentration level which is also effective over the positive control. There is critical need to enhance the use of plant extracts scientifically on field as part of Integrated Pests Management for safe food production.

Keywords: *A. craccivora, C. annum, A. sativum,* cowpea

1. Introduction

Aphid belongs to order Homoptera, family Aphididae and genus *Aphis* [1]. The adults are medium-sized, shiny black, grayish-green or brown insect [1], whose biology varies depending on climate and soil. Adults can be winged (alate) or wingless (apterous) with black cauda and siphunculi and the antennae are two third of the body length [1]. They are gregarious insects, forming clusters on buds, flowers, green pods, stems and underside of leaves [2]. Cowpea aphid (*A. craccivora* Koch) is described as a major and economic pest of cowpea, feeds on the plant sap causing extensive damage to the crop [3]. The aphid as an important pest of legumes plant is distributed on all continents, except Antarctic continent [4]. In Nigeria the pest is more common in the Northern part, especially during dry spells when the population can increase rapidly [2]. This species has been reported among the most serious pests of cowpea worldwide, causing significant losses in yield by attacking young seedlings and pods of matured plants [5]. Yield losses due to aphids attack was estimated at 20-40 percent [6]. In Nigeria cowpea yield loss to insect pests infestation have been estimated to be above 80 percent [7]. In different forms aphid causes losses in seed yield and crop production both qualitatively and quantitatively, these include; directly decrease plant productivity due sucking of nutrients, virus transmission, phytotoxicity caused by saliva toxins and excretion of honeydew which leads to black sooty mold growth and shedding of leaves [8]. The honeydew also harbors saprophytic fungi which cover leaves surfaces and increases leaves ageing [9]. The control of this insect pest have been emphasized on the use of chemical insecticides by many researchers and farmers which the insect developed resistance to them and are hazardous to consumers health [10]. Currently, Plant base insecticides (PBIs) are of more interest in integrated pest management (IPM) strategies worldwide as a means to promote agricultural production, environment sustainability and human health [11]. The toxicity of *Capsicum* spp. on insects is thought to be the effects of secondary metabolites including alkaloids, saponins and flavonoids compounds of this plant [12]. The insecticidal and fungicidal properties of *A. sativum* are partly due to enzyme inhibition [13]. There is little information on the use of plant extracts on the field for the control of insect pests. Therefore, the present study was designed to evaluate the potentiality of extracts from *C. annum* and *A. sativum for* the control of *A. craccivora* as these plants are safe, environmental friendly and less likely to develop resistance by the insect when compared to chemical insecticide.

2. Materials and Methods

2.1. Study Site

Field study was conducted at the research farm of International Institute of Tropical Agriculture (IITA) Kano, situated at Wasai town, Minjibir Local Government Area (12^0 08'N: 07^0 38'E) [14]. The laboratory investigation was however conducted at the Department of Biology, Kano University of Science and Technology, Wudil.

2.2. Collection and Processing of Plant Materials

The chili pepper (*C. annuum*) fresh fruits and bulbs of garlic (*A. sativum*) were purchased from "Yankaba" market (12.0106^0N: 8.5806^0E), thoroughly washed to remove debris and the earth remains. Both the chili fruits and the garlic cloves were chopped into bits using vegetable grater (HAOCAI) and allowed to dry under shade [15].

2.3. Extraction of Plants Materials

The procedure of Zuharah *et al*, [16] was adopted for the extraction of plants materials with some slight modification. The plants powders were subjected to extraction using methanol (250ml, Sigma aldrich) in soxhlet apparatus. The apparatus was run for approximately three hours until the solvent from the siphon tube turned almost colourless. The procedure was repeated twice by replacing the powder for each cycle. The excess methanol from the crude extracts collected was evaporated using vacuum rotary evaporator (Model: RE52-3) at 64°C temperature of the water bath. The methanol from the concentrated crude extracts was further removed by placing them in electric oven at 65°C, six hours for two days. The stock solution was prepared in accordance with the procedure of Shrankhla *et al*. [17]. Two gram (2g) of the methanolic crude extracts of *C. annuum* and *A. sativum* weighed separately using analytical balance (OHAUS, Model: AdventureSL AS214) were dissolved in 100ml of Dimethyl Sulfoxide (DMSO) [18] to obtain a final concentration of 20000ppm as stock solutions. These stock solutions were stored at room temperature in laboratory until required for use and they were diluted with distilled water to prepare 600ml of the range of desired test concentrations viz 200, 600 and 1000ppm during the time of plant spray

2.4. Land Layout and Experimental Design

Two experimental plots were prepared and demarcated into 5m x 3m with 1.5m inter plot space. Each plot contained four subplots each with the measurement of 1.67m x 3m which were replicated three times in a randomized block design [19]. Within the subplots are three pairs of ridges (each 70cm apart) which tallied with 200ppm, 600ppm and 1000ppm concentrations respectively for the plant extracts treatments application. These treatments are *C. annuum* spray subplots, *A. sativum* spray subplots, Magic force spray subplots (positive control) and subplots without treatment. The two cowpea genotypes consisted of an improved medium maturing cowpea seed (68 days) IAR-48 susceptible to all major pests of cowpea [14] and IT97K-499-35 resistance to pests [20] obtained from IITA were planted separately on each experimental plot during the main planting season (July – October, 2015) at space of 30cm intra-row (within ridge) [21]. Three seeds were planted at the depth of 4-5cm per hole. The growing plants were thinned to two plants per stand, 10 days after emergence.

2.5. Treatments Application

The treatments (*C. annuum*, *A. sativum* and Magic force) were applied to various plots which were labeled with wood pegs using Knapsack sprayer [22] at 15 days after sowing (DAS) [1].

2.6. Determination of *A. craccivora* Infestation Level on Cowpea Genotypes After Treatments Application

The observations of *A. craccivora* infestation on five cowpea stands selected randomly from each pair of ridges were done according to the method of Asante *et al*. [14] with slight modification. The observation commenced 20 DAS, at 5 days interval. The level of infestation was assessed using the scale provided by Asante *et al*. [14] where (0 = no aphids; 1 = 1-4 aphids; 3 = 5-20 aphids; 5 = 21-100 aphids; 7 = 101-500 aphids and 9 > 500 aphids). The score obtained in each stand for all the three replicated subplots was recorded and two observations were made from each treatment.

2.7. Data Analyses

Data collected were subjected to two way analysis of variance (ANOVA). Where the ANOVA indicated significant difference, least significant difference (LSD) was used to separate means and t-test was carried out to compare the two mean population scores of *A. craccivora on* the two cowpea genotypes. All analyses were conducted with SigmaStat statistical software (version 3.5).

3. Results

The study assessed the efficacy of *C. annuum* and *A. sativum* crude extracts for the control *A. craccivora* attacking cowpea plants on field. Table 1 shows the mean population scores of *A. craccivora* on cowpea genotype IAR-48 under different treatments application and concentration levels. The plants treated with *A. sativum* at 600ppm concentration level had the least population score of *A. craccivora*. This was followed by 200 and 600ppm concentration levels of the *A.* sativum, C. *annuum* and positive control all of which recorded the same population scores. The highest significant ($p < 0.05$) score of *A. craccivora* was observed in untreated control.

Table 2 shows the mean population scores of *A. craccivora* on cowpea genotype IT97K-447-35 under different treatments application and concentration levels. *A. sativum* treated subplot at 200ppm concentration level recorded no population score of *A. craccivora*. This was followed by 600 and 1000ppm concentration levels of *A. sativum*, and positive control. *C. annuum* treated subplot at 1000ppm concentration had similar population score with untreated control subplot which was the highest. All treatments did not differ significantly ($p > 0.05$).

The comparison of the mean population scores of *A. craccivora* among the two cowpea genotype did not indicated any significant difference ($p > 0.05$). The genotype IAR-48 recorded highest population score of *craccivora* in untreated subplot and some level of *A. craccivora* population scores were also recorded among other treated subplots. Genotype IT97K-447-35 had population scores on subplots treated with *C. annuum* at all concentration levels and untreated control which are equivalent to those obtained on genotype IAR-48. No population score and fewer population scores were observed on subplots treated with *A. sativum* at 200, 600, 1000ppm and positive control (Table 3).

Table 1. Mean Population Scores of *A. craccivora* on Treated Cowpea Genotype IAR-48

Treatments	**Concentrations (ppm)**	**Mean score for *A. cracivora***
C. annuum	200	1.333 ± 1.333^b
	600	1.333 ± 0.882^b
	1000	1.667 ± 1.202^b
A. sativum	200	1.333 ± 0.882^b
	600	1.000 ± 0.000^b
	1000	1.332 ± 0.333^b
Positive Control	1207.5	1.333 ± 0.882^b
Untreated Control		5.333 ± 2.963^a
LSD		2.818

Mean ± standard error denoted with the same letter within the column are not significantly different from each other (LSD - least significant difference P<0.05), ppm - part per million

Table 2. Mean Population Scores of *A. cracivora* on Treated Cowpea Genotype IT97K-499-35

Treatments	**Concentrations (ppm)**	**Mean score for *A. cracivora***
C. annuum	200	1.667 ± 0.667^a
	600	1.667 ± 1.667^a
	1000	2.667 ± 2.667^a
A. sativum	200	0.000 ± 0.000^a
	600	0.333 ± 0.333^a
	1000	0.667 ± 0.333^b
Positive Control	1207.5	0.333 ± 0.333^a
Untreated Control		2.667 ± 2.186^a

Mean ± standard error denoted with the same letter within the column are not significantly different from each other, ppm - part per million

Table 3. Comparison of *A. cracivora* Mean Population Scores between the Two Treated Cowpea Genotypes IAR-48 and IT97K-499-35

Treatments	Concentrations (ppm)	Mean score for *A. cracivora*	
		IAR-48	**IT97K-499-35**
C. annuum	200	1.333	1.667
	600	1.333	1.667
	1000	1.667	2.667
A. sativum	200	1.333	0.000
	600	1.000	0.333
	1000	1.333	0.667
Positive Control	1207.5	1.333	0.333
Untreated Control		5.333	2.667
Mean ± standard error		1.833±0.504	1.250±0.377
Difference			0.583
t-test			0.927
p value			0.370

ppm - part per million

4. Discussion

The study demonstrated the potentials of *A. sativum* and *C. annuum* for the control of aphid infestation on cowpea plant. The extract of *A. sativum* was found to decrease the population of *A. craccivora* on insects' susceptible cowpea and no population was recorded on insects' resistant cowpea while extract of *C. annum* on the susceptible cowpea reduce the population of aphid equivalent to positive control. This is in agreement with the findings of Baidoo et al. [23] who reported that products of neem efficient in managing *A. craccivora*. Some extracts from plant decreases the population of several species of aphids triggering high mortality, reduces fecundity and inhibiting population growth [24]. Also Stoll [25] and Panhwar [26] reported independently that chili pepper, garlic and ginger extracts are good control agents of some insect pests of cowpea. At 200 and 600ppm concentrations *A. sativum* extract effectively reduced the population of the aphids on the two cowpea genotypes (IT97K-499-35 and IAR-48 respectively) over the synthetic chemical (positive control). In conformity with this Sohail *et al*. [27] reported that garlic extract (2%) concentration was effective against aphid with mortality of 75% on tea cuttings. Also Prasannath and Mahendran [28] disclosed that at 5% concentration neem seed extract reduced significantly the population of aphid. Cannabis extract significantly reduced aphid population lower than the insecticides treatment with 66.41% over control [10]. Both *L. javanica* and *S. delagoense* extracts had pesticidal effects on aphids on rape [29]. However, this could be due the active bio-principles in the extracts of these plant materials. The plants extracts treatments did not depend on cowpea genotype as there was no significant difference between the two genotypes. Field observation after the spray revealed that none of the plant extracts used in this study produce phototoxic effect on the leaves of the cowpea plants. This agreed with Ahmed *et al*. [30] who reported that field observations indicated that none of the plant extracts including that of chili pepper and garlic used produce any phototoxic on cowpea leaf. In contrast, Olaifa and Adenuga [31] reported that neem products caused yellowing and subsequent shedding of leaves. The efficacy of plant-based insecticidal application may be improved if it is sprayed either in early morning or in late evening [32].

5. Conclusion

The extract of *A. sativum* at the level of 200ppm concentration was found to be the most effective particularly on genotype IT97K-499-35 recording no population of *A. cracivora* over the synthetic chemical treatment. The materials of these plants are used in ethnobotany for the remedy of various ailments; they are therefore safe, inexpensive, breakdown easily and environmental friendly unlike the synthetic insecticide. The use of *A. sativum* extract is recommended for field spray against *A. cracivora* particularly on insect's resistant cowpea genotypes. Further research should also be carried out to isolate, identify and characterized the active ingredients of these extracts and their mode of action.

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