Field bioefficacy of plant extracts for the control of post flowering insect pests of cowpea (*Vigna unguiculata* (L.) Walp.) in Nigeria

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ABSTRACT

Field experiment was conducted at the Teaching and Research Farms of Abubakar Tafawa Balewa University, Bauchi, Nigeria during the rainy seasons of 2006. The objectives of the study were to determine the efficacy of six plant extracts (sweetsop, chilli pepper, garlic, ginger, neem and tobacco) against the insect pests of cowpea (variety IT86D-719) and their effects on yield. The experimental field was first ploughed, harrowed and ridged before the commencement of the planting season. Twenty one experimental plots were demarcated and arranged into seven treatment plots. The size of each plot was 4m x 3m while interspaces between adjacent plot and blocks were 1m and 2m, respectively. The level of control was assessed by calculating percentage control of each treatment. Results of the experiments showed that all the plant extract treatments were significantly better than control treatments. Similarly, yield results corresponded positively with the effectiveness of the treatments. Results of the present finding therefore, suggest the use of all the tested plant extracts particularly tobacco, sweetsop and garlic as they have been found to be very promising biopesticides in the control of cowpea insect pests in Bauchi, Nigeria.

Keywords: Cowpea pests, plant extract, efficacy evaluation, biopesticides

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp. is one of the most important leguminous crops that is widely grown throughout the tropics, especially in the savanna zone of West Africa and other parts of the world (Singh, 1990). Cowpea is highly palatable, very nutritious and relatively free of anti metabolites. The dried seed provides an inexpensive source of protein in many diets in the tropics and sub-tropics (Kay, 1979). The analysis of the grain shows that it contains 23-33% protein, 60-66% carbohydrate, 5-6% fibre, 4.4-3.7% ash and 1.1-3.0% oil (Bressani, 1985). In Africa, cowpea is consumed in different forms. (Bressani, 1985).

The residual plant material is used for feeding livestock (Kay, 1979). However, in spite of the high nutritional values and usefulness of cowpea, the plant is attacked by a wide range of insect pests, which significantly reduce the yield (Booker, 1965a; Saxena, 1978). Over 130 species of insect pests have been recorded on cowpea in West Africa and they attacked virtually every part of the crop including the roots, leaves, flowers and pods (Kayumbo, 1975; Kumar, 1984; Singh, 1985; Apeji, 1992). A loss of 45-52% has been recorded on cowpea in northern Nigeria during the flowering stage, followed by 21-26% during pod formation, 7-9% during pre-flowering and 2-3 % in the establishment stage (Raheja, 1976).

Singh and Singh (1976) also reported that in Africa grain yield of cowpea is very low at peasant level and ranges from 240 to 300kg/ha. However, grain yield of between 1,000 to 4,000kg/ha is possible under optimal condition if fields are protected against insect pests attack (Booker, 1965b; Jackai and Singh, 1984). To obtain reasonable cowpea yield therefore, regular application of pesticides to the crop in the field is very essential (Taylor, 1968). However, chemical insecticides have over the years proved to be toxic to our health and they pollute our environment, besides, they are very expensive. It is against this background and coupled with neglect of research for searching alternative methods of controlling the insect pests of cowpea that the present research was initiated to determine the efficacy of the six selected plant products in controlling insect pests and yield of the cowpea plant.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm of the Abubakar Tafawa Balewa University, Bauchi during the raining season of 2006. Twenty one experimental plots were demarcated (4m x 3m) and arranged into seven treatments. Interspaces between adjacent plots and blocks were 1m and 2m, respectively. The intra-row spacing and inter-row spacing were 20cm and 75cm, respectively. Before the commencement of

planting fields were ploughed, harrowed and ridged. Before sowing, about 2kg seeds IT86-D-79 were dressed/ treated with a sachet of apron plus. Pre-emergence herbicide (Galex (R)) was applied after sowing in order to control the menace of weeds. Supplementary hoe weeding and other agronomic practices of raising good cowpea plants were followed. Furthermore, single super phosphate fertilizer was broadcasted to each of the experimental plots at the rate of 25kg P_2O_5 active ingredient per hectare during harrowing (Dungum *et al.*, 2005). In addition benlate was applied at the rate of 0.33kg ai/ha to control fungal diseases.

Seeds of sweetsop, *Annona squamosa* Linn. (Annonaceae). and neem *Azadircata indica* were purchased from Muda Lawal markets in Bauchi metropolis and used for the experiment. Plant materials were independently washed thoroughly, dried under shade. Plant materials of *Annona* spp and neem were grounded using pestle and mortar (*Annona* spp. and neem) while others using blender machine and thereafter sieved using a mesh of 1.5mm for extraction. The extract was then mixed with appropriate quantity of water and allowed to stay overnight and then filtered through a clean white cloth. The solutions were independently sprayed on the plants using CP_3 knapsack sprayer (Oparaeke *et al.*, 2000a). No any treatment was applied for the control. The spraying of the cowpea plants was done at 3 (seedling stage), 6 (lowery stage) and 8 (podding stage) weeks after planting. All the spraying operations were carried out in a fairly calm weather conditions.

For the purpose of evaluating the effectiveness of the plant extracts, five stands from each plot were selected randomly from the central middle row and tagged for recording observation on insect pests. Pre-spray populations of insects were recorded and thereafter population was observed at 1,3,5,7 days after treatment application. The assessment of individual insect pests was done using plant infestation scale, which placed plant parts in different classes of infestation (Kumar, 1984). However, assessment of thrips, *Maruca* was done by removing 20 flowers at random from the five randomly selected plants. The flowers were then placed in vials containing 30% alcohol and taken to the laboratory where the flowers were dissected the next day and the number of thrips found was recorded (Amatobi, 1994). Similarly, assessment of seeds produced per pod was recorded from five randomly selected plants. Five pods were picked at random from these plants and the total number of seeds per pod were thereafter counted and finally divided by the number of pods sampled to get the average. The pods from each plot were then threshed separately, winnowed and grains weights were recorded accordingly. Yield data were converted to kilograms per hectare before analysis of variance. The seed yield of all the harvested pods were calculated using the following formula.(Raheja, 1976). Seed Yield (kg/ha) = a x 10,000/b x 10000

Where a = Plot yield and b = Net plot size

While yield loss was calculated using the Judenko (1973) formula of assessing yield loss in the field as shown below:

$AL = (a - b) \times NAT$

Where: AL = Actual loss, a = Mean yield per un-attacked plant, b = Mean yield per attacked plant, NAT = Number of attacked plant

All the data obtained were statistically analysed using the conventional two way ANOVA. Students Newmans Keuls (SNK) test was used to differentiate between and among the treatment means (SAS Institute, 1989). Similarly, percentage levels of control (pods) were calculated using the following formula (Kondap and Upadyayi, 1985).

TCE% = (a-b)/a x 100

Where: TCE = Treatment control efficiency, a = Dry pods in uncontrolled plot, b = Dry pods in controlled plot.

RESULTS

Table shows that population of *C. tomentosicollis* and *M. vitrata* before spraying were not significantly different from each other in all the treatments. However, after spraying the cowpea plant with the plant extracts, sweetsop, garlic, chilli pepper and tobacco treatments significantly ($p < 0.05$) reduced the population of *C. tomentosicollis* one day after application when compared to control. Similarly, the crude extract of chilli pepper, and tobacco treatments significantly ($P < 0.05$) reduced the population of *M. vitrata*, while sweetsop and ginger treatment substantially reduced the population of *M. vitrata* one day after application. However garlic and neem slightly reduce *M. vitrata* population.

Sweetsop and chilli pepper treatments significantly ($p<0.05$) reduced *C. tomentosicollis* population after 3 days compared to the untreated plots. However, garlic, ginger and tobacco treatments were not significantly different from each other. There were no significant reduction of *C. tomentosicollis* population both at 5 and 7 days post treatment among the various treatments except *A. squamos*. Similarly, sweetsop, chilli pepper, garlic, ginger, neem and tobacco extract treatments significantly ($p>0.05$) reduced the population of *M. vitrata* 3 days post treatment compared to the control. However, there were no significant ($p<0.05$) differences among the plant extract treatments at 5 and 7 days post treatment on the control of *M. vitrata* population.

Table 4 shows the effectiveness of various treatments on the population of insect pests of cowpea plant 24hrs after treatment. Sweetsop and ginger treatments caused a reduction on the population of *C. tomentosicollis* 24 hours after treatment application. Chilli pepper, garlic, neem and

Table 1. Effect of plant extracts on the population of some post flowering insect pests of cowpea plant, 24 hours post treatment during the 2005 planting season in Bauchi.

Treatments	C. *tomentosicollis*		*M. vitrata*	
	24 HBS	24 HAS	24 HBS	24 HAS
A. squamosa	0.67	0.01[a]	50.33	27.0[bc]
C. frutescence	2.3	0.7[ab]	41.33	22.67[a]
A. sativum	2.67	0.0a	53.33	29.67[c]
Z. officinale	4.0	3.7b	71.67	26.67[bc]
A. indica	2.7	2.67[ab]	59.33	24.67[ab]
N. tabacum	5.0	2.01[ab]	99.0	23.33[a]
Control	1.67	7.7[c]	72.67	43.33[d]
NSK (0.05)	NS	2.86	NS	2.48

HBS = Hours Before Spray, HAS = Hours After Spray, Means within a column followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($p<0.05$) test

tobacco extracts reduced substantially the population of *C. tomentosicollis* 24 hours post treatment application. Furthermore, tobacco extract treatment significantly ($p<0.05$) controlle the population of *A. curvipes* 24 hours post treatment application compared to neem treatment while chilli pepper, garlic, sweetsop, ginger and neem treatment were found to be less effective in controlling the population of *A. curvipes* 24 hours after spray application. However, sweetsop, neem, tobacco, chilli pepper, ginger and garlic showed no significant ($p>0.05$) differences in controlling the population of *M. vitrata* 24 hours post treatment.

Table 4 indicates the effect of insecticidal plant extracts at 3, 5 and 7 days after treatment against some pests of cowpea. Chilli pepper, tobacco, neem, garlic, ginger treatment gave significantly ($p<0.05$) better result in reducing the population of *C. tomentosicollis* at 3 days, post treatment compared to control treatment while ginger and garlic treatments significantly ($p<0.05$) reduced the population of *C. tomentosicollis* at 5 days, post treatment. Sweetsop, chilli pepper, garlic, ginger, neem and tobacco treatments indicated no significant ($p>0.05$) differences with control treatment in controlling the population of *A. curvipes* 5 and 7 days post treatment. However, sweetsop, ginger, neem and tobacco treatment significantly ($p<0.05$) controlled the population of *A. curvipes* at 3 days after spray application compared to chilli pepper and garlic treatment. Equally, sweetsop, chilli pepper, garlic, ginger neem and tobacco treatments did not show any significant ($p>0.05$) differences with the control treatments in the control of *M. vitrata* population at 3, 5 and 7 days after the post treatment. The effect of insecticidal plant extracts on seeds per pod, seed yield (kg/ha) and yield loss (kg/ha) of cowpea plant is presented in figure 1. The result shows that plant extracts treated plots were scientifically ($p<0.05$) better than control in terms of number of seeds/pod. However, plots treated with extract of tobacco was found to give higher number of seeds yield compared to other plant extract.

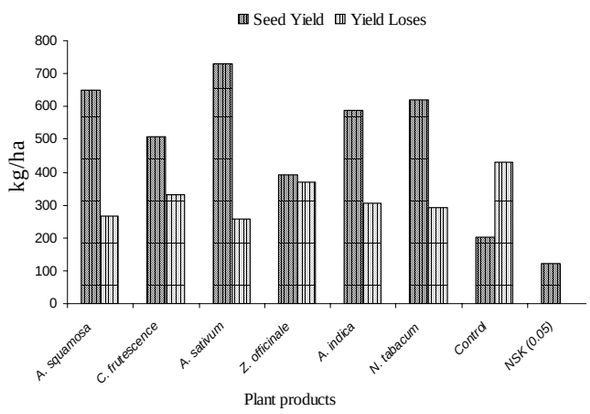

Figure 1. Effect of plant extracts on the yield and yield loss (kg/ha) of cowpea plant during the 2006 planting seasons

DISCUSSION

Statistical analysis of the result shows that application of plant extracts on cowpea plants at post flowering/podding

Table 2. Effect of plant extracts on the population of some post flowering insect pests of cowpea plant at 3, 5 and 7 days post treatment during the 2005 planting season in Bauchi.

Treatments	*C. tomentosicollis*			*M. vitrata*		
	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA
A. squamosa	0.01[a]	0.67	3.7[a]		34.7	21.67
C. frutescence	0.01[a]	1.0	0.7	26.7[a]	34.7	21.67
A. sativum	0.31ab	0.67	0.7	48.7[ab]	42.7	23.67
Z. offinale	0.3[ab]	1.33	0.4	10.7[a]	26.7	26.33
A. indica	0.67[ab]	0.67	1.0	14.7[a]	26.3	23.0
N. tabacum	1.0[ab]	0.33	1.4	16.4[a]	26.7	24.0
Control	2.0[b]	3.0	2.4	110.8[b]	40.0	9.3
NSK (0.05)	1.43	NS	NS	52.20	NS	NS

DPTA = Days Post Treatment, Means within a column followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($p<0.05$) test

stage of the plant significantly ($p<0.05$) reduced the population of the insect pests when compared with control. This result agrees with the findings of Amatobi (2000) who reported that crude extracts of cashew leaves and nuts at 10, 15 and 20% killed *A. craccivora*, *C. tomentosicollis, A. curvipes* and *M. vitrata* very quickly and reduced their population by about 70% compared to untreated control treatment. Furthermore, the result obtained during the experimental period showed that the plots treated with sweetsop and tobacco extracts gave significant ($p<0.05$) control of *C. tomentosicollis, M. vitrata,* and *A. curvipes* than control treatments. This result agrees with Mong and Sudderuddin (1978) who reported that neem, sweetsop and tobacco leaves extracts have been found to be toxic to *M. vitrata, C. tomentosicollis* and *Z. variegatus*. Plant extracts are known to possess toxic organic poison that is effective in reducing insect pest population (Fuglie, 1998; Gaby, 2000) including pod borer (William and Ambridge, 1996). However, several authors have shown the efficacy of different plant materials as biopesticides for the control of different pest of cowpea (Oparaeke *et al.*, 2000b; Okech *et al*., 1997; Oparaeke, 2004). Neem, West African black pepper, garlic bulb and African nutmeg, *Lippia adoensis* Hoschst have been reported to be effective against some crop pests species (Jackai and Oyediran, 1991; Oparaeke *et al*., 2000a) This result is in line with the findings of

Table 3. Effect of plant extracts on the infestation of some post flowering insect pests of cowpea plant, 24 hours post treatment during the 2005 planting season in Bauchi.

Treatments	*C. tomentosicollis*		*A. curvipes*		*M. vitrata*	
	24 HBS	24 HAS	24 HBS	24 HAS	24 HBS	24 HAS
A. squamosa	80.0	36.34[a]	4.0	0.33[a]	2.57	0.67
C. frutecence	86.67	42.0[a]	4.0	1.33[a]	1.33	1.67
A. sativum	117.33	62.0[a]	3.33	1.33[a]	2.33	2.33
Z. officinale	91.0	36.78[a]	4.0	0.33[a]	1.67	2.67
A. indica	154.33	62.0[a]	2.33	1.33[a]	2.67	0.67
N. tabacum	150.0	49.0[a]	4.33	0.0[a]	3.33	0.67
Control	166.33	161.67[b]	5.33	6.0[b]	2.67	3.67
NSK(0.05)	NS	60.98	NS	1.57	NS	NS

HBS = Hours Before Spray; Means within a column followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($p<0.05$) test, HAS = Hours After Spray

Table 4. Effect of plant extracts at 3,5 and 7 days after treatment on the infestation of some post flowering insect pests of cowpea plant during 2003 planting season in Bauchi.

Treatments	*C. tomentosicollis*			*A. curvipes*			*M. vitrata*		
	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA
A. squamosa	58[a]	61[a]	62.7	0.0[a]	3.67	1.0	12.0	27.0	11.6
C. frutecence	47[a]	44[a]	44.4	0.33[a]	2.0	0.0	4.7	26.67	15.0
A. sativum	1[a]	36[a]	36.4	0.33[a]	4.67	0.67	4.0	29.67	29.4
Z. offinale	76[a]	34[a]	34.4	0.0[a]	3.33	1.33	7.7	26.67	16.0
A. indica	52[a]	63[a]	63.0	0.0[a]	2.67	2.33	10.4	32.0	18.4
N. tabacum	56[a]	57[a]	63.0	0.0[a]	2.0	1.67	6.0	23.33	13.7
Control	144[b]	171[b]	84.7	3.0[b]	6.33	1.33	5.7	43.33	11.4
NSK(0.05)	24.28	26.97	NS	0.68	NS	NS	NS	NS	NS

DPTA = Days Post Treatment Application; Means within a column followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($p<0.05$) test

Stoll (1988) and Panhwar (2002) who independently reported that ginger, chilli pepper and garlic bulb are good biocontrol agents of some insect pests of cowpea.

Result of the present investigation clearly shows that, neem, garlic and ginger were more effective in controlling cowpea insect pests at podding stage than the other plant extracts. Neem, garlic and ginger extracts contain insecticidal properties that are lethal to a wide range of insects including *Maruca vitrata, M. sjostedti, Clavigralla tomentosicollis* and *O. phaseoli* (Stoll, 1988; Ostermanni, 1979; Oparaeke, 2007). Panhwar (2002) also reported that good aqueous solution of garlic, ginger and neem will effectively control worms, beetles and thrips in cowpea. Tobacco, sweetsop and chilli pepper were found to be less effective than neem, ginger and garlic extract in reducing cowpea pest population at podding growth stage. This confirmed the earlier work conducted by Gaby (1995) who reported that extracts of neem, garlic, ginger and chilli pepper prove to be less repellant in controlling the activities of insect pests of cowpea plant when compared to tobacco.

The yields obtained from plant extracts treated plots were significantly ($p<0.05$) higher than untreated control plots. This was in line with Panhwar (2002) and Fuglie (1998) who reported that plant extracts applied on field cowpea plants increased flower production per plant. Insect pests infestation on the field has been identified as the major obstacle to cowpea production. The experiments also showed that yield on plots treated with *A. squamos* was found to be significantly ($p<0.05$) better than chilli pepper treated plots (ginger, neem, and garlic). These results correspond positively with the earlier work conducted by previous researchers which showed that plant extracts increase the yield of vegetables and pea plants by protecting them from insect pests (Stoll, 1988; Panhwar, 2002; William and Ambridge, 1996). Similarly, Gaby (1988) showed that, application of plant extracts in powder or solution form significantly increased the yield of cowpea plants.

Fuglie (1998) showed that a timely application of the tobacco solution especially at the onset of flowering and pod formation prevented an initial build up of infestation pressure and consequently increases the yield of the crops. Grain yield losses were lower in plots treated with plant extracts (tobacco, sweetsop and garlic) when compared with control. This is possible because plant extracts were most effective against post flowering insect pests of cowpea plant. Panhwar (2002) reported that plant extracts application at flowering and pod formation stages reduced the level of infestation of insect pests and increased yield of plants. The results also supported the views of Stoll (1988) and Panhwar (2002) who independently reported that the effect of plant extracts on crops yield and yield component is dependent on the effectiveness of the individual plant extract. It would be desirable that economic threshold of the cowpea insect pests at flowering and podding stages be determined in order to make better use of plant extracts (Jackai *et al*., 1992).

Field observations indicated that none of the extracts used in this study produce any phototoxic on cowpea leaf. This contrast with the observation made by Olaifa and Adenuga (1998). They reported that neem products caused yellowing and subsequent shedding of leaves. The effectiveness of plant-based insecticidal application may be enhanced if it is sprayed either in early morning or in late evening (Oparaeke *et al*., 2003). Result of the experiment showed that all the tested plant extracts have potential value to substitute synthetic insecticides in pest management, because, they were found to be promising

in controlling the insect pests of cowpea. Although, the result strongly recommend the use of the entire tested plant extracts especially tobacco and sweetsop, extensive work on the appropriate concentration/dosage need to be worked out. There is also the need to further test the plant material to ascertain their effective dose and spraying schedules. Different plant parts, variety and age at harvest (Jone and Pagan, 1946), method of extraction, the age of the sample after preparation and storage condition (Tatterfield and Roach, 1923; Pagan *et al*., 1949) could affect the assessment of any plant materials as a biopesticides therefore, the need to standardize the above parameters is essential for effective exploitation of nature's endowment for the benefit of mankind. Recent studies of Bensen and Temple (2008) and Li *et al*. (2009) suggested various pest management practices for cowpea.

Research is also needed to identify, isolate and characterize the active ingredients responsible for insecticidal toxicity exhibited by plant materials (Oparaeke, 2004) and its mode of action. There is need to test the extract on other crop, which have similar pest complex as cowpea to verify the results obtained in this study for recommendation to farmers.

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