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Comparative Efficacy of Some Selected Plant Derived Biopesticides for the Control of Insect Pests of Cowpea (*Vigna unguiculata* (L.) Walp.) in Katsina State, Nigeria

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ABSTRACT Field trial was conducted at the Research Farm of the Katsina State Agricultural and Rural Development Authority during the farming season of 2004 with a view to evaluate/determine the efficacy of some selected plant-derived biopesticides against the insect pests of cowpea as well as their effect on yield. The variety of the cowpea used was IT86D-719 and the plant derived biopesticides evaluated during the trial were chilli pepper, garlic, ginger, neem, sweetsop and tobacco. The experimental field was ploughed, harrowed and thereafter ridged before the commencement of the 2004 planting season. A total of twenty one (21) experimental plots were demarcated and arranged into seven treatment plots. The size of each plot was 5m x 4m while interspaces between adjacent plot and blocks were 1m and 2 m, respectively. Results of the experiments showed that all the plant-derived biopesticide treatments were significantly ($p<0.05$) better than control treatment. The order of effectiveness of the treatments was tobacco (80-90%), sweetsop (75-85%), garlic (70-80), neem (72-78%), chilli pepper (60-70%) and ginger (30-50%). Furthermore, yield result corresponded positively with the effectiveness of the treatments. Results of the present finding suggest the use of tobacco, sweetsop and garlic as promising biopesticides in the control of cowpea insect pests.

Keywords : plant derived biopesticides, cowpea pests, efficacy and yield

Although, the center of origin of cowpea is not known it is however, believed to be widely cultivated all over the lowland areas of Africa, Asia and South America (Stelle and Mehra, 1980). Report from IITA (1983) clearly indicted that cowpea originated from West Africa specifically from the northern part of Nigeria. The claim that cowpea originated from West Africa is largely based on the fact that many of the wild species are found there (Singh *et al.*, 1983) but Padulosi *et al.* (1990) believed that cowpea originated from the Swaziland especially from the north-western region of the high belt, which shows a high degree of variability among population found there.

Cowpea production has been estimated at about 2-3 million metric tonnes from 7.7 million hectares. However, these are considered to be an under estimate of the real production level and total area cultivated, because cowpea are grown as multi-purpose crop on small farm holdings and much of the small-scale production is neither quantified nor included in crop production statistics (IITA, 1989).

Africa alone produces almost 95% of the world cowpea. The only developed country producing large quantity of cowpea is USA with a total annual production of about 60,000 metric tonnes (Dike and Mbah, 1992).

Currently, more than 70% of world cowpea production is concentrated in three countries: Nigeria, Brazil and Niger (IITA, 1989). Singh *et al.* (1983) reported that Nigeria produces about 0.9 million metric tones annually on 4.0 million hectares, most of which are from Katsina, Sokoto and Borno States.

Cowpea is used to a large extent for human consumption, to a lesser extent as green manure for improving soil fertility and many a times as a fodder crop for animal feeding (Akinyosoye, 1985). The immature pods are consumed by human being in different forms and in different localities. Occasionally, it may be planted as a cover crop on

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plantation or on fallow land (Onwueme, 1979). In addition, the cowpea plant being a legume, enriches the soil through nitrogen fixation in its root nodules. The estimated annual nitrogen fixation is reported to be 73-355 kg/ha, with a global average of 198 kg/ha (Duke, 1987).

However, despite the high nutritional values and usefulness of cowpea, the plant is attacked by a wide range of insect pests, which significantly lower 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 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 (1978) also reported that in Africa, grain yield of cowpea is very low on peasant farm ranging from 240 to 300 kg/ha. However, grain yield of between 1,000 to 4,000 kg/ha is possible under optimal condition if the cowpea plants are protected against insect pests attack (Booker, 1965b; Jackai and Singh, 1984).

Although, activities of these insect pests can be controlled by the application of chemical pesticides, however, public concerns over the use of the pesticides in agriculture and their effects on the environment are continuing to increase. For example, it is well known fact that many pesticides contaminate ground water and enter food chains that have an impact on a wide range of organisms; they also contaminate the atmosphere and soil particles. Further more, pesticides pose hazards to animal health and the user spraying the chemicals. These concerns have resulted in greater restriction on pesticides use and of course the desire for the development of sustainable, environmentally friendly strategies for the control of agricultural pests. The identification and screening of plant extracts for the control of insect pests of cowpea has over the years received significant amount of interest. In fact it was against this background that the present research project was initiated with the following objectives in view:

- To screen and determine the most effective plant derived biopesticides in controlling insect pests of cowpea plant.
- To determine the effects of these plant derived biopesticides on the yield and
- To determine losses caused by the insect pests on cowpea plant.

MATERIALS AND METHODS

Experimental design

The experiment was conducted at the Katsina State Agricultural Rural Development Authority (KTARDA) research farm during the raining seasons of 2004. During the trial, twenty one experimental plots were demarcated and arranged into seven treatment plots each with an average plot size of 5 m × 5 m. Each of the seven treatment plots was replicated three times in a randomize complete block design. Interspaces between adjacent plots and blocks were 1m and 2 m, respectively.

Land preparation, sowing, weeding and fertilizer application

Before the commencement of the planting season, the experimental field was ploughed, harrowed and ridged. Each plot was sown to cowpea variety IT86-D-79. Two seeds were sown per hole in order to avoid germination failure.

The intra-row spacing and inter-row spacing were 20 cm and 75 cm, respectively. However, before sowing, about 2 kg seeds were dressed/treated with a sachet of Apron plus. Pre-emergence herbicide (Galex®) 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 equally observed. Furthermore, single super phosphate fertilizer was applied in each of the experimental plots at the rate of 25 kg P_2O_5 active ingredient per hectare during harrowing (Dungum *et al.*, 2005). In addition, benlate was equally applied at the rate of 0.33 kg ai/ha to control fungal diseases.

Treatment composition

All the plant materials were purchased from Katsina

Central Market located in Katsina metropolis. Table 1 shows the list of the plants and their parts used during the experiment.

Preparation and application of the plant materials

Annona spp: Fresh seeds were collected from the fruits of matured annona plant, washed thoroughly, and dried under shade and thereafter grounded using pestle and mortar. This was finally sieved using a mesh of 1.5mm to produce an extract. About 15.0% of the extract of annona was diluted in 15 liters of water, mixed and sprayed on the three plots using CP_3 knapsack sprayer (Oparaeke *et al.*, 2000).

Chilli pepper: Hot chilli pepper was dried under the sun and grounded into powder using a blender machine. 15.0% of crude extract was added to 15 liters of water and allowed to stay over night. After filtering through a white cloth, the solution was then sprayed on the plants using CP_3 knapsack sprayer (Conacher, 1980).

Garlic: Garlic bulbs were dried under the sun and grinded using blender machine to produce an extract. Thereafter 15.0% of the crude extract was then diluted in 15 liters of water and sprayed on the plants using CP_3 knapsack sprayer (Oparaeke *et al.*, 2003).

Ginger: Rhizomes were acquired and dried under the sun, thereafter grounded and made into a paste. Finally, 15.0% of the extracted rhizomes paste was added to 15 liters of water, then filtered through a clean cloth and sprayed on the cowpea plants using CP_3 knapsack sprayer (Oparaeke *et al.*, 2005).

Neem seed: Matured neem seeds were collected, washed thoroughly and dried under the shade, then grinded using a blender machine into powder. Thereafter, 15.0% of the powder was suspended into 15 liters of water and left over night. This was later filtered through a clean white cloth and sprayed on plants using CP_3 knapsack sprayer (Oparaeke *et al.*, 2005).

Tobacco: Fresh tobacco leaves were collected, washed thoroughly and dried under the shade. The dried leaves were grinded into fine powder using blender machine. 15.0% extract of the tobacco leaves powder was soaked in 15 liters of water for 24 hours and sprayed on each of the three plots using a CP_3 knapsack sprayer (Oparaeke *et al.*, 2005).

Control: No treatment was applied.

Note

Spraying of the plant derived biopesticides on the cowpea plants was done at three different intervals i.e. 3, 7 and 8 weeks after planting when the plants were at vegetative, flowering and podding growth stages, respectively. However, after the application of each plant extract, the CP_3 knapsack sprayer was washed thoroughly in order to avoid contaminating the next plant derived biopesticides to be sprayed. All the spraying operations were carried out in a fairly calm weather conditions to avoid drifting of plant derived biopesticides to the adjacent plots. In addition, all the spraying operations were conducted early in the morning when the targeted insect pests were available and less active.

Table 1. Experimental Plants and Plant Parts Used

Treatment No	Insecticidal plants and their scientific names	Family	Plant parts used
T1	Sweetsop (*Annona squamosa* L.)	Annonaceae	Seeds
T2	Chilli pepper (*Capsicum frutescence* L.)	Solanaceae	Pepper fruit
T3	Garlic (*Allium sativum* L.)	Alliaceae	Bulb
T4	Ginger (*Zingiber officinale* L.)	Zingiberaceae	Rhizome
T5	Neem (*Azadirachta indica* A. Juss.)	Meliaceae	Seeds
T6	Tobacco (*Nicotiana tabacum* L.)	Solanaceae	Leaves
T7	Control	-	-

Evaluation of the efficacy of plant derived biopesticides

For the purpose of evaluating the effectiveness of the plant derived biopesticides, the following parameters were assessed during the field study.

Assessment of insect pests population

Five stands were selected randomly from the central middle row of each plot and tagged for recording observation on the insect pests. Pre-spray population of insects was taken and thereafter population of the insects 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 achieved by removing 20 flowers at random from the five randomly selected plants located within the central middle row of each plot. The randomly collected flowers were placed in a vials containing 30% alcohol and taken to the laboratory where the flowers were dissected the next day and the number of thrips found were recorded accordingly (Amatobi, 1994).

Assessment of seeds produced per pod

Assessment of seeds produced per pod was achieved by utilizing the earlier randomly selected plants. Five pods were picked from the five randomly selected 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.

Assessment of yield

Harvesting of dried pods started on 11^{th} November 2004, when the plant leaves had virtually turned yellowish and almost all the pods were fully dried. During the harvesting, two middle rows were selected and pods were picked in each plot within 24 hours. All the pods were placed in separate polythene bags. The bags were then labeled according to the treatment and weights of harvested pods were recorded accordingly. The pods from each plot were threshed separately, winnowed and grains weights were recorded accordingly. The seed yield of all the harvested pods were calculated using the following formula (Raheja, 1976).

$$\text{Seed Yield (kg/ha)} = \frac{a \times 10{,}000}{b \times 1{,}000}$$

Where

a = Plot yield

b = Net plot size

Assessment of yield loss and level of controls

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

Similarly, the percentage level of control (pods) was calculated using the following formula (Kondap and Upadyayi, 1985).

$$TCE\% = (a - b)/a \times 100$$

Where:

TCE = Treatment control efficiency

a = Dry pods in uncontrolled plot.

b = Dry pods in controlled plot.

Data analysis

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, 1990).

RESULTS

Table 2 shows the effect of application of plant derived biopesticides on the population of some cowpea insect pests at seedling stage 24 hrs after spraying. Sweetsop treatment gave significantly (p<0.05) better control of *A. craccivora* 24 hours post treatment when compared with the control treatment. Equally, ginger, chilli pepper, garlic, neem and tobacco treatments reduced the population of *A. craccivora* 24 hours post treatment, but they do not differ significantly (p<0.05) from each other. Similarly, no significant differences (p<0.05) was recorded between control and all the other plant derived biopesticides in terms of reducing the population of *E. dolichi* and *O. mutabilis* 24 hours post treatment.

Data presented on Table 3 show the effect of plant derived biopesticides on the population of insect pests of cowpea plant at seedling stage 3, 5 and 7 days post treatment. The plots treated with the plant derived biopesticides

Table 2. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at seedling stage 24 hours post treatment during the 2004 planting season in Katsina.

Treatment	*A. craccivora*		*E. dolichi*		*O. mutabilis*	
	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS
Sweetsop (*A. squamosa*)	29.33	3.33a	0.67	0.0	2.0	0.0
Chillipepper (*C. frutecence*)	62.33	26.67a	0.67	0.0	0.33	0.0
Garlic (*A. sativum*)	97.33	48.67a	1.0	0.0	0.0	0.0
Ginger (*Z. officinale*)	32.67	10.67a	0.0	0.0	5.0	0.0
Neem (*A. indica*)	35.67	14.67a	0.0	0.0	0.0	0.0
Tobacco (*N. tabacum*)	86.33	16.33a	0.0	0.0	0.67	0.0
Control	78.0	108.67b	0.0	0.0	1.33	0.0
NSK (p<0.05)	NS	48.10	NS	NS	NS	NS

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
**NS : Not Significant

Table 3. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at seedling stage 3,5 and 7 days after treatment during the 2004 planting season in Katsina.

Treatment	*A. craccivora*			*E. dolichi*			*O. mutabilis*		
	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA
Sweetsop (*A. squamosa*)	72.0a	0.67a	30.0a	0.0	0.0	0.0	0.0	0.0	0.0
Chillipepper (*C. frutecence*)	29.33a	44.0a	15.33a	0.0	0.0	0.0	0.0	0.33	0.0
Garlic (*A. sativum*)	54.0a	53.33a	34.0ab	0.0	0.0	0.0	0.33	0.0	0.0
Ginger (*Z. officinale*)	56.67a	29.67a	8.67a	0.0	0.0	0.0	0.0	0.0	0.0
Neem (*A. indica*)	32.67a	13.67a	8.67a	0.0	0.0	0.0	0.0	0.0	0.0
Tobacco (*N. tabacum*)	83.0a	38.0a	46.33ab	0.0	0.0	0.0	0.0	0.0	0.0
Control	178.67b	133.33b	72.0b	0.0	0.0	0.0	0.0	0.0	0.0
NSK (p<0.05)	31.2	23.8	15.8	NS	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
**NS : Not Significant.

showed a significant ($p<0.05$) reduction of the population of *A. craccivora* at 3,5 and 7 days post treatment compared to the control treatment. Furthermore, it was observed that population of *O. mutabilis* and *E. dolichi* disappeared in both control and plant derived biopesticides treated plots at 3, 5, 7 days post treatment application.

Table 4 shows the effect of various plant derived biopesticides on the population of insect pests of cowpea 24 hrs after treatment application. Neem, sweetsop, garlic, chilli pepper, ginger and tobacco treatments significantly ($p<0.05$) controlled the population of *A. craccivora* 24 hours after spray application, compared to the control treatment but the difference among the plant treatment was not significant. Similarly, neem gave a significant control of *E. dolichi* compared to the control while the difference between sweetsop, chilli pepper, garlic, ginger and control treatments was not significant at 24 hours post treatment. All the plant derived biopesticides treatments significantly ($p<0.05$) controlled the population of *O. mutabilis*, 24 hours after treatment application when compared with control. However, differences among the plant derived biopesticides treatments were not significant.

Sweetsop, chilli pepper, garlic, ginger, tobacco and neem treatment tremendously ($p<0.05$) controlled the population of *O. phaseoli* compared to control treatment 24 hours post treatment application. However, when effectiveness within the plant derived biopesticides was compared garlic, ginger as well as chilli paper and sweetsoap gave the highest control.

The effect of plant derived biopesticides on the population of insect pests of cowpea at flowering growth stage, 24 hours after treatment application is presented in Table 5. Sweetsop, chilli pepper, ginger, tobacco, garlic and neem treatment gave no significant differences ($p<0.05$) with control treatment in terms of reducing the population of *M. sjostedti*, *Mylabris* and *S. littoralis* at 24 hours post treatment application. However, population of *M. vitrata* in all the plant derived biopesticides treatments were significantly ($p<0.05$) reduced 24 hours after treatment application when compared with the control treatment.

The effect of crude-extracts of plant derived biopesticides at flowering stage on the population of insect pests of cowpea plant at 3, 5 and 7 days after treatment is presented in Table 6. Garlic, ginger, neem and tobacco treatments significantly ($p<0.05$) controlled the population of *A. craccivora* at 3, 5 days after spray application. However, plots treated with sweetsop, chilli pepper, garlic, ginger and neem treatments rather showed an increased in the population of *A. craccivora* at 7 days post treatment application. Similarly, no significant differences ($p<0.05$)

Table 4. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at flowering stages 24 hours post treatment during the 2004 planting season in Katsina.

Treatment	*A. craccivora*		*E. dolichi*		*O. mutabilis*		*O. phaseoli*	
	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS
Sweetsop (*A. squamosa*)	20.33	21.33a	5.67	1.33ab	8.33	0.0a	23.33	4.0b
Chillipepper (*C. frutecence*)	19.0	3.33a	8.0	0.67ab	14.67	0.0a	18.67	3.33ab
Garlic (*A. sativum*)	78.033	2.0a	8.0	2.0ab	4.67	0.0a	17.33	2.33a
Ginger (*Z. officinale*)	82.67	10.0a	12.67	1.0ab	5.33	0.33ab	20.0	2.67ab
Neem (*A. indica*)	61.67	0.0a	3.67	0.33a	6.0	0.33ab	13.33	8.0c
Tobacco (*N. tabacum*)	87.33	20.67a	7.67	1.33ab	5.33	0.0a	15.33	5.67bc
Control	102.0	106.33b	4.67	3.67b	17.33	1.0b	18.0	13.67d
NSK ($p<0.05$)	NS	45.80	NS	2.49	NS	0.6	NS	3.23

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
**NS : Not Significant

Table 5. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at flowering stages 24 hours post treatment during the 2004 planting season in Katsina.

Treatment	*M. sjostedti*		*M. vitrata*		*Mylabris* spp.		*S. littoralis*	
	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS
Sweetsop (*A. squamosa*)	0.33	0.0	0.67	2.0a	0.0	0.0	0.0	0.0
Chillipepper (*C. frutecence*)	0.67	0.0	0.33	0.0a	0.0	0.0	2.0	0.0
Garlic (*A. sativum*)	0.33	0.33	0.0	1.0a	0.0	0.0	0.0	0.0
Ginger (*Z. officinale*)	0.0	0.0	2.33	0.33a	0.67	0.0	1.0	0.0
Neem (*A. indica*)	1.33	0.0	0.0	2.0a	0.0	0.33	0.0	0.0
Tobacco (*N. tabacum*)	2.33	0.33	1.0	0.33a	0.33	0.33	0.33	0.0
Control	0.33	1.0	2.0	6.0b	1.33	0.33	0.0	0.0
NSK (p<0.05)	NS	NS	NS	2.49	NS	NS	NS	NS

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
**NS : Not Significant

Table 6. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at flowering stage 3, 5 and 7 days post treatment during the 2004 planting season in Katsina.

Treatment	*A. craccivora*			*O. mutabilis*			*E. dolichi*			*O. phaseoli*		
	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA
Sweetsop (*A. Squamosa*)	36.67a	17.33a	40.0a	5.0	50.33	0.0	1.0bc	1.33	0.0	6.67ab	8.33	3.67
Chillipepper (*C. frutecence*)	4.67a	8.67a	9.0a	1.0	5.67	0.0	0.33a	0.0	0.0	5.0a	5.33	5.33
Garlic (*A. sativum*)	0.0a	0.0a	20.0a	0.33	8.67	0.0	0.0a	0.0	0.0	4.0a	11.0	8.0
Ginger (*Z. officinale*)	0.0a	1.0a	8.67a	2.0	8.0	0.0	0.67ab	0.0	0.33	8.67ab	6.67	6.67
Neem (*A. indica*)	0.0a	0.0a	17.33a	1.0	5.67	0.0	0.33ab	0.0	0.0	6.67ab	8.67	4.0
Tobacco (*N. tabacum*)	2.33a	19.33a	6.0a	2.0	4.33	0.0	0.0a	0.0	0.0	5.33a	10.67	5.67
Control	146.67b	106.0b	150.0b	7.67	9.0	0.0	1.33c	0.67	0.0	12.33c	12.67	8.0
NSK (p<0.05)	50.49	49.60	47.44	NS	NS	NS	0.5	NS	NS	3.42	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
**NS : Not Significant

was recorded between plant derived biopesticides and control treatments in terms of reducing the population of *E. dolichi* at 3, 5 and 7 days after treatment application. Although, sweetsop, chilli pepper, garlic, ginger, neem and tobacco treatments significantly reduced the population of *O. phaseoli* at 3 days post treatment application, no significant (p<0.05) differences were recorded when the plant derived biopesticides treatments were compared with the control treatment at 5 and 7 days after treatment application in terms of reducing the population of the insect.

The effect of plant derived biopesticides on the population of insect pests of cowpea plant at flowering growth stage 3,5 and 7 days after treatment is presented in Table 7. Population of *M. sjostedti* at 3 days application of treatment was significantly (p<0.05) reduced in all the plots treated with the plant derived biopesticides when

Table 7. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at flowering stage 3,5 and 7 days post treatment during the 2004 planting season in Katsina.

Treatment	*M. sjostedti*			*M. vitrata*			*Mylabris* spp.			*S. littoralis*		
	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA
Sweetsop (*A. Squamosa*)	7.33ab	1.13	0.0	4.0b	3.67	6.33	0.0	0.0	0.0	0.0	1.0	0.0
Chillipepper (*C. frutecence*)	4.0a	4.33	0.0	3.0a	6.67	7.0	0.0	0.0	0.0	0.0	6.0	0.0
Garlic (*A. sativum*)	7.33ab	2.0	2.0	1.33a	4.0	7.33	0.0	0.0	0.0	0.0	4.67	0.0
Ginger (*Z. officinale*)	3.33a	2.0	2.0b	3.0ab	5.67	0.0	0.67	0.0	0.0	0.0	0.0	0.0
Neem (*A. indica*)	4.33a	6.0	0.33	1.33ab	4.67	6.67	0.33	0.0	0.0	0.0	6.33	0.0
Tobacco (*N. tabacum*)	9.67b	2.67	0.67	3.67ab	5.33	10.67	0.33	0.0	0.0	0.0	0.0	0.0
Control	14.0c	4.67	0.067	6.33c	11.33	9.33	0.0	0.0	0.0	0.0	7.67	0.0
NSK (p<0.05)	3.9	NS	NS	1.8	NS	NS	NS	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

**NS : Not Significant

Table 8. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at podding stage 24 hours post treatment during the 2004 planting season in Katsina.

Treatment	*A. craccivora*		*C. tomentosecollis*		*R. dentipes*		*A. curvipes*	
	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS
Sweetsop (*A. squamosa*)	125.0	44.67a	26.0	4.67a	4.67	4.33b	14.67	2.33ab
Chillipepper (*C. frutecence*)	0.0	0.0a	28.3	1.33a	3.67	0.33a	35.0	0.67a
Garlic (*A. sativum*)	0.0	0.0a	30.67	2.0a	8.67	0.0a	19.67	1.0a
Ginger (*Z. officinale*)	0.0	0.0a	46.67	4.0a	2.67	1.0a	16.0	1.33a
Neem (*A. indica*)	27.33	36.7a	37.33	5.67a	0.67	1.0a	19.33	1.0a
Tobacco (*N. tabacum*)	0.0	0.0a	45.33	0.0a	4.67	0.33a	17.0	0.67a
Control	161.33	158.33b	54.0	20.333b	4.67	6.67b	20.67	4.69b
NSK (p<0.05)	NS	57.65	NS	6.25	NS	2.96	NS	1.8

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

** NS : Not Significant

compared with the control treatment. However, no significant control was observed between control and plant derived biopesticides treatment at 5 and 7 days after treatment application. On the other hand, population of *M. vitrata* was drastically reduced ($p<0.05$) 3 days after the application of treatment when compared with the control treatment but at 5 and 7 days, the population rather increased to the extend that no significant differences were recorded between control and the plant derived biopesticides treatments. Furthermore, no significant differences was recorded between control and the plant derived biopesticides treatments in reducing the population of *Mylabris* spp. and *S. littoralis* at 3, 5 and 7 days after the treatment application.

Table 8 shows the effect of plant derived biopesticides on the population of some insect pests of cowpea at podding growth stage 24 hrs after treatment application. Chilli pepper, garlic, ginger, sweetsop, neem and tobacco treatments significantly ($p<0.05$) controlled the population of *A. craccivora*, and *C. tomentosicollis* 24 hours post treatment compared to the control treatments but the difference among the plant derived biopesticides was not significant. Similarly, chilli pepper, ginger, neem, garlic and tobacco treatments were highly effective in reducing the population of *R. dentipes* and *A. curvipes* 24 hours post treatment compared to the control treatments.

Table 9 shows the effect of plant derived biopesticides on the population of some insect pests of cowpea at podding 24 hours after treatment. Although, sweetsop, chilli pepper, garlic, ginger, neem and tobacco treatments reduced the population of *Mylabris* spp., *M. sjostedti*, *O. phaseoli* and *M. vitrata* at 24 hours after treatment but no significant differences ($p<0.05$) between these treatments and control were recorded/observed.

Data presented in Table 10 shows the effects of plant derived biopesticides on the population of insect pests of cowpea plant at podding 3, 5 and 7 days post treatment. Chilli pepper, sweetsop, neem, garlic, ginger and tobacco treatments significantly ($p<0.05$) controlled the population

Table 9. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at podding stage 24 hours post treatment during the 2004 planting season in Katsina.

Treatment	*Mylabris* spp.		*M. sjostedti*		*O. phaseoli*		*M. vitrata*	
	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS	24HBS	24HAS
Sweetsop (*A. squamosa*)	2.33	0.0	2.0	0.0	3.33	1.33	11.33	4.33
Chillipepper (*C. frutecence*)	1.0	0.0	4.33	0.0	2.0	1.33	5.33	4.33
Garlic (*A. sativum*)	4.0	0.0	5.0	0.0	0.0	2.67	3.0	5.33
Ginger (*Z. officinale*)	3.67	0.0	5.0	0.33	1.0	1.33	7.67	4.0
Neem (*A. indica*)	0.3	0.0	3.0	0.0	2.67	3.33	3.33	5.33
Tobacco (*N. tabacum*)	2.33	0.0	2.67	0.0	2.0	6.67	6.0	3.33
Control	3.67	0.0	5.67	0.0	2.33	8.67	9.67	10.33
NSK ($p<0.05$)	NS	NS	NS	NS	NS	NS	NS	NS

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
**NS : Not Significant

Table 10. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at podding stage 3, 5 and 7 days post treatment during the 2004 planting season in Katsina.

Treatment	*A. craccivora*			*C. tomentosicollis*			*A. curvipes*		
	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA
Sweetsop (*A. Squamosa*)	36.67a	17.33a	40.0a	5.0	50.33	0.0	0.0a	0.0	0.0
Chillipepper (*C. Frutecence*)	4.67a	8.67a	9.0a	1.0	5.67	0.0	0.0a	0.0	0.0
Garlic (*A. sativum*)	0.0a	0.0a	20.0a	0.33	8.67	0.0	0.0a	0.0	0.0
Ginger (*Z. Offinale*)	0.0a	1.0a	8.67a	2.0	8.0	0.0	0.0a	0.0	5.33
Neem (*A. indica*)	0.0a	0.0a	17.33a	1.0	5.67	0.0	0.0a	0.0	0.0
Tobacco (*N. tabacum*)	2.33a	19.33a	6.0a	2.0	4.33	0.0	0.0a	0.0	0.0
Control	146.67b	106.0b	150.0b	7.67	9.0	0.0	2.67b	0.0	0.0
NSK ($p<0.05$)	50.49	48.10	62.04	NS	NS	NS	1.08	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
**NS : Not Significant

of *A. craccivora* at 3,5 and 7 days post treatment when compared to the control treatment. Although, there was no significant differences (p<0.05) observed between plots treated with plant derived biopesticides and that of control in reducing the population of *C. tomentisicollis* at 3, 5 and 7 days after treatment application, significant differences between control and plant derived biopesticide treatment were observed in terms of reducing the population of *A. curvipes* at 3 days after the application of treatment (Table 10).

Data presented in Table 11 shows the effects of plant derived biopesticides on the population of insect pests of cowpea at 3, 5 and 7 days post treatment during podding stage. Sweetsop, garlic, chilli pepper, ginger and neem treatments significantly (p<0.05) controlled the population of *Mylabris* spp. at 3 days post treatment. Although, the differences among the plant derived biopesticides were not significant, neem and chilli pepper were significantly superior to the rest of the plant derived biopesticides in the reduction of *Mylabris* spp. population during the period. However, no significant difference was recorded between the plant derived biopesticides and the control treatments at 5 and 7 days post treatment. All the plant derived biopesticide treatments with the exception of sweetsop significantly (p<0.05) control the population of *M. sjostedti* at 3 days post treatment but at 5 and 7 days there was no significant (p<0.05) difference when compared to control treatment. Similarly, all the plots treated with plant derived biopesticides showed no significant (p<0.05) difference at 3, 5 and 7 days post treatment in reducing the population of *O. phaseoli* and *M. vitrata*, compared to the control plots.

The effect of plant derived biopesticides on seeds/pod, seed yield (kg/ha) and yield loss (kg/ha) of cowpea plant is presented in Table 12. Result of the experiment shows that there was no significant differences (p<0.05) between control and the other plant derived biopesticides treatment in terms of number of seeds/pod. However, plots treated with extract of tobacco were found to give higher number of seeds/pod compared to the other plant derived biopesticides. Although, the grain yield from all the plots treated with all the plant derived biopesticides were significantly (p<0.05) better than the grain yield obtained from the control plots. However, grain yield from the plots treated with extracts of tobacco, garlic and sweetsop gave the highest yield of seeds and were therefore rated, as more effective than the rest. Finally, cowpea plants protected with sweetsop, chilli pepper, garlic, ginger, neem and tobacco treatment showed no significant (p<0.05) differences with the cowpea plants in the control treatments in terms of yield loses kg/ha.

Table 11. Effect of plant derived biopesticides on the population of some insect pests of cowpea plant at podding stage 3,5 and 7 days during the 2004 planting season in Katsina.

Treatment	*Mylabris* spp.			*M. sjostedti*			*O. phaseoli*			*M. vitrata*		
	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA	3DPTA	5DPTA	7DPTA
Sweetsop (*A. Squamosa*)	7.33bc	1.33	0.0	4.0c	3.67	6.33	0.0	0.0	0.0	0.0	0.0	0.0
Chillipepper (*C. Frutecence*)	4.0ab	4.33	0.0	3.0ab	6.67	7.0	0.0	0.0	0.0	0.0	0.0	0.0
Garlic (*A. sativum*)	7.33bc	2.0	2.0	1.33a	4.0	7.33	0.0	0.0	0.0	0.3	0.0	0.0
Ginger (*Z. Offinale*)	3.33b	2.0	2.0	3.0ab	5.67	0.0	0.67	0.0	0.0	0.0	0.0	0.0
Neem (*A. indica*)	4.33ab	6.0	0.33	1.33a	4.67	6.67	0.33	0.0	0.0	0.0	0.0	0.0
Tobacco (*N. tabacum*)	9.67cd	2.67	0.67	3.67bc	5.33	10.67	0.33	0.0	0.0	0.0	0.0	0.0
Control	14.0d	4.67	0.067	6.33c	11.33	9.33	0.0	0.0	0.0	0.2	0.71	0.0
NSK (p<0.05)	3.9	NS	NS	2.6	NS	NS	NS	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

**NS : Not Significant

Table 12. Effect of plant derived biopesticides on the yield of cowpea plant during the planting season of 2004 in Katsina

Treatment	Seeds/pods	Seed yield (kg/ha)	Yield loses (kg/ha)
Sweet sop (*A. squamosa*)	13.0	1117bc	172
Chillipepper (*C. frutescence*)	12.0	1061bc	146
Garlic (*A. sativum*)	11.2	1013bc	162
Ginger (*Z. officinale*)	12.13	1108bc	130
Neem (*A. indica*)	12.13	888b	204
Tobacco (*N. tabacum*)	13.26	1293c	69
Control	10.13	428a	357
NSK ($p<0.05$)	NS	122.5	NS

*Means within a column followed by the same letter (s) do not significantly differ according to Student Newman Keuls ($p<0.05$) test

**NS : Not Significant

DISCUSSIONS

Effect of plant derived biopesticides on insect pests of cowpea at vegetative growth stage

Although, the results of screening of six aqueous plant derived biopesticides for the control of insect pests on cowpea plant exhibited varying degrees of efficacy against all the insect pests species assessed, it is interesting to note that the result clearly indicated that all the plant derived biopesticides treatments were significantly better than control treatment. Furthermore, the results indicated that extracts of sweetsop, chilli pepper, garlic, ginger, neem and tobacco have more deleterious effect on insect pests of cowpea plants population and reduces damage to cowpea especially during its seedling growth stage. Results obtained from this experiment had therefore confirmed earlier work done by previous researchers, which showed that some plant materials used as protectant agents have biopesticidal properties (*A. sativum*, *N. tabacum*, *A. indica*, *P. guineense* and *A. occidentale*). For instance Dungum *et al.* (2005) reported that the plant products normally act either through physical or biochemical processes thereby lowering the population of the insect pests. Saxena (1983) also reported that the activity observed in reduction of pest density using plant products might be in form of repellency, anti-feeding and phagodeterrency. Furthermore, plant extracts have been found to be effective against field insect pests of cowpea but not as effective as synthetic insecticides (Dike, 1980; Lajide and Adedire, 1999).

Although it is a well established fact that most plant products are less effective than synthetic insecticides, however, public mistrust in synthetic insecticides is creating a political and economic environment favorable for botanical use. In any case, it is important to note that among the plant derived biopesticides tested, tobacco and sweetsop were found to be the most effective in controlling some of insect pests population during the period of observations (1, 3, 5 and 7 days post treatment) but, the efficacy of all the tested plant derived biopesticides was observed to be generally slow when compared with the synthetic insecticides. The result agrees with the findings of Dent (1991) who uses biopesticides to successfully control insect pests of cowpea.

Studies earlier conducted by Gaby (1995), Fuglie (1998) and Panhwar (2002) have also confirmed the superiority of tobacco and sweetsop over the other tested plant derived biopesticides in controlling insect pests of agricultural crops. Tobacco usually acts as a respiratory, contact and stomach poison on many insect pests but may as well act as repellant on some insect pests such as *A. craccivora*, *C. tomentosicollis*, *A. curvipes*, *R. dentipes* and *M. vitrata* etc. while sweetsop is effective as an insecticide, repellent and growth inhibitor for insect pests of cowpea plant (PAN, 1995).

Although, neem and ginger were not significantly ($p<0.05$) better than the tobacco and sweetsop extracts, they were rated as the next best among the plant derived biopesticides in controlling the insect pests of cowpea plant at seedling stage. Neem extracts has been shown to produce protection both on stored cowpea grain and cowpea plant especially against weevils and field pests, respectively (Stoll, 1988). According to PAN (1995) the different plant derived biopesticides can be used for controlling insect pests of field crops but the seed contain the highest concentration of active substances that act as repellent and anti-feedant.

Although, garlic and chilli pepper provided lower protection to the cowpea seedling against insect pests infestation, never the less, these two plants derived biopesticides were reported to possess insecticidal properties that are normally effective in controlling broad spectrum pests of the cowpea plant (Stoll, 1988). In many instances, chilli paper and garlic were observed to act as stomarch poison or anti-feedant against many insect pests of cowpea (PAN, 1995). Similarly, Fuglie (1998) had reported that chilli pepper either in powder or liquid form or mix with other ingredients, is effective in killing or repelling many insect pests.

Effect of plant derived biopesticidess on insect pests of cowpea at flowering and podding stages

The application of plant derived biopesticides on cowpea plants at its flowering growth stage has significantly ($p < 0.05$) reduced the population of the insect pests when compared to the control treatment. The result agrees with the findings of Amatobi (2000) who in a green house study, reported that crude extracts of chilli papper fruit and tobacco leaves 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 the control treatment.

Further, statistical analysis of the result showed that the plots treated with sweetsop and tobacco extracts gave significant ($p<0.05$) control of *A. craccivora*, *C. tomentosicollis*, *M. vitrata*, *M. sjostdti*, *O. phaseoli*, *E. dolichi*, and *A. curvipes*, than the control treatments. The result agrees with the findings of 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 generally known to possess toxic organic poison that is effective in reducing insect pests population (Fuglie, 1998; Gaby, 1995). Similarly, William and Ambridge (1996) reported that plant extracts were found to be effective against wide range of insects including pod borer. However, several other authors have shown the efficacy of different plant materials as biopesticides for the control of different pest species (Oparaeke *et al.*, 2000b; Ekesi, 2000 and Okech *et al.*, 1997). Plant extracts from garlic bulb have also been reported to be effective against post-flowering insect pests of cowpea plant (Oparaeke *et al.*, 2005). Similarly, neem, West African black pepper, garlic bulb, African nutmeg, *Lippia adoensis* Hoschst have also been reported to be effective against some crop pests species (Jackai and Oyediran, 1991; Scott and Mckibbe, 1978; Olaifa *et al.*, 1987; Oparaeke *et al.*, 2000c; Ekesi, 2000). Okech *et al.* (1997) in a field trial found that *Tephrosia volgelii* Hook aqueous extracts not only reduced maize stalk borer (*Chilo partellus* Swinhoe) numbers and damage symptom but improved grain yield as well.

Equally, summary of the results obtained from the experiments also indicated that all the plant derived biopesticides treatments were significantly ($p<0.05$) better than the control treatment in reducing the insect pests population at the podding growth stage of the plant. However, when efficacy of the plant derived biopesticides treatments were compared, neem, garlic and ginger were rated, as more effective in controlling the insect pests of cowpea at podding stage than the other plant derived biopesticides. Neem, garlic and ginger extracts contain insecticidal properties that are usually lethal to a wide range of insects including *M. vitrata*, *M. sjostedti*, *C. tomentosicollis* and *O. phaseoli* (Stoll, 1989; Ostermanni, 1979). Similarly, Gaby (2000) and Panhwar (2002) also reported that neem, garlic and ginger were effective against pod borer insects and also protect plant against insect pest infestation for at least 2 weeks (Jacobson, 1989). Gaby (1995) in a laboratory trial had also reported that garlic, ginger and neem extracts were found to be effective in reducing the feeding efficiency of older larvae than younger ones. Panhwar (2002) reported that good aqueous solution of garlic, ginger and neem will effectively control worms, beetles and thrips in cowpea farms. Tobacco, sweetsop and chilli pepper were in this case found to be less effective than neem, ginger and garlic extract in reducing the population of insect pests of cowpea plant at podding stage. This confirmed the earlier work conducted by Gaby (1995) who reported that extracts of tobacco and chilli pepper prove to be less repellant in controlling the activities of insect pests of cowpea plant when compared with neem. Stoll (1988) and Panhwar (2000) had independently reported the superiority of ginger and garlic over chilli papper and sweetsop.

Effect of plant derived biopesticides on grain yield and yield component of cowpea

The yields obtained from plots treated with the plant derived biopesticides were in many cases, significantly ($p<0.05$) higher than the yield obtained from the untreated control plots. Insect pests infestation on the field has been identified as the major obstacle to cowpea production. Yield on farmer's field are on average less than 200kg/ha (Raheja, 1976). This could hardly pay for family used during production let alone, feeding the family during lean period (Dike and Mshelia, 1997).

Results of the present investigations showed that the number of seeds/pod was higher in tobacco treated plots. The experiments also showed that seed yield/pod on plots treated with tobacco extract was found to be higher than the seed yield/pod obtained from all the other plots treated with plant derived biopesticides (ginger, neem, garlic, sweetsop and chilli pepper). These results corresponded positively with the earlier work conducted by previous researchers which showed that some plant extracts especially tobacco increases the yield of vegetables and pea plants by protecting them from insect pests (Stoll, 1988; Panhwar, 2002; William and Ambridge, 1996). Similarly, Fuglie (1998) had shown 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. Gaby (1989) had also shown that, application of plant extracts in powder or solution forms significantly increased the yield of cowpea plants.

The grain yield (seed yield) of plots treated with plant derived biopesticides were significantly ($p<0.05$) better than the grain yield obtained from the untreated control. 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. However, among the plant derived biopesticides, tobacco treated plots were found to be better in grain yield than the plots treated with other the plant derived biopesticides. These results confirmed the earlier work done by previous researchers which showed that tobacco leaves are not only toxic to the insect pests of cowpea plant but possess the ability to increase the yields of the plant (Panhwar, 2002; Stoll, 1988).

Grain yield losses were lower in plots treated with plant derived biopesticides (tobacco, sweetsop, ginger, garlic, chilli pepper and sweetsop) when compared with untreated control plots. This was possible because the plant derived biopesticides were effective against the 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 crop's yield and yield component is dependent on the effectiveness of the individual plant extract.

Field observation indicated that none of the plant derived biopesticides used in this study produced any phototoxic on cowpea leaf. This contrast with the observation made by Olaifa and Adenuga (1998) about some yellowing and subsequent shedding of leave. However, effectiveness of plant-based insecticidal application may be enhanced if it is conducted early in the morning or late in the evening because of biological active principles contained in such plant extracts (Oparaeke *et al.*, 2003).

Conclusion and recommendation

Result of the experiments conducted showed that all the tested plant derived biopesticides have potential value to substitute synthetic insecticides in pest management. This is because they were found to be promising in controlling the insect pests of cowpea at vegetative, flowering and podding growth stages. Although, the result strongly recommend the use of the entire tested plant derived biopesticides 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 materials to ascertain their effective date and spraying schedules. Different plant parts, variety and age at harvest as well as the method of extraction, age of the sample after preparation and storage condition 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.

Research is also needed for identification, isolation and characterization of the active ingredients responsible for toxicity exhibited by plant materials and its mode of action. There is also the need to test the extract on other crop, which have similar pest complex/spectrum as cowpea to verify the results obtained in this study.

In summary results of the present investigation strongly recommend the use of all the tested plant derived biopesticides particularly tobacco, sweetsop and garlic in controlling the insect pests of cowpea. However, extensive research works on the appropriate concentrations/dosage, efficiency and methods of application of those plant products need to be carried out further.

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