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Frequency of application of four plant extracts in the control of major insect pests of cowpea, *Vigna unguiculata* (L.) Walp in Umudike, Nigeria

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ABSTRACT

Cowpea, *Vigna unguiculata* is a staple food crop of significant economic importance to man and animals in terms of its proteinous content supply. Every phenological stage in the life cycle of cowpea has at least one major insect pest. This research work was carried out to determine the effects of spraying botanical extracts (*Gmelina arborea*, *Ageratum conyzoides*, *Carica papaya*, *Vernonia amygdalina*) and the synthetic insecticide (Cypermethrin) in the control of these key pests of cowpea. The study was conducted at the Michael Okpara University of Agriculture, Umudike Teaching and Research Farm Umudike, Abia State. The experiment was laid out as a 6×2 Factorial in Randomized Complete Block Design (RCBD) with six treatments which were applied once a week and once in two weeks and replicated three times in 2014 and 2015 cropping seasons. Data were subjected to Analysis of Variance (ANOVA) and significant means were separated by Fisher's Least Significant Difference Test (LSD) at 5% level of significance. Results from this study clearly showed that the plant extracts used did not significantly reduce aphids population in 2015 but effectively controlled *M. sjostedti* population and *M. vitrata* damage in the two cropping seasons. The population of pod sucking bugs was also reduced. Grain yields were significantly higher ($p<0.05$) in 2014 than in 2015 cropping season. The implication of this result is that major insect pests of cowpea in the field can be effectively controlled using plant extracts applied once a week. Application of these plant extracts effectively reduced the population of the insects, reduced damage and increased yield.

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp.) is an annual crop in the Family Fabaceae (Singh et al., 2002). Cowpea is a dietary protein, a staple food crop of significant economic importance in Nigeria and worldwide (Emeasor et al., 2007; Magloire, 2005).

Cowpea is a grain legume grown mainly in the Savanna regions of the tropics and subtropics in Africa, Asia, and South America (IITA, 2010). In Nigeria, cowpea is grown mainly in the drier Northern zone – the Sudan savannah belt (Rachie, 1985) and the bulk of it in terms of world production, comes from this region.

In spite of the numerous utilizations of cowpea, production often falls below optimum. The reduction in yield has been attributed to several biotic and abiotic factors. The major constraint in the cultivation of cowpea is insect pests which attack at different and developmental stages of the plant. Insect pests of cowpea clearly identified as major and serious pests in the field are cowpea aphids, *Aphis craccivora* Koch

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(Hemiptera: Aphididae), the flower bud-thrips, *Megalurothrips sjostedti* (Trybom) (Thysanoptera: Thripidae), the legume Pod Borer, *Maruca vitrata* Fabricius (Lepidoptera: Pyralidae), a complex of pod-sucking bugs (PSBs) *Clavigralla tomentosicollis* Stal. (Hemiptera: Coreidae), *Anoplocnemis curvipes* L., *Riptortus dentipes* F., *Mirperus jaculus* L., *Aspavia armigera* F. and *Nezara viridula* L. and post-harvest bruchid *Callosobruchus maculatus*. These major pests feed on reproductive plant parts causing most economic damage thereby necessitating appropriate control (Karungi et al., 2000). Insect pests of cowpea have mainly been controlled with synthetic insecticides (Kabaru and Gichia, 2001). While this is known to increase production cost, the large number of sprays is hazardous to farmers' health as well as consumers'health and can also destroy non-target beneficial insects (for example, insect pollinators, predators) in the environment (Alabi et al., 2003).

These problems have necessitated the search for alternative and effective biodegradable insecticides. Plant extracts are gaining more popularity as biopesticides, because they are inherently less harmful than conventional pesticides (Oparaeke et al., 2000; Mitchell et al., 2004). Plant extracts act as mortality agents, repellents, antifeedants, attractants, oviposition deterrents, acute toxicity and sterility agents (Lale, 2002; Ben et al., 2010).

Some plant species have been reported to have insecticidal properties against some stored and field pests of crops. For instance, *Gmelina arborea* products have been reported to show insecticidal activity against *M. vitrata* pod borer larvae and pod sucking bug *C. tomentosicollis* on cowpea. Also, *Carica papaya* (pawpaw leaf), *Ageratum conyzoides* (Goat weed leaf) and *V. amygdalina* (bitterleaf) have been reported to possess insecticidal and repellent properties (Oparaeke et al., 2000; Ndor et al., 2012).

This study therefore evaluated the effects of spraying botanicals at different frequencies (once a week and once in two weeks) on cowpea insect pest density and damage and its influence on yield.

MATERIALS AND METHODS

Study site

The trials were carried out during the planting seasons of 2014 and 2015, in the Michael Okpara University of Agriculture, Umudike Teaching and Research Farm. Umudike is located on the Longitude 07°33'E, Latitude 05°29'N, Altitude 122 m with annual rainfall of 2177 mm, 72% relative humidity, monthly and ambient temperature of 17 to 36°C [National Root Crop Research Institute (NRCRI) Meteorological Station, Umudike] in 2014 and 2015.

Experimental design

The experimental site was cleared, ploughed and harrowed using a tractor and beds were made manually using hoes and shovels. Planting was done on the 22nd of September, 2014 and on 19th of August, 2015 in Umudike. The experimental bed size was 2.4 × 3 m, with inter-bed space of 1.5 m. Three cowpea seeds were sown per hole at a spacing 60 × 30 cm. Seeds that failed to germinate after four days were supplied and thinning to one plant per stand took place ten days after emergence. Each experimental plot consists of four rows of ten plants to give 40 plants per plot. The cowpea seeds planted were Ife brown [obtained from the International Institute of Tropical Agriculture (IITA)] Ibadan. The experiment consisted of six treatments; paw-paw leaf, bitterleaf, *Gmelina* leaf, goat weed leaf, Cypermethrin (as check) and control. The experiment was laid out as a Factorial in Randomized Complete Block Design (RBCD) and replicated three times. Four major insect pests of cowpea were targeted for management.

Preparation and application of plant extracts

Fresh and mature leaves of *C. papaya*, *V. amygdalina*, *A. conyzoides* and *G. arborea* were plucked and air-dried to a very low moisture level for 24 h under room temperature so as to make sure that the process of drying did not affect the potency of the active ingredients. A solution of the botanicals was made by weighing 300 g of each plant material into a wooden mortar and thoroughly pounded with a pestle. The pounded materials were placed into separate plastic buckets thereafter, 4 L of water was added to each of the buckets, which was vigorously stirred and allowed to stand over-night to allow the active ingredients to be extracted. The extractants were filtered with muslin cloth into separately labeled clean buckets to obtain a homogenous filtrate that was used for spraying. The buckets containing the aqueous solutions were taken to the field the next morning for spraying using a separate manually operated knapsack sprayer. A solution of Cypermethrin was made by diluting 4 mL of the insecticide in 4 L of water. Field applications of the botanicals and Cypermethrin commenced two weeks after planting (WAP).

Insect population counts and damage determination

Aphid infestation monitoring

A. craccivora infestation was assessed by visual rating on a 10 point scale (Table 1). From 10 randomly selected and tagged cowpea plants in the two middle rows of each plot, each stand was carefully inspected and the size of

Table 1. Scale for rating Aphid infestation on cowpea.

Rating	Number of Aphids	Appearance
0	0	No infestation
1	1-4	A few individual aphids
3	5-10	A few isolated colonies
5	11-30	Several small colonies
7	31-50	Large isolated colonies
9	>50	Large continuous colonies

Source: Litsinger et al. (1977).

A. craccivora colony on each plant was rated, recorded and the mean for the ten plants was calculated. Observations for infestation commenced from 26 days after planting (DAP), between 8 and 10 a.m. Observations were made weekly for four times (Litsinger et al., 1977).

Flower bud thrips counts

At least ten flowers were randomly picked from the two rows set aside for data collection. The population of *M. sjostedti* in each flower was assessed by counting when the flowers were opened in the field between 3 and 5 p.m. beginning from 45 DAP at five days' interval.

Legume pod borer (LPB) assessment

Damage to cowpea flowers by *M. vitrata* was assessed in the field between 3 and 5 p.m. beginning from 45 DAP at five days' intervals. The presence of holes and larvae on the flowers were the *Maruca* damage indices. Ten flowers were randomly selected from the two outer rows of each plot. Each flower was carefully opened and inspected on the spot for *Maruca* larvae or flower damage. The mean for the ten flowers was then calculated. Four observations were made at 45, 50, 55 and 60 DAP and the mean of these observations were calculated.

Assessment of PSBs infestation

Assessment of pod sucking bugs infestation was done twice a week from 45 to 63 DAP. This was based on visual observation of the two rows tagged for this data collection. Counting of PSBs was done and both nymphs and adults were recorded.Four observations were made weekly (Egho and Emosairue, 2010).

Grain yield

At 65 to 70 DAP, the pods were manually harvested according to treatments and placed into black medium sized polythene bags. They were sundried for two weeks and then shelled. The grains were then weighed with Triple Beam Balance (Haus Model) and the weight recorded. The yield per plot was also extrapolated to kg/ha (Egho and Emosairue, 2010).

RESULTS AND DISCUSSION

Population density of *A. craccivora* on cowpea sprayed with botanicals at different frequencies in 2015 cropping season in Umudike, Abia State

Results of the various treatments to control *A. craccivora* population density on cowpea twenty-six DAP are presented in Table 2. The control plots recorded the highest *A. craccivora* population density of 0.69, while the plots treated with *V. amygdalina* aqueous extract recorded the least population of *A. craccivora* (0.06). The plots treated with the synthetic insecticide, Cypermethrin also recorded a very low population of *A. craccivora* (0.12). *A. conyzoides* and *C. papaya* treated plots had population densities of 0.25 and 0.20 respectively, which implied that they were not as effective as *V. amygdalina* and *G. arborea*. Frequency of application was non-significant ($p<0.05$), as *A. craccivora* population densities on the plots sprayed with the aqueous botanicals and Cypermethrin, once a week (0.18) and once in two weeks (0.29) were the same.

Population density of *M. sjostedti* on cowpea sprayed with extracts of botanicals at different frequencies in 2014 and 2015 cropping seasons in Umudike, Abia State

The effects of *G. arborea, A. conyzoides, V. amygdalina, C. papaya* and Cypermethrin on the control of flower bud thrips, *M. sjostedti* at different frequencies is given in Table 3. In 2014 cropping season, the frequency of application (once a week and once in two weeks) showed a significant difference ($p<0.05$) in reducing the infestation of *M. sjostedti* on cowpea. The result showed that once in two weeks application of treatments recorded a higher mean number of *M. sjostedti* on cowpea flowers (7.72) when compared to once a week application of treatments (6.08).

In 2015 season, there was no significant difference ($p>0.05$) in the level of infestation by *M. sjostedti* due to frequency of application of the treatments. However, experimental plots sprayed once in 2 weeks had higher infestation (8.51) than plots sprayed once a week (7.00). The result showed that in both years, the plant extracts significantly reduced ($p<0.05$) *M. sjostedti* density on cowpea flower when compared with the control. The best

Table 2. Population density of *A. craccivora* on cowpea sprayed with botanical extracts and Cypermethrin once a week and once in two weeks in 2015.

Plant extracts	Frequency of application 2015		
	Once a week	Once in two weeks	Mean
A. conyzoides	0.18±0.06	0.32±0.10	0.25±0.08
C. papaya	0.16±0.09	0.24±0.11	0.20±0.10
G. arborea	0.09±0.02	0.10±0.14	0.10±0.22
V. amygdalina	0.02±0.01	0.09±0.16	0.06±0.11
Cypermethrin	0.07±0.04	0.15±0.07	0.12±0.06
Control	0.56±0.17	0.82±0.07	0.69±0.30
Mean	0.18±0.13	0.29±0.15	
LSD (0.05) plant extract		0.34	
LSD (0.05) freq. app.		0.20	
LSD (0.05) plant ext. × freq. app.		0.48	

Table 3. Population density of *M. sjostedti* on cowpea sprayed with botanical extracts and Cypermethrin once a week and once in two weeks in 2014 and 2015.

Plant extracts	Frequency of Application					
	2014			2015		
	Once a week	Once in 2 weeks	Mean	Once a week	Once in 2 weeks	Mean
A. conyzoides	5.56±1.34	7.93±1.02	6.75±1.02	6.80±0.22	8.18±0.05	7.49±0.22
C. papaya	8.12±1.06	8.78±0.82	8.45±0.62	8.82±0.93	9.92±0.22	9.37±0.31
G. arborea	6.43±1.53	9.12±0.17	7.78±0.96	7.92±0.21	8.78±0.22	8.35±0.60
V. amygdalina	5.98±1.20	8.10±0.56	7.04±0.76	6.40±0.38	7.48±0.48	6.94±0.61
Cypermethrin	1.39±0.16	2.02±0.12	1.70±0.17	1.82±0.46	2.72±0.11	2.27±0.25
Control	8.98±0.86	10.38±0.94	9.68±0.65	10.25±0.87	13.95±0.21	12.10±0.17
Mean	6.08±0.7	7.72±0.71		7.00±0.05	8.51±0.07	
LSD (0.05) plant extracts		1.57			1.58	
LSD (0.05) freq. app.		0.90			0.91	
LSD (0.05) plant ext. × freq. app.		2.21			2.23	

and most effective treatment was achieved with Cypermethrin and it significantly differed from all the aqueous plant extracts used.

The most effective aqueous plant extract in 2014 cropping season was achieved on plots treated with *A. conyzoides* and 2015 cropping season shows *V. amygdalina* as the most effective plant extract. The unprotected plots (control) recorded the highest population of *M. sjostedti* across both years.

In all the treatments used, the mean number of *M. sjostedti* density found on cowpea was higher in 2015 than in 2014 cropping season.

Population density and damage by *M. vitrata* on cowpea sprayed with extracts of botanicals at different frequencies in 2014 and 2015 cropping seasons

The effects of *G. arborea, A. conyzoides, V. amygdalina, C. papaya* and Cypermethrin on the legume pod borer, *M. vitrata* at different frequencies is given in Table 4. The number of larvae recorded on cowpea flowers and the holes created by those larvae on the flowers were significantly reduced ($p<0.05$) in all the plots treated with bio-insecticides and the synthetic insecticide compared

Table 4. Population density and damage by *M. vitrata* on cowpea sprayed with botanical extracts and Cypermethrin once a week and once in two weeks in 2014 and 2015 cropping seasons.

Plant extracts	Frequency of application					
	2014			2015		
	Once a week	Once in 2 weeks	Mean	Once a week	Once in 2 weeks	Mean
A. conyzoides	0.58±0.06	0.92±0.19	0.75±0.11	0.75±0.13	0.98±0.12	0.87±0.09
C. papaya	0.75±0.05	0.88±0.1	0.82±0.07	0.83±0.22	1.08±0.12	0.96±0.03
G. arborea	0.77±0.10	0.63±0.12	0.70±0.08	0.95±0.09	0.68±0.04	0.82±0.15
V. amygdalina	0.80±0.03	0.80±0.13	0.80±0.06	0.93±0.11	0.90±0.13	0.92±0.17
Cypermethrin	0.23±0.04	0.37±0.03	0.30±0.04	0.35±0.08	0.47±0.02	0.41±0.09
Control	0.93±0.07	1.20±0.20	1.07±0.11	1.42±0.18	1.58±0.03	1.50±0.14
Mean	0.68±0.06	0.80±0.08		0.87±0.05	0.95±0.04	
LSD (0.05) plant extracts		0.24			0.26	
LSD (0.05) freq. app.		0.14			0.15	
LSD(0.05)plant ext.×freq. app.		0.34			0.37	

with the unprotected plots. Although the efficacies of these treatments varied, they were significantly superior to the control. There was no significant difference ($p>0.05$) between the plots sprayed once a week and those plots sprayed once in two weeks in the population density and damage by *M. vitrata*. From Table 4, the results showed that Cypermethrin was most effective in the control of *M. vitrata* as its application recorded the lowest mean damage index of 0.30 and 0.41 in the year 2014 and 2015 respectively. The control plots recorded the highest mean damage by *M. vitrata* in 2014 (1.07) and 2015 (1.50).

Among the aqueous plant extracts, plots sprayed with *G. arborea* recorded a mean population of 0.70 in 2014 and 0.82 in 2015 of *M. vitrata* followed by *A. conyzoides* treated plots, which recorded a mean population of 0.7 in 2014 and 0.87 in 2015. In the *V. amygdalina* treated plots, 0.80 mean population of *M. vitrata* was recorded in 2014 and (0.92) in 2015 and *C. papaya* (0.82) in 2014 and (0.96) in 2015. The trend of results was the same in 2015 cropping season (Table 4). Also the weekly application was slightly lower in 2014 (0.68) and 2015 (0.87) than biweekly application in 2014 (0.80) and 2015 (0.95).

There was no significant difference in legume pod borer density and damage between the different treatment plots at the different frequencies.

Population density and damage by pod sucking bugs on cowpea sprayed with extracts of botanicals at different frequencies in 2014 and 2015 cropping season.

The effects of *G. arborea, A. conyzoides, V. amygdalina, C. papaya* and Cypermethrin on the complex of pod sucking bugs at different frequencies (once a week and once in two weeks) is given in Table 5.

There was a significant difference ($p<0.05$) between the mean densities of PSBs as affected by the application of the plant extracts and synthetic insecticide, once a week and once in two weeks in both years. The results obtained indicated that across both years, the experimental plots sprayed once a week recorded significantly lesser population and damage by pod sucking bugs with a density of 0.25 and 0.31 than plots sprayed once in two weeks with a density of 0.32 and 0.42 in 2014 and 2015 seasons respectively.

When compared to the unprotected plots, there was significant effect in both years. The synthetic insecticide treated plots showed significant difference ($p<0.05$) when compared to plots treated with aqueous plant extracts and control. Also the synthetic insecticide treated plots gave a lower number of bug population than the plant extracts treated plots. The synthetic insecticide treated plots gave a lower mean population of 0.28 across both years. This was followed by *C. papaya,* which gave 0.29, *G. arborea* gave 0.34, *V. amygdalina* gave 0.35, *A. conyzoides* gave 0.34 across both trials.

Effects of frequency of application of some plant extracts as bio-insecticide and Cypermethrin on the dry grain yield (kg/ha) of Cowpea, *V. unguiculata* in 2014 and 2015 seasons at Umudike, Abia State

From Table 6, it was observed that the unprotected plots from 2014 experiment recorded the least yield of 488 kg/ha which was obtained from plots sprayed once in two weeks while the highest yield was obtained from plots sprayed once a week with the synthetic insecticide. The result showed that plots sprayed once a week yielded

Table 5. Population density and damage by pod sucking bugs on cowpea sprayed with botanicals and Cypermethrin once a week and once in two weeks in 2014 and 2015 cropping seasons.

Plant extracts	Frequency of application					
	2014			2015		
	Once a week	Once in 2 weeks	Mean	Once a week	Once in 2 weeks	Mean
A. conyzoides	0.23±0.04	0.32±0.06	0.27±0.04	0.28±0.06	0.40±0.04	0.34±0.03
C. papaya	0.20±0.03	0.28±0.04	0.24±0.03	0.23±0.06	0.35±0.04	0.29±0.03
G. arborea	0.22±0.04	0.29±0.04	0.25±0.03	0.27±0.06	0.40±0.07	0.34±0.04
V. amygdalin	0.24±0.03	0.25±0.03	0.25±0.02	0.32±0.06	0.39±0.03	0.35±0.06
Cypermethrin	0.22±0.04	0.21±0.08	0.22±0.06	0.25±0.05	0.31±0.07	0.28±0.03
Control	0.39±0.02	0.57±0.01	0.48±0.01	0.48±0.07	0.66±0.03	0.57±0.03
Mean	0.25±0.02	0.32±0.03		0.31±0.02	0.42±0.01	
LSD (0.05) plant extracts		0.08			0.10	
LSD (0.05) freq. app.		0.05			0.06	
LSD (0.05) plant ext. × freq. app.		0.12			0.14	

Table 6. The effect of aqueous botanicals and synthetic insecticides on dry grain yield (kg/ha) from Cowpea, *V. unguiculata* under frequency application.

Plant Extracts	Frequency of Application					
	2014			2015		
	Once a week	Once in 2 weeks	Mean	Once a week	Once in 2 weeks	Mean
A. conyzoides	1492±167	802±121	1147±180	1047±26	718±14	883±94
C. papaya	814±50	536±88	675±77	625±104	519±50	572±69
G. arborea	1034±24	661±118	847±99	991±146	646±391	819±203
V. amygdalina	805±104	613±105	709±79	730±98	510±3	620±93
Cypermethrin	2998±98	1848±635	2423±386	1666±8	956±37	1311±71
Control	778±73	488±58	633±77	512±124	406±505	459±44
Mean	1320±194	824±148		929±23	626±48	
LSD (0.05) plant extracts		401.1			351.3	
LSD (0.05) freq. app.		231.6			202.8	
LSD (0.05) plant ext. × freq. app.		567.2			496.8	

1320 kg/ha of cowpea which was significantly different when compared to plots sprayed once in two weeks which produced 824 kg/ha of cowpea in 2014 trial. The results obtained from 2015 experiment, showed that once a week spray produced 929 kg/ha of cowpea, which was higher than the results obtained from once in two weeks application (626 kg/ha), however there was no significant effect between the two frequencies ($p>0.05$).

The grain yield per plot significantly ($p<0.05$) increased in all the tested plant extracts and the synthetic insecticide compared with the control. However, their efficacies varied from one treatment to another with the plants that received Cypermethrin producing the highest mean number (2423 kg/ha) of dry grain yield (kg/ha) in 2014 experiment. Plots treated with *A. conyzoides* gave a grain yield (1147 kg/ha), *G. arborea* extract (847 kg/ha), *V. amygdalina* extracts (620 kg/ha) and *C. papaya* extract (675 kg/ha). In 2015, the trend of results was not different from the results obtained in 2014 experiment with plots that was sprayed with Cypermethrin recording the highest dry grain yield (1311 kg/ha) followed by *A. conyzoides* extracts (883 kg/ha) *G. arborea* extracts (819 kg/ha), *V. amygdalina* extracts (620 kg/ha) and *C. papaya* extracts (572 kg/ha). The least dry grain yield (633 and 459 kg/ha) was harvested from the unprotected plots (control) in the two respective seasons.

DISCUSSION

With the exception of *A. craccivora* on the first season planting, all the major insect pests of cowpea – *M.*

sjostedti, *M. vitrata* and pod sucking bugs occurred in the study area, Umudike during the cropping seasons. Singh and Jackai (1985) reported that these insect pests usually occur wherever cowpea is cultivated in Nigeria. The absence of *A. craccivora* could probably be ascribed to the following reasons: (a) the non-cultivation of cowpea in this zone for several years, (b) weather factor which could have possibly hindered aphid migratory activity, as rains were heavy and frequent in 2014 season (c) the drift of chemicals from neighbouring farm. The absence of *A. craccivora* indicated in this study agrees with the findings of Degri and Hadi (2000) who reported from Bauchi, the absence of *A. craccivora* on field cowpea under heavy rain fed condition. Similar reports on the absence of *A. craccivora* cowpea plots have also been documented by Egho et al. (2014). Perhaps, *A. craccivora* would prefer a warm weather mixed with rains. In 2015 season, *A. craccivora* appeared early in all plots in the study area probably because of a short dry spell which could have enhanced the establishment of the insect colonies.

Findings from this research revealed that frequency of application have a significant effect on the relative abundance of insect pests affecting cowpea. The results indicate that application of aqueous plant extracts and Cypermethrin significantly reduced on cowpea the population and damage by all the major insect pests of cowpea once a week than once in two weeks. From the data, the study indicates that once a week spray/application is more productive and effective than once in two weeks spray. This result did not agree with Egho (2011) who reported that calendar schedule (seven and ten days' sprays) and monitored spray were not significantly different in their effect with pest number and yield.

Comparing the grain yield obtained from the two regimes of application, once a week application of treatments gave higher yield in both years (2014 and 2015 cropping seasons), than once in two weeks application. Grain yields obtained in this study compared favourably with grain harvested from Bauchi, Northern Nigeria (Degri and Hadi, 2000), Mokwa and Bida (Afun et al., 1991) and Asaba and Abraka (Egho, 2011). The results showed that cowpea production could be more profitable when treatments were applied once a week.

The use of plants, plant material or crude plant extracts for the protection of crops and stored products from insect pests have been recorded as one of the oldest crop protection methods (Thacker, 2002). Statistical analysis of the result showed that application of plant extracts on cowpea plants significantly ($p<0.05$) reduced the population of insect pests when compared to 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* and *M. vitrata* very quickly and reduced their population by about 70% compared to untreated control treatment. Furthermore, the results obtained during the experimental period showed that the plots treated with *A. conyzoides*, *V. amygdalina* and *G. Arborea* extracts gave significant ($p<0.05$) control of *M. sjostedti* than control treatments. The high potentials observed under these plant extracts could be attributed to insecticidal properties they contain that are lethal to a wide range of insects including thrips and cowpea pod borer (*M. vitrata*). This is in line with the results reported by Oparaeke (2006) which showed that *G. arborea* (stem bark or leaf) has better insecticidal properties as could be observed in its performance when in mixtures with other plants where thrips number per flower was lower (<1.0) compared with other treatments (except the synthetic insecticide check).

The high effectiveness of cypermethrin compared to *G. arborea*, *V. amygdalina*, *C. papaya* and *A. conyzoides* could also be associated with its standardized active ingredient formulations that have ''knockdown'' effects on pests immediately on exposure, like all pyrethroids do (Hills and Waller, 1988) whereas the low efficacy of the plant extracts could be, among other reasons, due to lack of the ''knockdown'' effect and rapid breakdown (non-persistence). The plant materials reduced population density of the insects mainly due to contact toxicity and acting upon the nervous system of the insects. The effectiveness of the synthetic insecticide is a confirmation of the earlier report of Brooke and Hines (1999) that chemical insecticides have been the primary control agent for agricultural pests.

Doubtless, the yield is the ultimate goal of the farmers and therefore, the quantity and quality of the harvested farm produce will depend on the soil fertility and insect pests infestation levels (Dent, 1991). The efficacy of these plant extracts were corroborated with the significant increase in grain yields recorded on plots where they were applied. The results indicated that the application of these extracts during the podding stage of cowpea considerably enhanced the grain yields obtained than those from the unsprayed control plots suggesting that damage inflicted on cowpea by insect pests were responsible for the significant reduction in grain yield observed under the control plots. The significant increase in grain yields recorded on plots treated with plant extracts compared to untreated control plots may therefore be attributed to the role of the plant extracts in reducing the incidence of pests.

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