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Full Length Research Paper

Evaluation of four insecticide formulations for the management of insect pests of cowpea

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ABSTRACT

Field trials were conducted in two locations (IAR Research Farm Samaru, Zaria, Kaduna State (Lat.11^{o} 11'N and 7^{o} 38'N) and Wase, in Minjibir local government of Kano State (Lat. 12 10^{0} 60.00^{11} and 8 40^{0} 0.00^{11} E), under rainfed conditions in the northern Guinea Savannah and Sudan Savannah of Nigeria. Each plot consisted of seven ridges (five main ridges and two discard ridges, one on either side of the main ridges) and spaced at 0.75 m apart. Each plot size was 26.25 m^2 (gross) and separated by a 1.5 m wide border margin on all sides. Four insecticide formulations: Chlorpyrifos 480 E. C. (Chlorpyrifos 480 g/L E.C), Chlorpyrifos plus (Chlorpyrifos 475 g/L+ Cypermethrin 47.5 g/L), Dimethoate 400 E. C. (Dimethoate 400g/L) Imidacloprid 70WG (Imidacloprid 70 WG.), (each applied at 1.5, 1.0 and 0.5 litre per hectare and 0.5, 1.0 and 1.5 kg/ ha for Imidacloprid), standard check (Cyperdicot) at 1.0 l/ha and an untreated control. All the treatments were replicated three times. The treatments were arranged in a randomized complete block design (RCBD). Population of thrips, *Megalurothrips sjostedti* Tryb., *M. vitrata* and *C. tomentosicollis* were sampled 24 hours before and after each spray for three weeks. All data were analyzed using Analysis of Variance (ANOVA) with SAS package and treatment means separated by Duncan Multiple Range test at 5 % level of significance. The results showed that all the four insecticides effectively reduced the population and infestation of insect pests and reduced flower abortion compared to untreated control.

Keywords: *Clavigralla tomentosicollis,* Insecticides, *Megalurothrips sjostedti, Maruca vitrata.*

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is an important grain legume in the tropics and subtropics. It is native to central Africa and belongs to the family Fabaceae (Cobley, 1956). Cowpea is eaten in the form of grain, green pods, and leaves (Adejumo, 1997). The roots are eaten in Sudan and Ethiopia, and the peduncles and stems are used as source of fibres in Nigeria (Adejumo, 1997). More than 11 million hectares are cultivated worldwide, 97 % of which is in Africa. Nigeria cultivated 4.5 million hectares annually representing over 60 % of total production (FAO, 2011). The major producing states in Nigeria include; Kaduna, Katsina, Zamfara, Bauchi, Sokoto, Kebbi, Plateau, Adamawa, Taraba, Gombe, Borno, Yobe, Jigawa, Niger, Benue, Nassarawa and Kano where most cowpeas are traditionally grown as intercrops with cereals such as millet, maize and sorghum(Steele, 1965; Emechebe and McDonald, 1979). In Nigeria, cowpea yield is very low, grain yield ranges between 100 and 300 kg/ha. This is due to several constraints such as weather, parasitic weeds, insects, and diseases. However, production can be improved through the use of improved pest-resistant and high-yielding varieties. In general, plant insect pests, diseases and weeds impose a serious threat to crop production in Nigeria. Population of weeds, insect pests and diseases have increased over the years especially by the introduction of monoculture farming in the country. The major pests of cowpea in the field in northern Nigeria, Niger, and Burkina Faso include: the legume pod borer, *Maruca vitrata* Fabricius; the coreid pod-bugs, *Clavigralla tomentosicollis* Stal and *Anoplocnemis curvipes* (F.); the groundnut aphid, *Aphis craccivora* Koch; and, thrips, *Megalurothrips sjostedti* Trybom and *Sericothrips occipitalis* Hood. Yields are however, Generally low, sometimes total yield losses and crop failure occur, due to the activities of a spectrum of insect pests which ravage the crop in the field at different growth stages. Due to the devastating effect of insect pests of Cowpea at almost every stage of its development, several approaches have been adopted in its control. Research into the control of these insect pests has centred primarily on the use of synthetic insecticides (Echendu, 1991). Amongst the insecticides are Azodrin, Thiodan DDT, Dursban and Dimecron, which have been found to be effective against the leafhoppers. Over the years, chemical pesticides had made a great contribution to the fight against pests and diseases. However, their widespread and long-term use resulted in insecticide resistance and biomagnifications of insecticides, which in turn resulted in restrictions on their export. Insect pests of cowpea have mainly been controlled with synthetic insecticides (Kabaru and Gichia, 2001; Alao and Adebayo, 2011).Therefore, this present work aimed at evaluating four synthetic insecticide formulations for the management of insect pests of cowpea.

MATERIALS AND METHODS

Study Area

Field trials were conducted in two location: IAR Research Farm Samaru, Zaria (Lat.11 11^{0}N and 7 38^{0}N) and Wase (Lat. 12 10^0 60.00^{11} and 8 40^0 0.00^{11} E) in Minjibir local government of Kano state) under rain fed conditions in the Guinea Savannah and northern sudan of Nigeria, respectively, with mean annual rainfall between 150 to 350 mm and temperatures range from 25 – 32 ^{0}C in the dry harmattan and harvest period (November - December). The temperature fluctuates from 18 – 24 ^{0}C. The soil type of Samaru is clay-loam with organic matter content less than 0.02 % and sandy loam at Wase. The colour of the topsoil varies from a slight- brown to dark-brown and the pH ranges from 6.5 - 8.5 (IAR, 2005).

Site Preparation and Experimental Layout

The fields were sprayed with Glyphosate (5 l/ha) to control grasses, sedges, some broad leaf and creeping weeds. After two weeks, the fields were disc harrowed and ridged.

An area measuring 1,671.9 m^2 each was marked out for the experiment with three replications (blocks) and each replication consisted of 14 plots each measuring 5.25 m x 5 m. Each block was separated from the next by a distance of 1.5 m. Each plot consisted of seven ridges (five main ridges and two discard ridges, one on either side of the main ridges) and spaced at 0.75 m apart. Each plot size was 26.25 m^2 (gross) and separated by a 1.5 m wide border margin on all sides. Four insecticide formulations: Chlorpyrifos 480 g/L E.C, Chlorpyrifos 475 g/L + Cypermethrin 47.5 g/L, Dimethoate 400 g/L, Imidacloprid 70 WG, standard check (Cypermethrin +Dimethoate) and untreated control. Each was applied at 1.5, 1.0 and 0.5 litre per hectare as follows: (Chlorpyrifos; 720 g a.i./ha, (480 g a.i./ha, and 240 g a.i./ha Chlorpyrifos plus; 712.5 g a.i. + 71.25 g a.i./ha, 475 g a.i. + 47.5 g a.i. /ha, and 237.5 g a.i. + 23.75 g a.i. /ha; Imidacloprid; 105 g a.i./ha, 70 g a.i. /ha and 35 g a.i. /ha; Dimethoate; 600 g a.i/ ha, 400 g a.i./ha, and 200 g a.i./ha, standard check (Cyperdicot ; 250+ 30 g a.i. /ha) and an untreated control were also used. All the treatments were replicated three times. The treatments were arranged in a randomized complete block design (RCBD).

Cowpea Variety and Sowing

Cowpea variety, SAMPEA 6 characterised by extra- large white seed with black eye, rough seed coat texture, adapted to Sudan and Guinea savannah. Late maturing (90 – 100 days), with estimated yield of 1000 – 1500 kg/ha, spreading habit, susceptible to scab, bacterial blight, septorial leaf spot, brown blotch, susceptible to beetles, thrips, *Maruca* pod borer, pod sucking bugs and chrysomelids. Seeds were dressed with Apron Star (Metalaxyl + Thiomethoxam) (1 sachet 10g /2 kg seed) and was sown three seeds per hole at 0.2 m apart intra row in the second week of August in both locations. Seedlings were thinned to two plants per stand two weeks after sowing (WAS). Compound fertilizer (NPK 15:15:15) was applied as side dressing at the rate of 37.5 kg a. i. / ha two WAS. Fungicide, Mancozeb extra 80wp (Mancozeb 650g/kg + Carbendazim 150 g/kg wp) was applied at the rate of 1.5 kg/ha before flowering.

Insecticide Treatment

Field applications of insecticides at varying levels (dosages); 0.5, 1.0, and 1.5 lha^{-1} using a 20 litre CP3 Knapsack sprayer commenced at 8 WAS which coincided with the period of onset of flowers in this cowpea variety. Foliar spraying started from 9.00 a.m. each day after insects sampling. All the insecticides were sprayed once every week for three weeks

Insects Sampling

Population of thrips, *Megalurothrips sjostedti* Tryb., pod sucking bugs, *Clavigralla tomentosicollis* and cowpea pod borers, *Maruca vitrata* were monitored. Twenty flowers were randomly removed from 10 plants per plot weekly

Table 1. Effect of insecticides rates on *M. sjostedti* population on cowpea flowers at Samaru and Wase

Treatment (g a.i/ha)	SAMARU- ZARIA						WASE-MINJIBIR					
	WEEK1		WEEK2		WEEK3		WEEK1		WEEK2		WEEK3	
			Mean Population	Thrips	Per- plant				Mean Thrips		Population per-plant	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Chlorpyrifos 240	8.67^{b}	0.71^{b}	1.22^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	6.67^{bcd}	0.81^{b}	1.33^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
480	4.67^{c}	0.71^{b}	1.05^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	3.67^{d}	0.81^{b}	1.00^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
720	8.67^{b}	0.88^{b}	1.68^{b}	0.71^{c}	0.71^{c}	0.71^{c}	6.67^{bcd}	0.90^{b}	2.00^{b}	0.71^{c}	0.71^{c}	0.71^{c}
Chlorpyrifos plus 237.5+23.75	6.33^{bc}	0.71^{b}	1.05^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	6.67^{bcd}	0.90^{b}	1.33^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
475+47.5	7.33^{bc}	0.71^{b}	1.05^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	6.67^{bcd}	0.71^{b}	1.33^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
712+71.2	5.67^{bc}	0.71^{b}	0.88^{c}	0.71^{c}	0.71^{c}	0.71^{c}	5.00^{cd}	0.71^{b}	0.67^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
Dimethoate 200	8.33^{b}	0.88^{b}	1.22^{bc}	0.71^{c}	0.71^{c}	1.25^{b}	7.00^{abcd}	0.71^{b}	1.33^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
400	6.67^{bc}	0.71^{b}	1.17^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	6.67^{bcd}	0.71^{b}	1.00^{bc}	0.71^{c}	0.71^{c}	0.71c
600	7.67^{bc}	0.71^{b}	1.05^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	4.57^{cd}	0.81^{b}	1.33^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
Imidacloprid 35	13.67^{a}	0.71^{b}	1.32^{bc}	1.38^{b}	1.18^{b}	1.18^{b}	10.33^{a}	0.71^{b}	0.90^{bc}	0.71C	1.81^{b}	1.12^{B}
70	6.33^{bc}	0.71^{b}	1.05^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	7.00^{abcd}	0.71^{b}	1.33^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
105	9.00^{b}	0.71^{b}	1.05^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	7.00^{abcd}	0.71^{b}	1.67^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
Cyperdicot 250+30	7.33^{bc}	0.71^{b}	1.46^{bc}	0.71^{c}	0.71^{c}	0.71^{c}	7.33^{abc}	0.71^{b}	1.33^{bc}	0.71^{c}	0.71^{c}	0.71^{c}
Control	8.00^{bc}	2.66^{a}	2.74^{a}	2.41^{a}	2.48^{a}	2.34^{a}	9.67^{ab}	6.67^{a}	6.33^{a}	7.00^{a}	6.00^{a}	4.00^{a}
S.E +	1.08	0.09	0.23	0.18	0.13	0.15	1.06	0.25	0.36	0.57	0.29	0.41

Mean followed by different letter (s) in the same column are significantly different at 5% probability level of significant

before and after spraying and stored in a solution of 30 % ethanol. The keels of the flowers were separated in a Petri dish under a binocular microscope to free the thrips and *Maruca* pod borers before counting the insects. The counts were converted to log number before analysis (Dina, 1982). Insect pests sampling was conducted 24 hours before and after each spray every week between 7.00 and 8.00 a.m. (that is the period the insects are less active). The flowers were then taken to the laboratory and dissected. Thrips found were counted and recorded. *M. vitrata* and *C. tomentosicollis* were also sampled 24 hours after each spray for three weeks. *M. vitrata* was sampled by removing 20 flowers at random per plot and placed in vials containing 30 % ethanol. It was then taken to the laboratory where larvae found were counted and recorded accordingly. *C. tomentosicollis* were sampled visually and the number of the bugs on 5 plants/ plot randomly selected.

Number of aborted flowers/plant by counting the number of flowers that drop on the ground from five stands selected randomly at 10 WAS.

Data Analysis

All data were analyzed using Analysis of Variance (ANOVA) with SAS package (SAS, 2003) and treatment means separated by Duncan Multiple Range Test.

(DMRT) at 5% level of significant (SAS Institute, 2003).

Table 2. Effect of insecticide rates on *M. vitrata* population on cowpea flowers/ pods at Samaru and Wase

Treatment (g a.i/ha)	SAMARU-ZARIA						WASE-MINJIBIR					
	WEEK1		WEEK2		WEEK3		WEEK1		WEEK2		WEEK3	
	Mean *M. Vitrata* population Per- plant						Mean *M. Vitrata* population Per- plant					
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Chlorpyrifos 240	6.33^{bc}	1.33^{b}	1.00^{cd}	0.71^{b}	0.81^{b}	0.71^{b}	6.67^{ab}	1.33^{bc}	1.33^{cd}	0.71^{b}	0.71^{b}	0.71^{b}
480	6.00^{bc}	0.71^{b}	1.24^{bcd}	0.71^{b}	1.24^{b}	0.71^{b}	5.00^{bcd}	1.00^{bcd}	1.00^{d}	0.81^{b}	1.00^{b}	0.71^{b}
720	6.67^{abc}	1.33^{b}	0.90^{cd}	0.71^{b}	0.90^{b}	0.71^{b}	6.67^{ab}	1.67^{b}	1.00^{d}	0.81^{b}	0.67^{b}	0.71^{b}
Chlorpyrifos plus												
237.5+23.75	5.67^{bc}	0.90^{b}	0.90^{cd}	0.71^{b}	0.71^{b}	0.71^{b}	5.33^{abcd}	1.00^{bcd}	0.90^{d}	0.71^{b}	0.81^{b}	0.71^{b}
475+47.5	5.00^{bc}	0.81^{b}	0.90^{cd}	0.71^{b}	0.90^{b}	0.71^{b}	5.00^{bcd}	0.71^{cd}	1.57^{bc}	0.81^{b}	0.90^{b}	0.71^{b}
712+71.2	6.67^{bc}	1.24^{b}	0.90^{cd}	0.81^{b}	0.81^{b}	0.71^{b}	7.00^{a}	0.90^{cd}	0.90^{d}	0.90^{b}	0.81^{b}	0.71^{b}
Dimethoate 200	5.33^{bc}	0.90^{b}	0.71^{d}	0.71^{b}	0.81^{b}	0.71^{b}	5.00^{bcd}	0.57^{d}	0.81^{d}	0.71^{b}	0.90^{b}	0.71^{b}
400	6.00^{bc}	2.00^{b}	1.67^{b}	0.71^{b}	0.71^{b}	0.71^{b}	5.67^{abcd}	0.81^{cd}	0.90^{d}	0.81^{b}	0.90^{b}	0.71^{b}
600	5.33^{bc}	2.00^{b}	1.33^{bc}	0.81^{b}	0.90^{b}	0.71^{b}	5.00^{bcd}	0.81^{cd}	2.00^{b}	0.71^{b}	0.71^{b}	0.71^{b}
Imidacloprid 35	10.00^{a}	0.90^{b}	0.81^{cd}	0.81^{b}	2.14^{b}	0.71^{b}	4.67^{cd}	0.81^{cd}	0.90^{d}	0.71^{b}	0.81^{b}	2.47^{a}
70	6.00^{bc}	0.71^{b}	1.00^{cd}	0.71^{b}	0.81^{b}	0.71^{b}	5.00^{bcd}	1.67^{b}	0.90^{d}	0.71^{b}	0.81^{b}	0.71^{b}
105	5.00^{bc}	0.81^{b}	0.71^{d}	0.71^{b}	1.00^{b}	0.71^{b}	4.33^{cd}	0.81^{cd}	0.90^{d}	0.71^{b}	1.00^{b}	0.71^{b}
Cyperdicot 250+30	3.67^{c}	2.00^{b}	0.90^{cd}	1.00^{b}	0.91^{b}	0.71^{b}	4.00^{d}	1.67^{b}	0.90^{d}	0.81^{b}	0.71^{b}	0.71^{b}
Control	8.00^{ab}	6.67^{a}	7.00^{a}	5.33^{a}	5.67^{a}	5.00^{a}	6.00^{abc}	5.00^{a}	3.33^{a}	3.67^{a}	3.67a	3.67^{a}
S.E +	1.13	1.46	0.18	0.20	0.45	0.15	0.56	0.21	0.18	0.11	0.14	0.49

Mean followed by different letter (s) in the same column are significantly different at 5% probability level of significance

RESULTS

Effect of insecticides rates on *Megalurothrips. sjostedti* population on cowpea flowers at Samaru and Wase during 2012 cropping season

The effect of different rates of insecticides on *M. sjostedti* population is shown on Table 1. The result showed that there was significantly higher *M. sjostedti* population on the cowpea flowers at Samaru than Wase before insecticide application. After first week of insecticide application there was significant difference ($p<0.05$) between the insecticide treated plots and untreated control, but there was no significant difference among the insecticidal treatments in the two locations. Before the second application of the insecticides, the untreated control had the highest ($p<0.05$) thrips population compared with the insecticides treated plots. After the second week of application, the insecticidal treatments drastically reduce ($p<0.05$) thrips population in treated plots compared with the untreated control but there was also no significant difference among the treated plots except for Imidacloprid at 35 g a. i/ha at Samaru with higher($p< 0.05$) insect population. At the third week of insecticide application, there was no significant difference before spraying among the treated plots except for Imidacloprid (35 g a.i/ha). Higher number of thrips ($p<0.05$) was observed in the untreated plots compared with the treated plots in both locations. After third week of spraying, the thrips population was significantly reduced ($p<0.05$) in insecticides treated plots compared with untreated plots. However, among the treated plots, there were significant differences ($p<0.05$) between Dimethoate (200 g a.i/ha) and Imidacloprid (35 g a. i./ha) only in Samaru compared with other insecticide treated plots in Samaru which were not significantly different and Imidacloprid (35 g a.i/ha) in Wase only (Table 1). There were no significant difference among various rates of insecticides at first and second week except for Imidacloprid at 35 g a.i./ha which was significantly higher ($p<0.05$) than at 70 and 105 g a. i. /ha, the same thing at third week in Samaru. In Wase, there was no significant difference at first and second week of application among the various rates but higher *M. sjostedti* population was recorded in plot treated with Imidacloprid at 35 g a.i. /ha compared to other higher rates. All the insecticides at various rates performed significantly better than the untreated control (Table 1).The population of thrips was reduced by almost hundred percent. For instance, the plots treated with Chlorpyrifos at 240 g a. i/ha reduced from 8.67 to 0.71 at Samaru. Similarly the insects' population were reduced from 10.33 to 0.71 after spraying Imidacloprid at 35 g a. i./ha at Wase.

Effect of insecticides rates on *Maruca. vitrata* population on cowpea flowers and pods at Samaru and Wase in 2012 cropping season

The effect of insecticides and rates on the cowpea pod borer *M. vitrata* population on cowpea after the first week of insecticidal treatments, there was significant difference ($p<0.05$) among the different treatments (Table 2) in both locations, but no significant difference among the insecticides in Samaru. In Wase, Cyperdicot (250+30 g a.i/ha), Chlorpyrifos (720 g a.i/ha, Imidacloprid (70 g a.i/ha) and Chlorpyrifos plus (712 g a.i/ha) showed significantly higher ($p<0.05$) number of *M. vitrata* compared with Dimethoate at 200 g a.i/ha, Chlorpyrifos plus at 475+47.5 g a.i/ha and 712+71.2 g a.i./ha, Dimethoate at 400 and 600 g a.i/ha and Imidacloprid at 35 and 105 g a.i/ha. The results of *M. vitrata* populations before spraying also showed that there was significant difference ($p<0.05$) among the insecticidal treated plots and the untreated control in both locations. After the second week application of treatment, there was significant reduction ($p<0.05$) of *M. vitrata* in the insecticidal treated plots compared with untreated control but there was no significant difference among the insecticidal treatments in both Samaru and Wase. After the second week of application, there was a significant reduction ($p<0.05$) of *M. vitrata* in the insecticide treated plots compared to the untreated control, but no significant differences among the insecticidal treatment in Samaru. However, significant differences ($p<0.05$) were recorded among the insecticidal treatments in Wase. Plots treated with Imidacloprid at 35 g a.i/ha had higher ($p<0.05$) *M. vitrata* than other insecticidal treatment but not significantly different from untreated control in Wase. There was significant lower ($p<0.05$) *M. vitrata* population count at first week in plot treated with Imidacloprid at 70 g a.i. /ha than at 35 and 105 g a.i. /ha only in Wase.

Population of *M. vitrata* reduced drastically with insecticide treatments. For instance, the population of the insects were reduced from 6.67 t0 1.33 in plots treated with Chlorpyrifos at 720 g a.ai./ha in Samaru and from 6.67 1.33 in plots treated with Chlorpyrifos at 240 g a.i./ha in Wase. The same trend followed for the rest of the insecticide treatments in both locations.

Effect of insecticides rates on *Clavigralla tomentosicollis* population on cowpea pod at Samaru and Wase in 2012 cropping season

The effect of insecticides rates on *C. tomentosicollis* population on cowpea pod is shown in Table 3 which indicated that after the first week of treatment application, there was significant reduction ($p<0.05$) in the population

Table 3. Effect of insecticide rates on C. *tomentosicollis* population on cowpea pods at Samaru and Wase

	SAMARU-ZARIA						WASE-MINJIBIR					
	Mean *C.tomentosicollis*		**Population per-plant**				**Mean *C.tomentosicollis***		**Population per-plant**			
Treatment (g a.i./ha)	**WEEK1**		**WEEK2**		**WEEK3**		**WEEK1**		**WEEK2**		**WEEK3**	
	Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Chlorpyrifos 240	8.67^{a}	4.67^{bc}	4.00^{bc}	2.67^{cd}	3.00^{cd}	1.33^{bc}	5.67^{cde}	4.00^{bc}	3.67^{b}	2.33^{bcd}	2.67^{bc}	1.24^{bc}
480	7.67^{abc}	2.00^{efg}	2.66^{cde}	1.67^{defg}	2.00^{cde}	1.33^{bc}	8.33^{a}	1.67^{e}	3.67^{b}	2.67^{bc}	2.00^{cd}	1.00^{bc}
720	8.00^{ab}	2.33^{efg}	3.00^{cde}	2.00^{cdef}	1.67^{de}	1.24^{bc}	7.67^{ab}	1.67^{e}	2.67^{cd}	1.67^{def}	2.00^{cd}	0.90^{bc}
Chlorpyrifos plus 237.5+23.75	5.67^{cde}	2.00^{efg}	1.67^{ef}	1.33^{efg}	1.00^{e}	0.81^{bc}	8.67^{a}	2.67^{cde}	1.33^{ef}	0.90^{f}	1.33^{d}	0.81^{c}
475+47.5	9.33^{a}	1.67^{fg}	2.33^{def}	1.33^{efg}	2.00^{cde}	1.00^{bc}	7.00^{ab}	2.00^{de}	4.00^{b}	2.67^{bc}	2.00^{cd}	1.00^{bc}
712+71.2	6.00^{bcd}	2.67^{def}	3.33^{cd}	2.33^{cde}	2.33^{cde}	0.90^{bc}	4.67^{def}	2.67^{cde}	2.33^{cde}	1.33^{ef}	1.67^{cd}	1.00^{bc}
Dimethoate 200	4.67^{de}	3.33^{cde}	3.33^{cd}	1.67^{defg}	1.67^{de}	0.90^{bc}	3.67^{f}	1.67^{e}	2.33^{cde}	1.67^{def}	2.00^{cd}	0.90^{bc}
400	3.67^{de}	1.00^{g}	1.67^{ef}	1.00fg	1.33^{de}	0.81^{bc}	4.33^{ef}	2.24^{de}	1.33^{ef}	1.00^{f}	1.67^{cd}	0.90^{bc}
600	3.67^{de}	2.00^{efg}	2.67^{cde}	1.67^{defg}	1.33^{de}	0.81^{bc}	5.67^{cde}	2.67^{cde}	2.33^{cde}	1.00^{f}	1.00^{d}	0.90^{bc}
Imidacloprid 35	4.00^{de}	4.00^{cd}	4.00^{bc}	3.00^{c}	2.33^{cde}	0.90^{bc}	4.00^{ef}	3.33^{bcde}	3.33^{bc}	2.00^{cde}	1.67^{cd}	0.90^{bc}
70	4.00^{de}	2.10^{efg}	7.00^{a}	5.67^{a}	4.67^{ab}	2.24^{bc}	6.36^{bcd}	4.67^{b}	1.67^{def}	1.33^{ef}	2.00^{cd}	1.67^{b}
105	3.33^{e}	1.00^{g}	1.00^{f}	0.90^{g}	1.67^{de}	0.71^{c}	3.00^{f}	2.00^{de}	1.00^{f}	0.90^{f}	0.90^{ssd}	0.81^{c}
Cyperdicot 250+30	8.33^{a}	4.33^{c}	5.00^{b}	4.00^{b}	3.67^{bc}	1.33^{bc}	6.33^{bcd}	3.67^{bcd}	4.00^{b}	3.00^{b}	3.33^{b}	1.67^{b}
Control	8.33^{a}	7.00^{a}	8.00^{a}	6.33^{a}	5.67^{a}	6.33^{a}	8.33^{a}	7.67^{a}	8.33^{a}	6.67^{a}	5.67^{a}	6.67^{a}
S.E +	0.72	0.48	0.48	0.32	0.54	0.98	0.60	0.51	0.62	0.26	0.33	0.25

Means followed by different letter (s) in the same column are significantly different at 5% probability level of significance

of the insects in the treated plots compared with untreated control which had highest population of *C. tomentosicollis* in both locations during the season. Significant differences (p<0.05) were also recorded among the insecticides treated plots. Imidacloprid(105 g a.i/ha). Dimethoate (400 g a.i /ha), Chlorpyrifos plus (237.5+23.75, 475+47.5 and 712+71.2 g a.i/ha), Chlorpyrifos at 480 and 720 g a.i/ha had the lowest insect population compared to other insecticide treated plots. At the second week before spraying, the population count of *C. tomentosicollis* was higher and significantly different (p<0.05) in the control than in the insecticide treated plots, except for plots treated with Imidacloprid at 70 g a.i/ha. There were significant differences among the insecticide treated plots, where Imidacloprid (105 g a.i/ha) showed significantly lower (p<0.05) *C. tomentosicollis* counts. Chlorpyrifos at 237.5+23.75 g a.i./ha and Dimethoate at 400 g a.i./ha had significantly lower (p<0.05) pod sucking bugs counts than Chlorpyrifos at 240 g a.i./ha, Imidacloprid (35 g a.i./ha and 70 g a.i./ha) and Cyperdicot (250+30 g a.i./ha) in Samaru. Similarly, in Wase, significant differences (p<0.05) were recorded between the insecticide treated plots and untreated control, on one hand and among insecticide treated plots, on the other. Imidacloprid at 105 g ai./ha had significantly lower (p<0.05) *C. tomentosicollis* population than other insecticidal treatments. Imidacloprid (70 g a.i./ha), Dimethoate at 200, 400 and 600 g a.i./ha and Chlorpyrifos plus at 237.5+23.75 g a.i./ha were also significantly different (p<0.05) from Chlorpyrifos at 240 and 480 g a.i./ha, Chlorpyrifos plus at 475+47.5 g a i./ha and Cyperdicot (250+30 g a. i./ha) in Wase. After the second week of insecticides application, there was significant difference (p<0.05) between insecticide treated

Table 4. Effect of insecticide rates on flower abortion of cowpea due to insect pest at Samaru and Wase

Treatment (g a.i./ha)		Aborted flowers	
		SAMARU	WASE
Chlorpyrifos	240	2.33^{b}	1.67^{bc}
	480	2.00^{bc}	1.67^{bc}
	720	2.00^{bc}	1.67^{bc}
Chlorpyrifos plus			
	237.5+23.75	2.00^{bc}	1.33^{bc}
	475+47.5	1.67^{bc}	1.33^{bc}
	712+71.2	2.33^{b}	1.33^{bc}
Dimethoate	200	1.67^{bc}	2.00^{b}
	400	1.00^{c}	2.00^{b}
	600	1.24^{bc}	0.67^{c}
Imidacloprid	35	1.00^{c}	1.00^{bc}
	70	1.57^{bc}	1.33^{bc}
	105	1.00^{c}	1.33^{bc}
Cyperdicot			
	250+30	1.67^{bc}	1.67^{bc}
Control		5.33^{a}	4.33^{a}
S.E +		0.36	0.31

Means followed by different letter (s) in the same column are significantly different at 5% probability level of significance

plots and untreated control in Samaru and Wase except for Imidacloprid at 70 g a.i./ha in Samaru only while significant differences (p<0.05) were also recorded among the insecticide treated plots. Imidacloprid at 105 g a.i./ha, Chlorpyrifos at 480 g a.i./ha, Chlorpyrifos plus at 237.5+23.75 and 475+47.5 g a.i./ha and Dimethoate at 400 g a.i./ha did not show any statistical difference with Cyperdicot (250+30 g a.i./ha) in Samaru. In Wase, there was also significant reduction (p<0.05) in *Clavigralla. tomentosicollis* population among the insecticide treated plots. At the third week of insecticide application, there was significant difference (p<0.05) in Samaru between the insecticide treated plots and untreated control before spraying except for Imidacloprid at 70 g a.i./ha. and among the insecticide treated plot. After application of insecticides, there was significant reduction (p<0.05) of *C. tomentosicollis* population compared with untreated control and among the insecticide treated plots in both locations (Table 3). Imidacloprid at 105 g a.i./ha had lowest insect population compared with other treated plots but not significantly different from other insecticide treatments in Samaru but was significantly different (p<0.05) from Cyperdicot (250+30 g a.i./ha) and Imidacloprid at 70 g a.i./ha only in Wase. There were also significant differences among the insecticidal treated plots; Chlorprifos plus (237.5+23.75 g a.i./ha), Imidacloprid at 105 g a.i./ha were significantly lower (p<0.05) than Cyperdicot (250+30 g a.i./ha) and Imidacloprid at 70 g a.i./ha among other insecticide treatments. At second week after insecticide application, plots treated with Chlorpyrifos at 480 g a. i. /ha were significantly different (p<0.05) from Chlorpyrifos at 720 g a.i. /ha, also significantly lower *C .tomentosicollis* was recorded in Chlorpyrifos plus at 237.5+ 23.75 g a.i. /ha than at 475+47.5 g a.i. /ha. Dimethoate at 400 and 600 g a.i. /ha had lower (p<0.05) *C. tomentosicollis* population count than at 200 g a. i. /ha. Imidacloprid at 105 g a.i. /ha had higher (p<0.05) *C. tomentosicollis* count than at 35 g a.i. /ha. At third week after application, Imidacloprid at 105 g a. i. /ha showed significantly lower (p<0.05) insect population count than at 70 g a.i. /ha.

Effect of insecticide rates on flower abortion of cowpea due to insect pest at Samaru and Wase in 2012 cropping season

The effect of insecticide rates on flower abortion of cowpea is shown on Table 4, the result showed that the untreated control plots had significantly higher (p<0.05) number of aborted flowers than the insecticide treated plots at both locations. Similarly, among the treated plots, there were significant differences (p<0.05); Chlorpyrifos at 240 g a.i./ha and Chlorpyrifos plus at 712+71.2 g a.i./ha had significantly higher (p<0.05) number of aborted flowers compared with Dimethoate at 400 g a.i./ha and Imidacloprid at 105 g a.i./ha in Samaru. However, in Wase-Minjibir, Dimethoate at 200 and 400 g a.i./ha had significantly higher (p<0.05) number of aborted flowers compared with Dimethoate at 600 g a.i./ha only. All other treated plots have no significant difference among each other.

DISCUSSION

Cowpea is known to shed up to 80 % of its flowers due to natural causes such as insect pests during development, and this could negatively affect pod formation (Ojehomon, 1968; Dzemo *et al*., 2010). Pod set could also be affected by other factors such as growing conditions, soil fertility, moisture content and flower abortion/damage by insect pests. Applications of different insecticides at various rates on cowpea plants showed that *Megalurothrips. sjostedti Maruca vitrata* and pod sucking bug (*Clavigralla tomentosicollis*) control are essential to guarantee sustainable production of the crop. *M sjostedti* is an important pest of the reproductive structures (flowers) of cowpea, with early feeding leading to flower bud and flower shedding, consequently poor pod setting (Singh & Taylor, 1978; Tamo *et al*., 1993). There is therefore usually the need for farmers to apply insecticides at appropriate rate during flowering to minimise such damage. Protecting the crop with insecticide application increased yields several fold (Tanzubil, 2000). In nature, peak populations of pod pests do not occur at early flowering unless the crop is planted late. Therefore, high levels of pod pests could lead to total loss of the crop, especially where there is little or no rain to trigger new flushes or re-growth. The study had shown that the four synthetic insecticide formulations (Chlorpyrifos, Chlorpyrifos plus, Dimethoate and Imidacloprid) were effective on *M. sjostedti* and pod borer (*Maruca vitrata*) population control since the unprotected plots had higher population counts and damage than insecticide protected plots. This result concurred with reports that application of insecticides generally reduces cowpea pest infestation and markedly increases crop yields (Karungi *et al*., 2000; Ebenezer, 2010). The result of this study on pod borer showed that two spray applications of these insecticides would not totally take care of the insects like the thrips, it was the third applications that actually reduced the population of the insects. The first application of insecticide treatments at onset of flowers reduced the insects (*Maruca. vitrata*) population and the second application further reduced the insect population which implies that application of these insecticides thrice could produce good yield of cowpea crop as four and five spray regimes as reported by Dina (1979). This is of critical importance from the point of view of lower costs, environmental hazards and the effects of spray frequencies and intensity on non-target organisms. The insecticide treatments application at flower budding controls thrips infestation and ensures optimal flowering. The second spray protects the pods from damage by pod borer and pod sucking bugs. Drastic reduction in population of *M. vitrata* was recorded which proved the effectiveness of the insecticide treatments as reported also by Ebenezer (2010).

The second and third applications could sustain the reduction of the insect's (pod borers) population couple with appropriate rates. *Clavigralla tomentosicollis* population shot up at second week of treatment because that was when the crop (cowpea) started podding. Imidacloprid at 70 g a.i./ha was less effective because high insects population count was recorded. Chlorpyrifos plus at 237.5+23.75 g a. i. /ha maintained lowest C. *tomentosicollis* population count in both locations. The drastic reduction in the population of insects under studied resulted from the killing of insects attributed to the knock down action of the insecticides, their active ingredients and mode of actions, as all except Chlorpyrifos plus who has both systemic and contact (Chlorpyrifos and Cypermethrin) are systemic which are absorbed by plant tissues and kill the sucking insects that feed on the crop (www.hedydchem. com., 2010).

On aborted flowers, plots treated with Chlorpyrifos at 240 g a. i./ha and Chlorpyrifos plus at 712+71.2 g a. i./ha had higher number of aborted flowers than other treatments in Samaru, but in Wase Dimethoate at 200 g a. i./ha showed higher aborted flowers than other treatments, although no significant difference was noticed. The different insecticides at various concentrations were very effective.

The percentage pod damage to number of pods obtained was very minimal. Chlorpyrifos at 240 and Dimethoate at 200g a. i. /ha recorded higher number of pods at Samaru while higher number of pods were obtained in Chlorpyrifos (720g a. i./ha) and Dimethoate(200g a. i./ha) at Wase compared to other treatments. Most of the insecticide treated plots had higher number of pods than the untreated control. Similarly, all the insecticide treated plots at Samaru produced higher number of pods than insecticide treated plots at Wase. The lowest number of pods (114.67) were obtained in plots treated with Dimethoate at 400g a.i./ha at Samaru while the lowest number of pods (80.00) was gotten from plots treated with Chlorpyrifos plus at 475+47.5 g a.i./ha at Wase. On pod damage, Figure 2.0, all the insecticide treated plots had lower pod damage than untreated plots. The lowest pod damaged (2.67) was observed in plots treated with Dimethoate at 200 g a.i./ha in Samaru while the lowest pod damage (3.17) was obtained in plots treated with Chlorpyrifos at 240 g a.i./ha at Wase. Untreated plots had highest pod damage (9.00 and 9.10) in both locations respectively. Pod damage was higher (6.67) compared to other insecticide treated plots at Samaru in plots treated with Dimethoate at 400 g a.i./ha while in Wase, plots treated with chlorpyrifos plus at 475 + 47.5 g a.i./ha and Dimethoate at 600 g a.i./ha had the highest pod damage. Results from this study then indicate that properly timed insecticide application remains an important strategy for suppressing cowpea insect pests on the field if properly managed.

CONCLUSION

This study showed that the four different insecticide formulations (Chlorpyrifos, Chlorpyrifos plus, Imidacloprid and Dimethoate) effectively reduced the infestation of *Megalurothrips sjostedti, Maruca vitrata,* and *Clavigralla tomentosicollis* on cowpea in both locations. There were significant differences in the three concentrations from 0.5, 1.0 and 1.5l/ha. Application of Imidacloprid at 105 g a. i./ha (1.5 l/ha) was most effective for the control of *C. tomentosicollis* at both locations. Hence, the lower concentrations (0.5 and 1.0 l/ha) of all the insecticides would be adequate to effectively manage the flowering and post flowering insect pests of cowpea such as *Megalurothrips sjostedti*, *Maruca vitrata* and *Clavigralla tomentosicollis* and increase productivity.

RECOMMENDATIONS

The four insecticide formulations (Chlorpyrifos, Chlorpyrifos plus, Dimethoate and Imidacloprid) could be used at the application rate of 0.5 l/ha - 1.0 l/ha to effectively reduce infestation of insect pests of cowpea and flower abortion. They could also be used complementarily with other pest control options to significantly improve cowpea grain yields, thereby generating income to poor farmers in rural areas.

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