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Full Length Research Paper

Yield performance of cowpea as influenced by insecticide types and their combinations in the dry savannas of Nigeria

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Insecticide spray offers the most effective control of insect pests where resistant varieties are not available as is the case with the legume pod borer and pod sucking bug complex. Field experiments were conducted in the northern Guinea and Sudan savannas (Samaru and Minjibir, respectively) zones of Nigeria during 2005 to 2007 rainy seasons to evaluate the efficacy of common and new insecticides in the Nigeria markets for field control of insect pests of cowpea. Post spray insect counts showed that the new insecticide combinations gave control of thrips, *Megalurothrips sjostedti* (Order: Thysanoptera, Family: Thripidae) statistically similar to Monocrophos. *Maruca vitrata* (Order: Lepidoptera, Family: Crambidae) population densities were significantly reduced by the application of the insecticide regime of Imidacloprid (first spray), Cypermethrin (second and third) which however was not different from Cypermethrin-Dimethoate. The no spray plots gave significantly higher fodder yield in Samaru. The highest mean grain yields at Minjibir were obtained from plots sprayed with Imidacloprid + Cypermethrin + Cypermethrin (1391 kg/ha) while highest mean grain yield (924 kg/ha) in Samaru was from Monocrophos applied three times. Considering safety issues and environmental concerns, Imidacloprid (first spray) and Cypermetrin (second and third sprays) is recommended in a three insecticide spray recommendation for cowpea cultivation, especially in the Sudan Savanna of Nigeria and three sprays of Cypermethrin-Dimethoate in the northern Guinea Savanna.

Key words: Cowpea, *Megalurothrips sjostedti, Maruca vitrata*, tricel, courage, grain yield.

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp. (Family: Fabacea)] is an important grain legume in West Africa and in many parts of the tropics (Singh et al., 2002). It provides an inexpensive source of protein and minerals for the urban and rural people of the region and is an important crop in the cereal-legume cropping systems, especially of the drought prone dry savannas of West Africa. However, the on-farm yields of cowpeas are very low in this region. The low on-farm grain yields averaging 25 to 300 kg/ha in West Africa (Rachie, 1985; Mortimore et al., 1997), and 150 to 400 kg/ha in Uganda (Sabiti et al., 1994) compared to 1500 to 3000 kg/ha in research Institute (Ajeigbe et al., 2005; Singh and Ajeigbe, 2002) are mainly due to a number of insect pests. Consequently, significant increases in yield are attained as a result of spraying. For example, Edema and Adipala (1996) attributed approximately 70% yield reduction to insect pest alone.

In Nigeria, Algahli (1992) realized yield increase of 50 to 200%, while Kyamanywa (1996) working in Kenya got

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a 15-fold increase in cowpea grain yield due to insecticide sprays. Insect pests cause maximum damage to cowpea from seedling stage to grain storage (Ajeigbe and Singh, 2006). The most damaging of all insect pests are those that occur during flowering and podding, and these include flower thrips, *M. sjostedti* (Order: Thysanoptera, Family: Thripidae), the legume pod borer, *M. vitrata* (Order: Lepidoptera, Family: Crambidae) and a complex of pod and seed suckers, of which *Clavigralla tomentosicollis* (Order: Hemiptera, Family: Coreidae) is the dominant species in Africa (Jackai and Adalla, 1997). According to Jackai et al. (1985), it is not possible to grow cowpea commercially without the use of insecticide sprays. This is due to the lack of acceptable level of resistance to pod borers and pod sucking bugs in the available germplasm lines including the crossable wide relatives (Fatokun et al., 1997). Therefore, the improved varieties still need 2 to 3 sprays of insecticides (Ajeigbe and Singh, 2006; Asante et al., 2001). Faced with the insect pest problems, some farmers have resorted to indiscriminate use of insecticides to reduce pest damages, sometimes applying as many as 5 to 7 times instead of the 2 to 3 times as recommended (Ajeigbe and Singh, 2006). Several insecticides are available in the market and some are extremely dangerous and may pose hazardous consequences to the user and the environment. Also, the use of insecticides must be minimized due to high cost and harmful effects on humans and the environment (Giliomee, 1997).

This study was undertaken to compare the effectiveness of common and new insecticides in the Nigerian market for cowpea insect pest management. The aim is to determine which insecticide type, combination and/or application sequence will provide best control of cowpea flower thrips, *M. sjostedti* and legume pod borer, *M. vitrata* and considering safety issues. Thus, a relatively safe insecticide could be recommended for high cowpea grain production.

MATERIALS AND METHODS

Location and land preparation

Trials were conducted during 2005, 2006 and 2007 crop seasons at the International Institute of Tropical Agriculture (IITA) Research farm, Minjibir (Sudan savanna) near Kano (12° 08' N, 8° 40' E) and the Institute of Agricultural Research (IAR), farm in Samaru (Northern Guinea savanna), near Zaria (11° 11' N, 7° 38' E) in northern Nigeria. The plots were disc harrowed twice, a basal dose of 100 kg NPK 15:15:15/ha was broadcasted and ridged prior to planting. Planting of the trial in each year was done in July, in Minjibir and August in Samaru following a good rain the previous day. A randomized complete block design with four replications was used. Each plot consisted of 4 rows, 5 m long, with an inter-row spacing of 0.75 m and hill-to-hill distance of 0.2 m within the rows. A blank row was left between each plot. To ensure proper stand establishment, four seeds were planted at each hill and thinned to two plants/hill a week after germination. The plots were kept weed-free using hand hoe at 3, 6 and 9 weeks after planting. During the spray operations, a polythene sheet was held between the plot boundaries to stop the drift of insecticide from plot to plot.

Varieties and insecticide treatments

The cowpea variety used was an improved medium maturing dual purpose variety (IT90K-277-2). This variety is very popular in the region and has also been released in several countries (Singh et al., 2006). Sprays were applied using a hand sprayer at the pre-flowering, 50% flowering (10 to 14 days after first spray) and at podding (10 to 14 days after second spray) stages of the crop. The treatments included 9 insecticide treatments and a control as follows:

1. Cypermethrin 10% EC three times (Cyper*3),
2. Imidacloprid 17.8% SL three times (Courage*3),
3. Chlorpyrifos 48% EC three times (Tricel*3),
4. Monocrotophos 40% SL three times (Mono*3),
5. Endosulfan 35% EC three times (Endosulfan*3),
6. Cypermetrin-Dimethoate EC at 30 g + 250 g ai ha^{-1} three times (Cyper-D*3),
7. Chlorpyrifos as 1st spray, Cypermethrin as 2nd and 3rd sprays (Tricel + Cyper + Cyper),
8. Monocrotophos as 1st spray, Cypermethrin as 2nd and 3rd sprays (Mono + Cyper + Cyper),
9. Imidacloprid as 1st spray, Cypermethrin as 2nd and 3rd sprays (Courage + Cyper + Cyper),
10. No spray (control).

Insecticides

Cypermethrin is a synthetic pyrethroid, moderately toxic and primarily used as an insecticide. It acts as a fast-acting neurotoxin in insects and degrades rapidly in soil and plants with a half life of 8 to 16 days. Acute oral LD50 in water is 4123 mg/kg body weight. Imidacloprid is a systemic, chloro-nicotinyl insecticide with soil, seed and foliar uses for the control of sucking insects including rice hoppers, aphids, thrips, whiteflies, termites, turf insects, soil insects and some beetles. It has relatively low toxicity. Oral LD50 is 450 mg/kg body weight of rat.

Chlorpyrifos is an organophosphate insecticide. It is used to kill insect pests by disrupting their nervous system. Chlorpyrifos has an advantage over other products in that it is effective against a wide range of plant eating insect pests. It is classified by the World Health Organisation as a Class II, 'moderately hazardous' pesticide. It is relatively non-persistent in the environment. Oral LD50 for rats is 95 to 270 mg/kg.

Monocrotophos is an organophosphate non systemic insecticide with contact and stomach action. It is acutely toxic to birds and for that reason has been banned in the U.S. and many other countries. It is highly hazardous, and has been responsible for deaths resulting from accidental or intentional exposure. It is highly toxic orally, as well as by inhalation or absorption through the skin. Acute oral LD50 is 23 mg/kg. However, it does not have long persistence in the environment.

Endosulfan is a neurotoxic organochlorine insecticide. It is highly toxic and an endocrine disruptor and it is banned in the European Union, and several other countries; however it is still used extensively in many countries. It is acutely neurotoxin to both insects and mammals. LD50 is 30 to 80 mg/kg weight of rat.

Dimethoate is an organophosphate insecticide used to kill insects on contact. Dimethoate is moderately toxic and non-persistent with oral LD50 ranging from 150 to 400 mg/kg. It is a safer alternative to more persistent Monocrotophos. It was used in the trial as a commercial formulation involving Cypermetrin + dimethoate EC at 30 g + 250 g ai ha^{-1}.

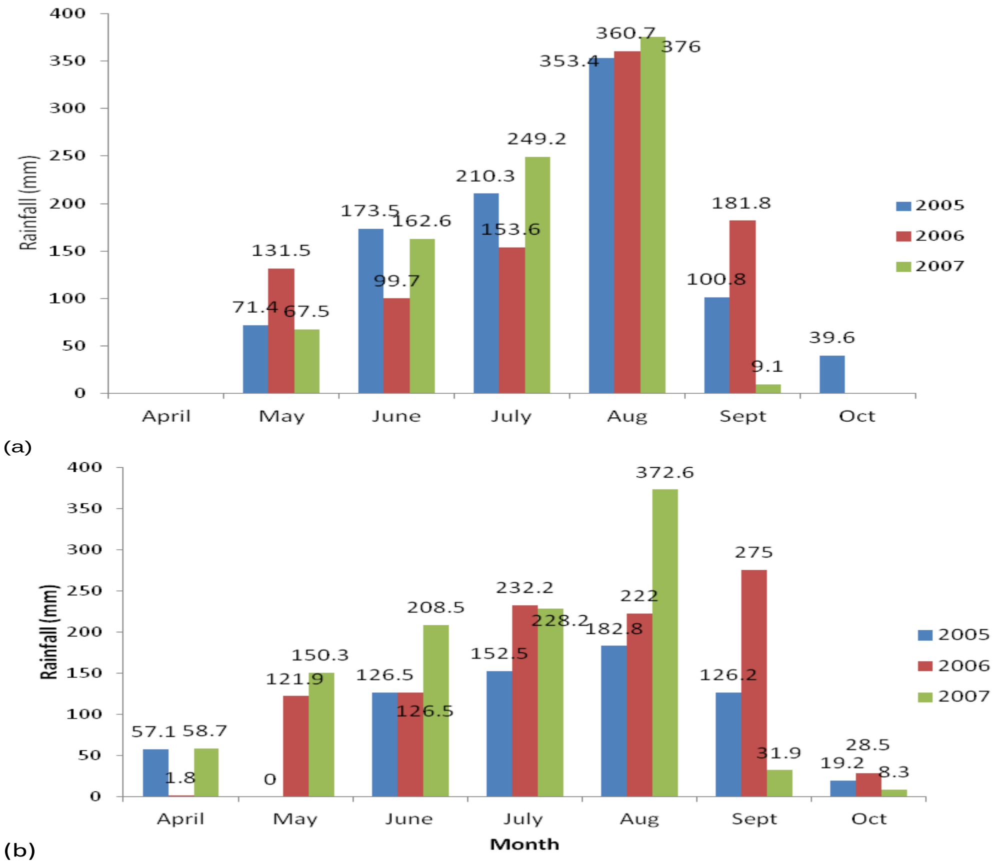

Figure 1. Monthly rainfall in (a) Minjibir and (b) Samaru from 2005 to 2007.

Data collection

Data were collected during rainfall; this is to assist any relevant interpretation of results. Field data was collected on the two middle rows of each plot while the two outer rows served as border rows. At onset of the spray treatment, a day before each of the insecticide spray, five flowers were randomly picked per plot and placed in bottled vial filled with ethylene. They were later taken to the laboratory for insect count; the flowers were opened and observed under the microscope (Asante et al., 2001). The number of legume pod borer, thrips and other unidentified larvae or adult insect in the flower were counted and recorded as Maruca count and thrips count, respectively. At maturity, cowpea pods were harvested from the net plots and sun dried to a constant weight. The cowpea pods were threshed and the grain was weighed. The stover left after pod harvest was cut and sun dried to a constant weight and the weight recorded. Recorded weights were extrapolated to yield per ha. The data collected were analyzed using GENSTAT Discovery 3 program (2007). Analysis of variance (ANOVA) was carried out, and least significant difference (LSD) at 5% were calculated where the ANOVA showed significant differences.

RESULTS

Rainfall

The monthly total rainfalls (mm) for the three years in the locations are given in Figure 1. Rainfall data during the growing season showed that higher rainfalls were received at Samaru compared to Minjibir. The month of August generally had the highest rain in both Minjibir and Samaru. Rains generally start in April in the northern Guinea Savanna (Samaru), peaks in August and ends in September with a few showers in October while it starts in May in the Sudan Savanna (Minjibir), peaks in August and ends in September.

Insect infestation

The mean number of insect count on cowpea flower in the different environments is presented in Table 1. Significant differences were found among the different environments for number of insect found in cowpea flowers twelve days after insecticide spraying. *M. vitrata* infestation rates (8, 6, and 4, first, second and third count, respectively) were significantly higher in Minjibir in 2007 than Minjibir 2006 and Samaru 2007. However, thrips infestation rates were significantly higher in Samaru in the first count, compared to other locations and counts. The effect of the different insecticide treatments on the number of insect in the flowers of cowpea in Sudan and

Table 1. Effect of environment on number of insect in cowpea flowers (insect/5 flowers).

Location	First count		Second count		Third count	
	Maruca	Thrips	*Maruca*	Thrips	*Maruca*	Thrips
Minjibir 2006	3.2	0.45	1.9	0.42	1.3	8.7
Minjibir 2007	7.6	5.9	6.06	2.17	3.8	2.2
Samaru 2007	3.9	13.68	2.1	2.02	0.5	3.8
LSD (5%)	3.2	5.9	1.2	0.5	1.7	3.2
F probability	0.033	0.004	0.001	0.001	0.008	0.006

Table 2. Effect of different insecticides on number of insect in cowpea flowers (insect/5 flowers).

Treatment	First count		Second count		Third count	
	Maruca	Thrips	*Maruca*	Thrips	*Maruca*	Thrips
Minjibir (Sudan savanna)						
Control	7	5	12	5	4	5
Cyper*3	8	5	2	0	2	1
Mono*3	10	9	5	0	4	1
Tricel*3	6	7	5	2	4	4
Courage*3	7	6	7	1	5	3
Endosulfan*3	7	6	7	5	5	3
Cyper+D*3	9	5	3	1	3	2
Tricel+Cyper+Cyper	6	6	4	4	4	1
Mono+Cyper+Cyper	7	7	7	2	4	3
Courage+Cyper+Cyper	9	4	9	3	4	1
Mean	8	6	6	2.7	4	2.24
LSD (5%)	NS	NS	4.3	2.25	NS	NS
F probability	0.153	0.26	0.03	0.001	0.597	0.307
Samaru (Northern guinea savanna)						
Control	5	12	3	3	0	10
Cyper*3	5	11	2	2	1	2
Mono*3	3	16	3	1	0	3
Tricel*3	4	15	1	3	1	2
Courage*3	4	11	2	1	0	6
Endosulfan*3	3	13	2	3	0	4
Cyper+D*3	5	12	1	2	1	3
Tricel+Cyper+Cyper	4	20	2	3	1	3
Mono+Cyper+Cyper	4	18	3	2	1	2
Courage+Cyper+Cyper	3	10	3	2	0	4
Mean	3.83	13.68	2.1	2.02	0.5	3.78
LSD (5%)	NS	NS	NS	NS	NS	4.2
F probability	0.573	0.123	0.541	0.434	0.748	0.01

northern Guinea savannas (NGS) of Nigeria is presented in Table 2. There was no significant difference among the various plots during the first insect count which was done before the first spray. Insect count in cowpea flower in Minjibir, before the second insecticide spray showed significantly ($P < 0.05$) lower *Maruca* under plot sprayed with Cypermethrin and Cypermethrin-Dimethoate (2 and 3, respectively) while flower thrips count were significantly lower under the plots sprayed with Monocrotophos, Cypermethrin (0) Imidacloprid and Cypermethrin-Dimethoate (1). There was no significant difference among the treatments in insect infestation in the third flower count before the third spray. Similar observations were made in Samaru in the northern Guinea savanna zone. However, there was no significant difference among the various plots during the first and second insect counts. Significantly lower numbers of thrips were found in flowers of plots sprayed with Cypermethrin and

Table 3. Effect of different insecticide and combination on grain yield of cowpea in savannas of Nigeria

Treatment\year	Minjibir				Samaru			
	2005	2006	2007	Mean	2005	2006	2007	Mean
Control	347	380	265	330	209	245	0	151.3
Cyper*3	691	1349	1667	1236	250	1288	462	666
Mono*3	813	1500	1200	1171	902	1197	672	924
Tricel*3	695	1318	1258	1090	357	1016	458	610
Courage*3	675	1232	557	821	274	726	292	430
Endosulfan*3	708	1413	1359	1160	772	1080	298	716
Cyper+D*3	968	1084	1451	1167	567	1046	690	768
Tricel+Cyper+Cyper	871	1579	1460	1303	545	1118	258	640
Mono+Cyper+Cyper	899	1478	1049	1142	952	1088	396	812
Courage+Cyper+Cyper	832	1926	1416	1391	515	1054	150	573
Mean	750	1326	1168	1081	534	986	367	629
LSD (5%)	NS	488	374	246	432	347	147	186
F probability	0.402	0.001	0.001	0.001	0.008	0.001	0.001	0.001

Chlorpyrifos. The control (no spray) had significantly higher number of thrips in its flower compared to other treatments before the third spray.

Grain yields

The mean grain yield of cowpea as affected by year, location and insecticide are given in Table 3. Significant differences were observed for grain yield among the years and between the two locations. In Minjibir, mean cowpea grain yield was significantly higher in 2006 (1326 kg/ha) than 2007 (1168 kg/ha) and 2005 (750 kg/ha). There was no significant difference in the grain yield produced among the insecticide treatments in Minjibir in 2005 while significant differences were observed in 2006 and 2007. Mean grain yield ranged from 265 kg/ha (nospray control in 2007) to 1926 kg/ha in Courage + Cyper + Cyper (2006). Courage + Cyper + Cyper produced the highest grain yield (1926 kg/ha) in Minjibir in 2006 which was significantly higher than 6 of the remaining 9 treatments. However in 2007, Cyper*3 (1667 kg/ha) produced the highest grain yield which was significantly higher than 4 of the remaining treatments. Mean cowpea grain yield obtained across the three years in Minjibir showed that the treatment Courage + Cyper + Cyper (1391 kg/ha) produced highest mean yield which was significantly higher than 4 other treatments but not significantly different from Tricel + Cyper + Cyper (1303) and Cyper*3 (1236). In all three years, no spray produced significantly lower grain yields than the sprayed treatments.

In Samaru, significant differences were observed in the grain yields produced among the insecticide treatments in 2005, 2006 and 2007. Cowpea grain yield ranged from 0 kg/ha (no spray control in 2007) to 1288 kg/ha in Cyper*3 (2006). Mono + Cyper + Cyper (952) and Mono*3 (902) produced the highest grain yields in 2005, and these were significantly higher than yields produced by four of the remaining 8 treatments. In 2006, nospray (245) and Courage*3 (726) produced significantly lower yields than the other treatments, while there were no significant difference among them. In the three years mean, Mono*3 (924) and Mono + Cyper + Cyper (812) produced the highest grain yields which were significantly higher than yields obtained from 7 and 4 other treatments, respectively.

Fodder yields

The effect of different insecticide spray and their combinations on cowpea fodder yield is given in Table 4. In Minjibir, there was no significant difference among the treatments in 2005 (mean of 1382 kg/ha) and 2006 (mean of 1476). However, significant differences were observed in 2007. Fodder production among the different insecticide treatments in 2007 ranged from 1064 kg/ha in Courage + Cyper + Cyper to 3940 kg/ha in Courage*3. Courage*3 produced significantly higher mean fodder than other treatments across the years. The nospray treatment (1831 kg/ha) produced significantly higher fodder than three insecticide treatments while there was no significant difference among the other treatments. In Samaru, there was no significant difference in fodder production among the various insecticide treatments in 2005 (mean of 601 kg/ha), while significant differences were observed in 2006 (mean of 1022), in 2007 (mean of 514) as well as across the years mean (712 kg/ha). Mean fodder production across the three years among the different insecticide treatments ranged from 525 kg/ha in Cyper*3 to 1256 kg/ha in the nospray treatment. The nospray treatment produced significantly higher fodder than the insecticide treatments in 2006, 2007 and across

Table 4. Effect of different insecticide and combination on fodder yield of cowpea in savannas of Nigeria.

Treatment	Mijibir				Samaru			
	2005	2006	2007	Mean	2005	2006	2007	Mean
Control	938	1662	2893	1831	694	1895	1180	1256
Cyper*3	1365	1214	2145	1575	361	881	332	525
Mono*3	1386	1879	1629	1631	638	831	366	612
Tricel*3	1589	1247	1746	1527	916	781	416	704
Courage*3	1799	2062	3940	2600	513	1081	582	725
Endosulfan*3	1372	1446	1496	1438	597	1263	465	775
Cyper+D*3	1127	848	1762	1246	458	898	449	602
Tricel+Cyper+Cyper	1379	1480	1579	1479	458	815	399	557
Mono+Cyper+Cyper	1624	1197	1097	1306	819	881	532	744
Courage+Cyper+Cyper	1239	1729	1064	1344	555	765	416	579
Mean	1382	1476	1935	1598	601	1022	514	712
LSD	NS	NS	787.2	441	NS	527	195.5	222
F probability	0.602	0.114	0.001	0.001	0.316	0.001	0.001	0.001

Table 5. Correlation coefficient of selected variable.

	Seed (kg)	Fodd (kg)	Maruca2	Thrips2	Others2	100 seed wt.	Thresh (%)	Hindex
Seed kg	1							
Fodd kg	0.34	1						
Maruca2	-0.41	0.39	1					
Thrips2	-0.34	-0.07	0.09	1				
Others2	0.12	0.04	0.04	-0.17	1			
100 seed wt.	-0.02	0.16	0.37	-0.29	0.1	1		
Thresh (%)	0.70*	-0.1	-0.55*	-0.39	0.14	0.04	1	
Hindex	0.59*	-0.48	-0.72*	-0.29	0.1	-0.18	0.86*	1

*, Significant at 5%.

year mean.

Relationships between insect infestation and yields

The correlation coefficients among the various variables measured are given in Table 5. *Maruca* infestation had a significant negative correlation with grain yield (-0.41), threshing (%) (-0.55) and harvest index (-0.72). The correlation between thrips infestation and grain yield (-0.34), threshing (%) (-0.39) and harvest index (-0.29) were also negative. However, the correlations among the different insect infestations were low: between *Maruca* and thrips infestation (0.09), *Maruca* and other flower insects (0.04), while the correlation between thrips and other flower insects was -0.17. A positive correlation (0.39) was found between *Maruca* infestation and fodder yield.

DISCUSSION

As expected, the average total rainfall and duration were higher in Samaru which is in the NGS than Minjibir in the Sudan savanna. Planting was done later in Samaru so that the cowpea matures at the end of the rains. Apart from the total rainfall received, its duration and prevailing temperature has significant effect on insect abundance. Muthoni et al. (2008) noted higher incidence of flower thrips on legumes during shorter rainy season than longer ones, especially when temperature was higher during the short rainy seasons. Higher and active population of *M. sjotsdti* can be found at temperature as low as 15°C and as high as 30°C. However, the highest thrips populations were found when the mean temperature ranged from 27 to 29°C (Alghali, 1992).

The pre-spray flower insect infestations were fairly uniform as shown by the lack of significant differences in the insect count before the first insecticide sprays. *Maruca* infestation appeared to be higher in Minjibir than Samaru, though Samaru received higher rainfall than Minjibir. This was due to the difference in planting dates, while planting was done in July in Minjibir; it was done in August in Samaru and the cowpeas flower towards the end of the rains after the peak of *Maruca* population in the area. While the *Maruca* and thrips counts did not show significant difference among the insecticide treatments in Samaru, the cowpea grains produced showed significant differences, implying that the control of other insect pest (e.g, pod sucking bugs) are important in this location. This confirm the observation of Amatobi (1994) who reported higher incidence of pod sucking bugs in Samaru compared to Minjibir. It is generally known that the insect pest complex on cowpea is higher in the more humid areas compared to the drier areas as evident in this trial (Amatobi, 1995; Tarawali et al., 1996).

Significant differences that were observed for grain yield among the years and between the two locations did not follow the pattern of flower insect count revealing the importance of other factors in yield reduction. These other factor will include the foliage pests, pod sucking bugs and possibly rainfall distribution in these areas. Asante et al. (2001) noted that two sprays of Cypermetrin + Dimetheoate increased grain yield from 225 to 900 kg/ha for cowpea planted in July and August in Kano, they also found out that insecticide application was more profitable for cowpea planted in late July than those planted in June or early July. Integrated insect control requires that insect population build-up should be monitored, and insecticide should only be used when the population attained action threshold levels. The thrips populations in this study exceeded the economic threshold of seven thrips per inflorescence (Anonymous, 1996) only before the first spray, and recommended three thrips per flower as reported by Salifu (1992) and Schipps et al. (2000). This implies high level of controls of thrips by most of the insecticides used, though there are indications of less control by tricel. Significant differences were observed among the different insecticide chemicals for grain yield even when there was no significant difference among them for flower insect count, signifying the importance of the foliage flowers. Insecticide application is the most popular and widely practiced control measures against cowpea insect pests, regardless of the scale of farming operations (Amatobi, 1995). Many systemic and contact insecticides and their combinations have been tested for the control of major pests, such as aphids, *Maruca*, thrips and pod sucking bugs (Jackai et al., 1985; Amatobi, 1994; Jackai and Adalla, 1997). Because of environmental concern and safety issues in the use of insecticides by small scale farmers in tropical Africa, only the least toxic insecticides should be recommended and as such, integrated pest control should be used.

Kurungi et al. (1999) noted that cowpea management practices that combine early planting close spacing and minimum insecticide application was most effective in reducing pest infestation. Several authors Ajeigbe and Singh (2006), Asante et al. (2001) and Kamara et al. (2010) noted that three strategic insecticides sprays are effective in the control of insect pest of cowpea. The present study compares cowpea productivities under different insecticide, using improved early maturing varieties under close spacing with three strategic insecticide applications. Integrated pest management, using a combination of resistant varieties planting dates and less toxic insecticides, should be advocated. The *Maruca* counts in flowers reveal that Monocrotophos may be less effective in controlling this insect species compared to Cypermetrin and Cypermethrin-Dimethoate; however, the efficiency of the different insecticides in the control of pod sucking bugs was not investigated, and damage caused by pod sucking bugs may account for the differences in yield between the different insecticides (Amatobi, 1994).

Three insecticides sprays in this study is comparable to the well timed minimum application of two sprays of Sherpa plus (Cypermethrin-Dimethoate) recommended by Amatobi (1994), Ajeigbe and Singh (2006) and Javaid et al. (2005) for economic production of grains on short season cowpea varieties (60 to 70 days), and three sprays for medium duration varieties (Ajeigbe and Singh, 2006; Asante et al., 2001). For dual purpose cowpea variety (IT90K-277-2), three sprays is worthwhile, this justifies the additional grains that could be obtained in addition to the fodder which is of immense value in the traditional crop-livestock systems of farmers in northern Nigeria. Cowpea farmers routinely apply insecticide as both preventive and curative measures against insect pests. Some of them also apply insecticide at higher rate and frequencies (Hirose, 1990). Thrips have been found to be key pest in areas where pesticide inputs are high. This suggest that misuse of insecticide have favored development of resistance to insecticides, the mechanisms of which is however unknown (Talekar, 1991). Similarly, Ekesi (1999) reported that *M. vitrata* field populations at Samaru were found to be resistant to Cypermetrin, Dimetheoate and Endosulfan. The resistance ratio ranged from 15 to 92 fold.

Less toxic chemicals like Cypermetrin are as effective as, or more effective than Monocrotophos in the control of some insect pests (pod borer) of cowpea. Since Imidacloprid provide effective control of aphids and thrips in addition to being less toxic to the user as well as environment, it can be used as the first insecticide spray on cowpea. Considering safety issues and environmental concerns, Imidacloprid (first spray), Cypermetrin (second and third sprays) is recommended in a three insecticide spray recommendation for cowpea cultivation, especially in the Sudan Savanna of Nigeria and three sprays of Cypermethrin-Dimethoate in the northern Guinea Savanna. Well timed and monitored insecticide application on cowpea reduce 50% of cost of insect pest control and have unquantifiable benefit to the environment when compared to calendar spraying (Afun et al., 1991). Some of the insecticides reduced cowpea fodder yields in both locations. However, the reduction in fodder yields were compensated for by the higher grain yields obtained in these treatments, implying that total biomass production may be similar.

A higher and significant correlation between *Maruca* infestation grain yield compared to thrips and other flower insect infestation implies that *Maruca* was a more important insect pest of cowpea in this region. Recent advances in transgenic cowpea have shown promising in their resistance to *Maruca* (Higgins et al., 2010), the use of which would further reduce the need for insecticide protection significantly. However, if the transgenic varieties have no resistance to thrips and pod sucking bugs, insecticide use may not be completely eliminated in cowpea production. New and less toxic insecticides, and their combinations, provide effective control of thrips (*M. sjostedti)* and pod borer (M. vitrata) on cowpea in the dry savannas of Nigeria. Considering safety issues and environmental concerns, Imidacloprid (first spray), Cypermetrin (second and third sprays) is recommended in a three insecticide spray recommendation for cowpea cultivation, especially in the Sudan Savanna of Nigeria, while three sprays of Cypermethrin-Dimethoate is recommended for the northern Guinea Savanna. *Maruca* pod borer *(M. vitrata)* was a more important insect pest of cowpea in this region than thrips (*M. sjostedti)*. However, provision of resistance to *Maruca* through a welcome development, may not eliminate the needs for spray in cowpea except if linked or backed up with concurrent provision of appreciable level of resistance to thrips.

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