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Evaluation of cultivars and insecticides on insect pests and grain loss of rainfed cowpea (*Vigna unguiculata* (L.) Walp.) at Baga, Lake Chad shore area of Nigeria

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Field trials were conducted to determine effects of cultivar and insecticide application on grain yield and yield loss of cowpea to insect pest during the 2008 and 2009 cropping seasons at Baga (13° 29" N and 13° 32" E), Lake Chad shore area of Nigeria. Three cowpea varieties (Kanannado, Borno brown and IT98k-1312), two insecticides [cypermethrin (30 g) + dimethoate (250 g) and neem seed aqueous extract] and three spray regimes (one each at budding, flowering and podding) were evaluated for the control of pest on cowpea. The treatments were laid in a strip-split plot design and replicated three times each. The results reveal that flower thrips (*Megalurothrips sjostedti)*, Legume pod borer (*Maruca vitrata),* Blister beetle (*Mylabris* spp.) and Pod Sucking Bug (*Anoplocnemi scurvipes*) were the major insect pests of rainfed cowpea in the area. The variety Borno brown failed to produce flower in both seasons. IT98k-131-2 was more tolerant to damage by insect pests of budding, flowering and podding stages. Higher percentage increase in grain yield was achieved by three sprays of either Cymbush super EC (87.68 and 61.09%) or NSAE (81.85 and 53.69%) over control in 2008 and 2009, respectively. Pod damage of 22.3-26.3% was recorded in untreated control while in cowpea treated with Cymbush super EC and NSAE, pod damage was 7.0-7.4 and 8.8-10.6%, respectively. Grain yield loss of about 43-45% was recorded in untreated control and this was attributed to the damage caused by insect pests of budding, flowering and podding stages. Cowpea treated with Cymbush super EC and NSAE had 16-31 and 31-34% grain loss, respectively. IT98k-131-2 sprayed three times with either Cymbush super EC or NSAE gave consistently the best grain yield in both seasons. However, NSAE gave averagely higher marginal return (25.45) than Cymbush super EC (18.00) in the study. Three sprays also gave the highest marginal returns over control. Insecticide application once each at budding (35-40 DAS), flowering (50%) and podding (10 day after second spray) was effective in reducing insect pests' infestation and increased grain yield of rainfed cowpea in the Lake Chad shore area. Three sprays of either Cymbush super EC or NSAE gave economically the best control of insect pest and the best grain yield of cowpea. The variety IT98k-131-2 can be cultivated for resistance and high yield. Neem seed aqueous extract can be used as an alternative insecticide for safe, cheap and effective control of insect pests in cowpea.

Key words: Cowpea variety, spray regime, NSAE, insect pest, cymbush super EC, Lake Chad shore.

INTRODUCTION

Cowpea (*Vigna unguiculata*) popularly known as black eye peas or bean is widely grown in the tropics and subtropics. A major food legume in Africa, it is extensively cultivated in the low land tropics of Asia and Latin America. It is traditionally considered as a food legume of the poorest of the poor and is mostly cultivated by small-scale farmers as a subsistence crop (IITA, 1989). Cowpea is widely grown in the Guinea and Sudan savannas of Nigeria with Borno state being the major producer (Kamara et al., 2007). It is also extensively grown around the shores of Lake Chad basin area of Nigeria as a sole crop.

Insect pest damage is the major cause of low grain yield in cowpea around the Lake Chad shore area where the crop is grown in a monocrop. It was reported that the impact of insect pest attack on cowpea is more pronounced when it is grown in a monocrop (Jackai and Singh, 1983). In a preliminary survey conducted, farmers in the area observed grain loss of more than 75% due to insect pest. Similarly, more than 70% or even entire crop failure was recorded due to insect pest alone (Raheja, 1976; Jackai and Daoust, 1986).

To reduce this huge grain loss, farmers indiscriminately spray insecticide and this has been identified as one of the causes of pest outbreak due to the effect of synthetic insecticide on natural enemies. Environmental effects of insecticides have been of great concern recently and there is no information on effective spray schedule and resistance of the common cowpea cultivars in the area to the major insect pests. The establishment of minimum number of sprays required for an effective control of the insect pest of cowpea is as necessary as the control of the pest itself. The objectives of this study are to determine the most resistant cowpea cultivar to insect pests among the three cultivars evaluated in the study, the spray regime that gives an economic control of cowpea pests and the best yield of the crop and the grain yield loss of cowpea due to insect pests.

MATERIALS AND METHODS

The experiment was conducted at Baga (13° .29" N and 13° 32" E) in 2008 and 2009 raining seasons.

Sources of planting materials

Seeds of three cowpea varieties, IT98K- 131- 2, was obtained from IITA Kano substation; the other two varieties, Borno brown and Kanannado, were obtained from Borno State Agricultiural Development Programme (BOSADP) office in Maiduguri. Cymbush super EC® [Cypermethrin (30 g) + dimethoate (250 g)] was purchased from a BOSADP accredited agrochemical dealer in Maiduguri. Neem seed aqueous extract (NSAE) was obtained from a laboratory preparation made following the procedure described by Anaso and Lale (2001).

Experimental design and treatments

An area of 50 X 30 m was cleared of shrub and grasses and burnt before the first rain of the season.The factorial experiment consisted of three cowpea varieties (IT98K- 131- 2, Kanannado and Borno brown) as vertical factor, an untreated control (sprayed with water only) and two insecticides (Cymbush super EC® and NSAE) as horizontal factor and three spraying regimes (one each at budding, flowering, and podding) as sub plot. Each treatment was allocated to a plot of 4 X 4 m with alleys of 0.75 and 1.5 m between plots and replications, respectively. Each treatment was replicated three times. Seeds dressed with Apron plus® at 10 g / 1 kg were sown at the rate of 2 seeds per hole at the spacing of 75 X 50 cm. Each plot had 35 stands arranged in 5 rows of 7 stands each, with 2 plants per stand. Sowing was conducted on 7 July, 2008 and 15 July, 2009. NSAE was applied at the rate of 2.5 kg / 25 L (w/v)/ha, while Cymbush was applied at 280 g a.i / ha using a CP15 Knapsack sprayer.

Insect sampling and identification

Megalurothrips sjostedti were counted from five flowers randomly picked from each stand in the two outer rows of each plot. The Legume pod borer, *Marucavitrata* was counted from flowers and pods of plants in one of the rows that were sampled for thrips assessment. *Anoplocnemis curvipes* and *Mylabris* spp. adult were counted from the two outer rows of each plot using a tally counter. The counts commenced when the insects appeared on the crop and were done on weekly basis from budding until harvest. All insects were identified, at the insect museum of Institute for Agricultural Research, Ahmad Bello University, Zaria.

Determination of grain yield (kg/ha)

Matured and dried pods from each of the three inner rows of each plot were harvested. The harvest for each plot was shelled, winnowed and the grains weighed and recorded in kg/ha.

Assessment of grain yield, grain loss and marginal returns

(i) *Grain yield (kg)* = No. of productive plants / ha X no. of pods / plant X no. of seeds / pod X wt. of a normal seed (Raheja, 1976).

(ii) *Grain loss (kg)* = Total no. of plants / ha X no. of damaged and shed pods and flowers due to damage / plant X no. of damaged seeds / pod X wt. of a normal seed (Raheja, 1976).

$$\text{(iii) } \textit{Grain loss (\%)} = \frac{\text{Grain yield loss (kg)}}{\text{Potential yield (kg) that is Grain yield + Grain yield loss}} \times 100$$

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Table 1. Percentage Relative abundance of the insect pests associated with rainfed cowpea at Baga in the Lake Chad Basin area of Nigeria in 2008 and 2009.

Major insect pests	Percentage Relative abundance/4m^2		
	2008	2009	Mean
Megalurothrips sjostedti	43.8	49.9	46.8
Mylabris spp.	32.2	41.5	36.8
Maruca vitrata	16.8	3.9	10.4
Anoplocnemi scurvipes	7.2	4.7	6.0

$$\text{(iv) Marginal returns} = \frac{\text{Cost (N) of increase in grain yield per additional spray}}{\text{Cost (N) of additional spray / treatment}}$$

(Amatobi, 1995)

It should be noted that: i. cost of cowpea grain at the prevailing market price shortly after the harvest was N100/kg; ii. Cymbush super EC and its application cost N1700/ha. iii. Neem seed aqueous extract and its application cost N850/ha.

$$\text{(v) Pod damage (\%)} = \frac{\text{No. of damaged pods / plant}}{\text{Total no. of pods / plant / treatment}} \times 100$$

Data analysis

Data were square root transformed and subjected to analysis of variance to determine significant differences between treatments and means were separated using LSD test at 5% probability. Analysis was run by statisti x 8.0 software.

RESULTS

The results in Table 1 show that in both 2008 and 2009 cropping seasons *M. sjostedti* was the highest in abundance followed by *Mylabris* spp. *A. curvipes* was the lowest in abundance.Table 2 shows that in both 2008 and 2009 rainy seasons, Borno brown did not produce flowers. The number of legume pod borer, Blister beetle and grain yield were significantly higher in IT98k-131-2 than in Kanannado in 2008. In 2009, the number of *A. curvipes* was significantly higher in IT98k-131-2 than in Kanannado; however, grain yield was relatively higher in IT98k-131-2 than in Kanannado. For insecticide effect (Table 2), *M. sjostedti*, *Mylabris* spp. and *A. curvipes* and damaged pod were significantly lower in cowpea treated with Cymbush or NSAE than in untreated control in both seasons. However, grain yield was significantly higher in cowpea treated with Cymbush and significantly lower in untreated control than in cowpea treated with NSAE in 2008. In 2009, grain yield loss was significantly lower in cowpea treated with Cymbush and significantly higher in untreated control than in cowpea treated with NSAE. Cowpea sprayed thrice or twice had significantly higher grain yield and significantly lower grain yield loss, number of *A. curvipes* and *Mylabris* spp. than cowpea sprayed once in 2008 (Table 2). In 2009, grain yield was significantly higher and grain yield loss, number of *A. scurvipes* and *Maruca vitrata* were significantly lower in cowpea sprayed thrice than in cowpea sprayed once. The number of *M. sjostedti* and *Mylabris* spp. were significantly lower in cowpea sprayed thrice and significantly higher in cowpea sprayed once than in cowpea sprayed twice in 2009.

Interaction effects of variety and insecticide in 2008 (Table 3) shows that IT98k-131-2 sprayed with Cymbush had significantly lowered the number of *M. sjosted* than NSAE. Similarly, the number of *M. vitrata* was significantly lower in Kanannado and IT98k-131-2 sprayed with Cymbush than IT98k-131-2 sprayed with NSAE and untreated control. *Mylabris* spp. was significantly lower inKanannado sprayed with either Cymbush or NSAE and IT98k-131-2 sprayed with Cymbush than IT98k-131-2 sprayed with NSAE. Grain yield was significantly higher in IT98k-131-2 sprayed with Cymbushthan untreated control. Grain yield loss was significantly lower in Kanannado and IT98k-131-2 treated with either of the insecticides than in untreated control. While sustaining significantly higher infestation, damaged pod and grain yield loss, the lowest grain yield occurred in the untreated controls.

For variety and spraying regime interaction, *Mylabris* spp. was significantly lower in Kanannado sprayed thrice than IT98k-131-2 sprayed twice or once. *A. scurvipes* was significantly higher in IT98k-131-2 sprayed once than the other treatments except Kanannado sprayed once; the lowest number occurred in Kanannado sprayed thrice. Grain yield loss was significantly higher in IT98k-131-2 sprayed once than in IT98k-131-2 or Kanannado sprayed thrice. Grain yield was significantly higher in IT98k-131-2 sprayed twice or thrice than inKanannado sprayed once (Table 3). For insecticide and spraying regime interaction, three sprays of either Cymbush or NSAE had significantly lowered the number of *M. sjostedti, M. vitrata*, *Mylabris* spp. and *A. scurvipes* and pod damage than untreated control. Grain yield was significantly higher in cowpea sprayed thrice or twice with Cymbush than the untreated control.

Results in Table 4 show that for variety and insecticide interaction, *M. sjostedti* and grain yield loss were significantly lower in Kanannado or IT98k-131-2 sprayed

Table 2. Effect of Variety, Insecticide and spray Regime on insect pests, damage and grain yield of rainfed cowpea at Baga, Lake Chad Basin area of Nigeria in 2008 and 2009.

Treatment	No. of Flower thrips/stand		No. of Maruca larvae/row		No. of Blister beetle/row		No. of PSB/row		Percentage Damaged pod		Grain yield Loss (%)		Grain yield (kg/ha)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Variety (A)														
Kanannado	1.28	2.19	1.16	1.15	1.21	2.11	1.06	1.08	4.94	5.06	8.31	8.06	18.85(354.13)	32.72(1069.270)
Borno brown	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
IT98k-131-2	1.29	2.18	1.16	1.08	1.47	1.89	1.09	1.24	4.77	4.63	8.59	7.71	22.65(512.02)	35.75(1276.92)*
P-value(0.05)	0.00	0.00	0.00	0.03	0.00	0.04	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00
LSD	0.08	0.13	0.08	0.09	0.18	0.83	0.05	0.09	0.70	0.58	1.01	0.56	2.48	3.26
Insecticide (B)														
Cymbush	1.11	1.55	1.03	1.07	1.11	1.60	1.02	1.09	2.63	2.72	5.66	4.09	18.87(355.12)	26.01(675.52)
NSAE	1.16	1.82	1.09	1.08	1.15	1.53	1.03	1.03	2.96	3.26	5.62	5.89	15.77(247.76)	24.38(593.14)
Control	1.31	2.01	1.19	1.08	1.42	1.87	1.09	1.19	5.13	4.72	6.63	6.78	7.85(60.65)	19.08(362.97)
P-value(0.05)	0.00	0.02	0.04	0.90	0.02	0.48	0.01	0.05	0.07	0.00	0.13	0.00	0.00	0.03
LSD	0.06	0.28	0.12	0.05	0.21	0.74	0.04	0.13	0.42	0.65	1.21	0.66	2.97	4.97
Spraying regime (C)														
Regime #1	1.21	1.88	1.12	1.12	1.33	1.81	1.08	1.16	3.76	3.55	6.37	6.11	12.23(148.60)	21.28(451.79)
Regime #2	1.19	1.80	1.12	1.07	1.19	1.66	1.04	1.10	3.40	3.73	5.95	5.62	14.62(212.74)	22.33(497.54)
Regime #3	1.18	1.69	1.07	1.04	1.16	1.53	1.03	1.03	3.55	3.41	5.59	5.03	15.64(243.74)	25.86(667.53)
P-value(0.05)	0.12	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.10	0.07	0.00	0.00	0.00	0.00
LSD	0.03	0.07	0.04	0.04	0.06	0.08	0.03	0.05	0.22	0.39	0.41	0.31	1.03	2.73
Interaction														
AB	S	S	S	S	S	NS	S	S	S	S	NS	S	S	S
AC	S	S	NS	NS	S	S	NS	S	NS	NS	NS	S	S	NS
BC	NS	S	NS	NS	S	S	NS	NS	S	NS	NS	S	S	NS
ABC	NS	NS	NS	NS	NS	S	NS	NS	NS	NS	NS	S	NS	NS

*Figures in parenthesis are untransformed. Regime #1 = spray at budding; Regime #2 = spray at budding and flowering; Regime #3 = spray at budding, flowering and podding.Data are square root transformed.$y = \sqrt{x + 1}$. LSD= least significant difference.

with Cymbush and significantly higher in the untreated control than in Kanannado or IT98k-131-2 sprayed with NSAE. *M. vitrata* was significantly lower in cowpea sprayed with Cymbushthan untreated control. *A. scurvipes* was significantly lower in Kanannado or IT98k-131-2 sprayed with NSAE than IT98k-131-2 sprayed with Cymbush. Damaged pod was significantly lower in Kanannado or IT98k-131-2 sprayed with Cymbushthan IT98k-131-2 sprayed with NSAE. Grain yield was significantly higher in Kanannado sprayed with Cymbush than untreated control (Table 4). For variety and spraying regime, *M. vitrata* and grain yield loss significantly lower in IT98k-131-2 sprayed thrice than in IT98k-131-2 and Kanannado sprayed once. *A. scurvipes* was significantly lower in Kanannado sprayed thrice or twice than IT98k-131-2 sprayed twice or once. Grain yield was significantly higher in IT98k-131-2 sprayed thrice than Kanannado sprayed twice or once (Table 4). For insecticide and spraying

Table 3. Effect of interaction on Insect pests, Damage and Grain yield of rainfed cowpea at Baga, Lake Chad Basin area of Nigeria in 2008.

Interaction	No. of flower thrips/stand	No. of Maruca Larvae/row	No. of Blister beetle/row	No. of pod sucking bugs/row	Percentage damaged pods	Grain yield loss (%)	Grain yield (kg/ha)
A x B							
A1 x B1	1.17	1.05	1.18	1.01	3.61	7.85	25.31(639.49)
A1 x B2	1.20	1.11	1.05	1.04	3.97	7.69	19.79(390.80)
A1 x B3	1.48	1.20	1.39	1.12	7.25	9.39	11.43(129.71)
A2 x B1	NA	NA	NA	NA	NA	NA	NA
A2 x B2	NA	NA	NA	NA	NA	NA	NA
A2 x B3	NA	NA	NA	NA	NA	NA	NA
A3 x B1	1.15	1.05	1.15	1.04	3.27	8.13	30.31(917.45)
A3 x B2	1.16	1.16	1.39	1.06	3.90	8.16	26.52(702.42)
A3 x B3	1.20	1.29	1.88	1.15	7.14	9.51	11.12(122.72)
P-value(0.05)	0.00	0.04	0.01	0.04	0.67	0.38	0.00
L S D	0.06	0.09	0.18	0.06	0.61	0.94	3.04
A x C							
A1 x C1	1.32	1.19	1.32	1.09	5.28	8.96	16.13(259.27)
A1 x C2	1.22	1.17	1.18	1.05	4.63	8.23	19.86(393.50)
A1 x C3	1.28	1.09	1.13	1.03	4.93	7.74	20.54(420.89)
A2 x C1	NA	NA	NA	NA	NA	NA	NA
A2 x C2	NA	NA	NA	NA	NA	NA	NA
A2 x C3	NA	NA	NA	NA	NA	NA	NA
A3 x C1	1.30	1.18	1.66	1.15	5.01	9.15	19.56(381.59)
A3 x C2	1.31	1.20	1.41	1.06	4.59	8.61	23.00(527.91)
A3 x C3	1.25	1.11	1.35	1.04	4.72	8.03	25.39(643.86)
P-value(0.05)	0.04	0.25	0.00	0.08	0.46	0.12	0.00
L S D	0.12	0.11	0.24	0.06	1.47	1.03	6.29
B X C							
B1 x C1	1.13	1.05	1.27	1.05	2.90	6.42	15.73(246.40)
B1 xC2	1.09	1.05	1.07	1.00	2.23	5.55	19.47(378.20)
B1 x C3	1.10	1.00	1.00	1.00	2.76	5.00	21.41(457.47)
B2 x C1	1.17	1.13	1.29	1.07	3.26	5.99	13.36(177.41)
B2 x C2	1.18	1.13	1.09	1.03	2.85	5.72	16.23(262.38)
B2 x C3	1.12	1.02	1.06	1.00	2.76	5.13	17.73(313.35)
B3 x C1	1.32	1.19	1.42	1.09	5.13	6.69	7.61(56.87)
P-value(0.05)	0.27	0.22	0.00	0.68	0.11	0.10	0.00
L S D	0.16	0.12	0.28	0.07	2.06	3.62	10.34

Figures in parenthesis areuntransformed.Data are square root transformed. $y = \sqrt{x} + 1$. A1= Kanannado; A2= Borno brown; A3= IT98k-131-2; B1= cymbush super EC; B2=NSAE; B3= untreated control; C1= one spray; C2= two sprays; C3= three sprays.LSD= least significant difference.

regime interaction, the number of *M. sjostedti* was significantly lower in cowpea sprayed thrice with Cymbush than in untreated control. *Marucavitrata* was significantly lower in cowpea sprayed thrice with Cymbush or NSAE than in cowpea sprayed once with NSAE but comparable with the other treatments. *Anoplocnemiscurvipes* did not occur in cowpea sprayed thrice with Cymbush or NSAE however, the number was significantly lower in cowpea sprayed twice with NSAE than in cowpea sprayed once with Cymbush and the untreated control. Damaged pod and grain yield loss were significantly lower in cowpea sprayed thrice with Cymbush than in the untreated control. Cowpea sprayed thrice with Cymbush had the highest grain yield, although there were all comparable (Table 4).

The marginal return obtained on each additional spray

Table 4. Effect of interaction on Insect pests, Damage and Grain yield of rainfed cowpea at Baga, in the Lake Chad Basin area of Nigeria in 2009.

Interaction	No. of Flower thrips /stand	No. of Maruca Larvae /row	No. of Blister beetle /row	No. of Pod Sucking Bugs /row	Percentage Damaged pods	Grain yield loss (%)	Grain yield(kg/ha)
A x B							
A1 x B1	1.83	1.11	1.84	1.09	3.70	6.08	39.26(1540.66)
A1 x B2	2.24	1.16	1.80	1.05	4.14	8.29	36.41(1324.69)
A1 x B3	2.52	1.23	2.69	1.10	7.33	9.79	22.47(503.95)
A2 x B1	NA	NA	NA	NA	NA	NA	NA
A2 x B2	NA	NA	NA	NA	NA	NA	NA
A2 x B3	NA	NA	NA	NA	NA	NA	NA
A3 x B1	1.81	1.10	1.97	1.17	3.45	5.21	37.77(1425.20)
A3 x B2	2.22	1.14	1.79	1.05	4.64	8.37	35.72(1274.63)
A3 x B3	2.51	1.20	1.91	1.49	5.82	9.53	33.76(1139.01)
P-value(0.05)	0.04	0.02	0.38	0.00	0.54	0.00	0.01
L S D	0.19	0.07	0.49	0.11	0.73	0.92	5.18
A1 x C1	2.32	1.20	2.33	1.15	4.82	8.65	29.74(883.41)
A1 x C2	2.22	1.14	2.07	1.07	5.39	7.93	31.19(971.88)
A1 x C3	2.05	1.10	1.94	1.03	4.95	7.59	37.22(1383.96)
A2 x C1	NA	NA	NA	NA	NA	NA	NA
A2 x C2	NA	NA	NA	NA	NA	NA	NA
A2 x C3	NA	NA	NA	NA	NA	NA	NA
A3 x C1	2.31	1.14	2.12	1.34	4.83	8.69	33.09(1094.41)
A3 x C2	2.19	1.08	1.90	1.24	4.80	7.93	34.79(1209.62)
A3 x C3	2.04	1.03	1.65	1.13	4.27	6.49	39.35(1547.74)
P-value(0.05)	0.01	0.08	0.00	0.04	0.01	0.00	0.18
L S D	0.29	0.08	0.53	0.14	1.29	1.55	6.31
B X C							
B1 x C1	1.66	1.13	1.74	1.18	2.91	5.09	23.40(546.61)
B1 xC2	1.57	1.06	1.62	1.08	2.85	3.99	24.11(580.44)
B1 x C3	1.41	1.03	1.45	1.00	2.38	3.21	30.52(930.16)
B2 x C1	1.96	1.14	1.83	1.08	3.05	6.47	21.36(455.12)
B2 x C2	1.81	1.08	1.45	1.02	3.62	6.09	23.79(565.11)
B2 x C3	1.69	1.03	1.32	1.00	3.10	5.11	27.98(781.66)
B3 x C1	2.01	1.08	1.87	1.23	4.70	6.78	19.08(362.97)
P-value(0.05)	0.02	0.12	0.00	0.40	0.00	0.00	0.16
L S D	0.59	0.09	0.70	0.16	2.06	3.42	16.62

Figures in parenthesis are untransformed.Data are square root transformed. $y = \sqrt{x} + 1$. A1= Kanannado; A2= Borno brown; A3= IT98k-131-2; B1= Cymbush super EC; B2= NSAE; B3= untreated control; C1= one spray; C2= two sprays; C3= three sprays.LSD= least significant difference.

of Cymbush or NSAE in both 2008 and 2009, was positive (Table 5). Higher percentage increase in grain yield was recorded in cowpea treated with Cymbush than with NSAE in both 2008 and 2009.

DISCUSSION

The failure of Borno brown to produce flowers in both 2008 and 2009 rainy season indicates that Borno brown is not suitable for rainy season cultivation in the Lake Chad Basin area. However, this may be due to short duration of rainfall (average of 78 days) experienced in the area over the study period. It was earlier reported that pod set in cowpea could be affected by moisture stress (Ojehomon, 1968; Dzemo et al., 2010). In contrast, Kanannado, also a long duration variety (90-120 days), performed well over the same period. The reason for this

Table 5. The marginal returns of rainfed cowpea for different spray regimes of Cymbush and NSAE in 2008 and 2009 cropping seasons.

Spray level	Cymbush			NSAE		
	Grain yield (kg/ha)	MR	Grainyield increase over control (%)	Grain yield (kg/ha)	MR	Grainyield increase over control (%)
2008						
Control	56.87			56.87		
Regime #1	246.40	11.15	333.27	177.41	14.18	211.96
Regime #2	378.20	18.90	565.03	262.38	24.18	361.37
Regime #3	457.47	23.57	704.41	313.35	30.17	451.00
2009						
Control	362.00			362.00		
Regime #1	546.61	10.86	51.00	455.12	10.96	25.72
Regime #2	580.44	12.85	60.34	565.11	23.90	56.11
Regime #3	930.33	33.42	157.00	781.66	49.37	115.93

MR= marginal return. Regime #1 = spray at budding; Regime #2 = spray at budding and flowering Regime #3 = spray at budding, flowering and podding.

variety differences not is readily explainable. Although, Kanannado is known to be suitable for dry season cultivation (Singh et al., 1996), suggesting that the variety may be more tolerant to harsh conditions than Borno brown. Significantly higher number of *M. vitrata* and *Mylabris* spp. were accompanied by higher grain yield in IT98k-131-2 than in Kanannado in 2008, suggesting that IT98k-131-2 performed better than Kanannado despite the higher infestation by the insect pests. Moreover, untreated IT98k-131-2 had significantly higher grain yield than untreated Kanannadoin 2009 although these were comparable in 2008. This suggests that IT98k-131-2 may be more tolerant to infestation and damage by insect pests of flowering and podding stages than Kanannado. Kamara *et al*. (2007) and Oniyebe et al. (2006) reported that IT98k-131-2 has profuse flowering and podding ability. It was possible that IT98k-131-2 may have compensated for insect pests damage by producing more flowers and pods.

IT98k-131-2 treated with Cymbush super EC had significantly higher grain yield than Kanannado. However, both insecticides significantly reduced *M. sjostedti*, *A. scurvipes*, damaged pods and significantly increased grain yield than the untreated control in both 2008 and 2009. Nevertheless, the prospect of higher grain yield from profuse flowering and podding in the face of insect pests' damage is likely to be higher with a combination of increasing sprays of Cymbush and IT98-131-2 than with the other combinations of varieties and insecticides.

Significant reduction of insect pests' infestation and grain yield loss and increase in grain yield were achieved by applying insecticide two or three times, once each at budding and flowering or once each at budding, flowering and podding stages compared to when applied once at budding. The result implies that farmers in the Sahel area of the Lake Chad Basin can significantly improve grain yield and reduce grain yield loss from insect pests' infestation and damage by applying two or three sprays of insecticide. Dugje et al. (2009) reported that 2-3 sprays of insecticide are required for a good crop of cowpea in Northern Guinea savanna. In this work, grain yield increased by 8.98, 6.63 and 5.83% in 2008 and 13.31, 1.69 and 7.40% in 2009 for one, two and three sprays, respectively of Cymbushover NSAE compared with the control. Clearly, the increase in grain yield from Cymbush compared with NSAE was larger only for the first spray at budding; the increases were not much for two and three sprays at flowering and podding respectively, over the study period. Farmers will benefit more by using NSAE sprays if more than one spray is required to control the insect pests in cowpea fields.

Two to three sprays of Cymbush was more effective against *M. sjostedti*, *Marucavitrata*, *Mylabris* spp. and *A. scurvipes* than sprays of NSAE; however, three sprays of NSAE significantly lowered the number of *Mylabris* spp. and *A. scurvipes*. Consequently, the number of damaged pod was significantly lowered by 2-3 sprays of either Cymbush or NSAE; however, grain yield was significantly higher with 2-3 sprays of Cymbush. This result implies that farmers in the area can control insect pests of budding, flowering and podding stages with 2-3 sprays of Cymbush or 3 sprays of NSAE or a combination of the two to increase grain yield. The marginal return shows that spraying cowpea up to three times is more profitable than spraying once or twice. However, relatively higher marginal returns were recorded with NSAE than with Cymbushin this study. This may have been due partly to the differences in the cost of the pesticides. This result implies that NSAE could be used as an alternative to or in combination with synthetic insecticide to control insect

pests for a profitable cowpea production. Egho (2011) reported that neem bio-pesticide can form a component of an Integrated Pest Management Programme of cowpea pest.

The percentage relative abundance of insect pests of cowpea in the area showed that *M. sjostedti*, *Mylabris* spp., *M. vitrata*, and *A. curvipes* in descending order were the major insect pests encountered during the study period. It was reported earlier that *M. sjostedti*, *M. vitrata* and *A. curvipes* are the most important insect pests of cowpea in Nigeria (Amatobi, 1995; Kyamanyawa, 1996; Karungi et al., 2000; Dzemo et al., 2010).

Conclusion

It can be concluded that, IT98k-131-2 has some degree of resistance to insect pests of budding, flowering and podding stages when compared to Kanannado. Pod damage and grain loss were reduced by application of Cymbush and NSAE. However, Cymbush was more effective than NSAE. The spraying regime for the best and economic grain yield of cowpea can be achieved by three sprays of either Cymbush or NSAE applied once each at budding, flowering and podding stages. Consequently, the marginal return on the use of NSAE appeared to be more advantageous. Alternatively, Cymbush can be used at a highly reduced rate when integrated with NSAE, thereby reducing the risk of exposure and damage these might cause the sole user of synthetic Cymbush. The major insect pests of cowpea in the study area are *M. sjostedti*, *Marucavitrata*, *Mylabris* spp. and *A. scurvipes*.

Recommendations

It is recommended that the variety IT98k-131-2 be cultivated for high yield and resistance to some major insect pest of cowpea. Also, Neem Seed Aqeuous Extract is a cheap, safe, and effective bio insecticide for the control of insect pest of cowpea.

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