

Seeds of Neem Tree (*Azadirachta indica* A. Juss). Promising Biopesticide in the Management of Cowpea Insect Pests and Grain Yield in the Early Cropping Season at Asaba and Abraka, Delta State, Nigeria

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Abstract

Literature on the use of neem extract as biopesticide in the management of field insect pests on cowpea in Nigeria is scanty. The present study evaluated the efficacy of extract of neem seeds at 5 percent concentration for the control of the cowpea aphid, *Aphis craccivora* Koch, flower bud thrips, *Megalurothrips sjostedti* Tryb, legume pod borer, *Maruca vitrata* Fab, and a spectrum of pod sucking bugs (Coreidae bugs) all key field insect pests of cowpea. The experiments were conducted in the early cropping season in two locations – Asaba and Abraka, Delta State, Nigeria. At Asaba, the study took place in the Teaching and Research Farm of the Agronomy Department, Asaba Campus and at Abraka on a plot of land situated close to the Agricultural Sciences Department, Delta State University, Abraka. The experiments consisted of two calendar sprays – 7 days' spray intervals at 5 times and 10 days' spray intervals at 4 times and monitored spray and a control. There were 4 treatments and 3 replicates, organised into a randomised complete block design (RCBD). The results indicated that more insect pests occurred at Asaba than Abraka plot. The calendared spray treatments significantly ($P < 0.05$) reduced *M. sjostedti* at Asaba and *A. craccivora* colonies at Abraka plot compared to control. Grain yield was significantly higher at Abraka (1630.70 kg ha⁻¹) compared to Asaba (404.90 kg ha⁻¹). The neem seed extract at 5 percent concentration in the management of the cowpea insect pest is quite attractive. However, the botanical causes delay in cowpea flowering.

Keywords: Neem seed extract, Cowpea, Insect pests, Asaba/Abraka, Early season

1. Introduction

A major arable crop cultivated in the tropical and subtropical regions of the world is the leguminous crop - cowpea (*Vigna unguiculata*) (L) Walp) of the family Fabaceae. Man benefits from it in several ways - the grains are cheap source of protein to man (IITA, 1984; Anderson, 1985; Alabi *et al.*, 2003) and in recent times, largely depends on it because of the rising cost of meat, fish and egg. Cowpea is rich in vitamins, minerals and low in fats. Its other importance is in the livestock industry (Job *et al.*, 1983) fibre production (Rachie, 1985) and restoration of soil fertility/erosion control (Okigbo, 1978).

In Nigeria, cowpea is grown mainly in the drier Northern zone – the Sudan savannah belt (Rachie, 1985) and bulk of it in terms of world production, comes from this region. Lately, however, the cultivation rapidly extended to the Western and Eastern States of Southern Nigeria (Ejiga, 1979; FOS, 1995; Emosairue *et al.*, 2004). Because of the high demand, concerted efforts to maximize production are being put in place and all factors affecting the growth and development of the crop have become serious concern to farmers.

Despite all management strategies to improve and increase yield, grain production is still very low at the farm level (Omongo *et al.*, 1997) because of certain constraints largely due to the activities of diseases and insect pests (Taylor, 1964) Damage due to a spectrum of insect pests on the crop while in the field has been put at 60 percent (Booker, 1965; Singh and Allen, 1980). Insect pests of cowpea clearly identified as major and serious

pests are the cowpea aphid, *Aphis craccivora*-Koch, the flower bud thrips, *Megalurothrips sjostedti* Tryb, the legume pod borer, *Maruca vitrata* Fab and a spectrum of pod sucking bugs which include *Clavigralla tomentosicollis* Stal, *C. shadabi*, Doll, *Anoplocnemis curvipes* Fab, *Riptortus dentines* Fab, *Aspavia armigera*, Fab, *Nezara viridula* L and *Mirperus jaculus* Thnb, (Jackai *et al.*, 1988).

A number of control measures for these pests are available but the common and most reliable is the use of synthetic chemicals (Ayoade, 1975) and good grain yield have been recorded (Jackai and Daoust, 1986; Jackai, 1993; Karungi *et al.*, 2000) Sometimes, however, commercial farmers excessively spray their farms – from 8-10 times during the growing season (Omongo *et al.*, 1997) and this poses serious health hazard to farmers and consumers. Moreover, unwise use of chemicals affects non-target organisms, toxic to mammals, and ultimately leads to environmental pollution (Alabi *et al.*, 2003). This awareness has led to a growing world outcry on the need to minimize the use of synthetic chemicals, not to discard them however (Stern, 1973) but to compliment with other control methods. A growing trend in the control of crop pests is the use of insecticides of plant origin which are compatible with the environment and devoid of dangers posed by synthetic chemicals. Many extracts with insecticidal property from various plants are now available (Jackai, 1983; Arnason *et al.*, 1989).

This research work studied the effect of the extract of the seeds of neem tree (*Azadirachta indica*) on four major insect pests of cowpea and influence of grain yield under calendar and monitored application during the early cropping season in two widely apart agro-ecological zones in Delta State.

2. Materials and Methods

The experiments were undertaken during the early cowpea planting season (2005) in two agro-ecological zones – Asaba and Abraka, about 135 kilometres apart; both experience different climatic conditions. Asaba occupies the drier northern part of Delta State while Abraka is located in the south, and experiences more rainfall. The experimental site at Asaba was the Teaching and Research Farm of the Agronomy department, Delta State University. The land was ploughed and harrowed with a tractor. At Abraka the farm site was a plot of land, about 100 metres to Campus 1, Delta State University. The land there was prepared manually with local implements – hoes and shovels. At both locations, the experimental bed size was 5 x 3m, with inter-bed space of 1.5m. At both locations, the seeds planted were Ife brown – obtained from the International Institute of Tropical Agriculture, Ibadan, Nigeria. Three seeds per hole were planted, at planting space of 60 x 30cm (Remison, 1978e). Planting took place on 29th May 2005 at Asaba while it was on 14th June, 2005 at Abraka. Seeds that failed to sprout were replaced 4 days after planting and thinning to two plants per stand took place 10 days after plant emergence. Each experimental plot consisted of 6 rows of 36 plants. Application of insecticide – neem seed kernel extract (NSKE) was carried out weekly starting from 25 days after planting (Afun *et al.*, 1991).

The NSKE – an insecticide of plant origin was prepared from the seeds of Neem tree (*Azadirachta indica*) following the method reported by Rezaul Karim *et al.* (1992). The experiment consisted of 4 treatments and 3 replicates, organised into a randomised complete block design (RCBD). The treatments were: calendar spray at 7 days' intervals (CA.S7) applied 5 times; calendar spray at 10 days' intervals (CA.S10) applied 4 times; monitored spray carried out only when insect infestation/damage reach or exceeded the action threshold (AT), and a control – without chemical spray.

The effect of NSKE on major insect pests of cowpea – *Aphis craccivora* Koch, *Megalurothrips sjostedti* Tryb, *Maruca vitrata* Fab. and pod sucking bugs and influence on yield in the two study areas were assessed and compared.

2.1 Insect observation and Data Collection

Aphis craccivora: Cowpea infestation was assessed in the morning between 8 and 10 a.m., from the two middle rows of each plot at the age of 25 days. Twenty cowpea stands were selected randomly, tagged and inspected for aphid colony size. The size on each stand was rated visually (Litsinger *et al.*, 1988) (Table 1) and the mean for the twenty stands was calculated. Six weekly observations were made.

Megalurothrips sjostedti: Cowpea damage by *Megalurothrips sjostedti* was assessed in the morning between 8 and 10 a.m. when the plants were 30 days old. The assessment was by visual rating based on known symptoms of *Megalurothrips sjostedti* such as browning of stipules, leaf or flower buds and abscission (Table 2). Twenty cowpea stands from the two middle rows were randomly tagged and each was inspected for damage, scored and mean for the 20 stands calculated and recorded. Four observations were made at 6 days' intervals.

Maruca vitrata: Infestation of cowpea flowers by *Maruca* was assessed by counting in the field between 3 and 5 p.m. The presence of holes and larva on the flowers were the *Maruca* damage index. Twenty flowers in the two

outer rows of each plot were chosen randomly, carefully opened and examined on the spot. There were five observations at 5 days' intervals. Mean for the 20 flowers was then calculated and recorded.

Pod sucking bugs (PSBs): Population of PSBs which rested on cowpea stands in the two middle rows were counted weekly, between 8 and 10 a.m. at 45 days after planting (DAP). Since PSBs do similar damage, all were counted together. Four observations were made.

Grain yield: Grain yield was determined when the pods were 65 to 70 days old. Matured pods from the two central rows were harvested with hands into well labelled black polythene bags according to treatments and replicates. The pods were then dried in the sun for one week and then shelled with hands. The dry grains were weighed with a triple beam weighing balance (Haus model) and the weights recorded. The mean of replicates for each treatment was then calculated. The yield was extrapolated to kilograms per hectare.

2.2 Yield related components

Number of pods per plant: At 60 days the number of pods per plant was determined in the field. Two long sticks were used to mark out 1 metre distance in the two middle rows of each plot. The pods and their stands that were in this distance were then counted. The number of pods was then divided by the number of plant stands.

$$\text{Number of pods/plant} = \frac{\text{No. of pods}}{\text{No. of plant stands}}$$

Pod load (PL) and Pod damage (PD): These were visually scored in the field at 60 DAP when the pods were filled, matured but still green. From the two middle rows of each plot, PL and PD were visually rated (Jackai *et al.*, 1988) (Table 3). The presence of holes and frass on pods and sticking together of pods were used as *Maruca* damage index.

Pod evaluation index (Ipe): The formula – PL x (9 – PD) was used to assess Ipe, where PL is pod load and PD, pod damage (Jackai *et al.*, 1988).

Pod length and seed damage: Pod length and seed damage by coreid bugs were determined in the biology laboratory. Matured pods were harvested with hands from the two middle rows of each plot at 65 DAP. They were sun-dried for one week. Twenty pods were randomly picked from each bag and each was measured with a tiny flexible thread to determine the length. They were opened each with hands and the number of seeds per pod were counted. The seeds were then classified into aborted seeds per pod, wrinkled seeds/pod and seeds with feeding lesions/pod. Means for pod length and the seed categories were calculated.

The data for insect observation, yield and yield related components were subjected to analysis of variance (ANOVA) and significant means separated by Fisher's Least Significant Difference Test (LSD), at 5% level of significance.

3. Results

The response of four key insect pests of cowpea under neem seed kernel extract (NSKE) application during the early season at Asaba is presented in Table 4. *A. craccivora* was not recorded during the season. The NSKE at CA.S7 significantly ($P < 0.05$) prevented damage of *M. sjostedti* to cowpea when compared to control. There were no significant differences in the protected plots and control with regards to flower bud thrips, *M. vitrata* and pod sucking bugs. In the same season, at Abraka (Table 5), *A. craccivora* appeared; however, the calendar spray regimes (CA.S7 and CA.S10) significantly ($P < 0.05$) reduced aphid population when compared to the unprotected plots (control). For *M. Sjostedti* damage, flower bud thrips population and *M. vitrata* significant differences did not exist among the various treatments and when compared to control. Moreover, pod sucking bugs were absent during the period of study. Comparing Asaba and Abraka agro-ecological zones, in terms of impact of NSKE on the insect pests (Table 6) *A. craccivora* infestation was significantly ($P < 0.05$) higher at Abraka when compared with Asaba. For *M. sjostedti*, the pattern was different, damage was more at Asaba and significantly ($P < 0.05$) higher than Abraka. Similarly, flower bud thrips were significantly higher in population at Asaba than Abraka. For *M. vitrata*, there was no significant difference in the two locations, although Asaba recorded slightly higher population. The pod sucking bugs were statistically similar in both locations but with Asaba having slightly higher bug population.

On grain yield during the early season at Asaba, yields were moderately high in all the treatments. However, there were no significant differences in NSKE protected plots and control (Table 7). Similar situation was recorded for yield related components (except aborted seeds/pod). At Abraka in the same season, grain yields were generally high in the various treatments. However, no significant differences existed in the protected plots

and control (Table 8). Similarly, all the yield related components in all the treatments were not significantly different.

Comparing grain yield at both study areas – Asaba and Abraka (Table 9), Abraka location was significantly ($P < 0.05$) higher than Asaba in dry grain yield. Similarly, one hundred seeds weight, number of pods per plant, pod load and pod evaluation index were significantly higher at Abraka. On the other hand, pod length, number of seeds/pod, pod damage, wrinkled seeds per pod and seeds with feeding lesions were significantly higher at Asaba compared to Abraka. There was no significant difference in aborted seeds per pod at both locations.

4. Discussion

The key insect pests that decimate cowpea in the field at Asaba and Abraka during the early cropping season and their control with the synthetic chemical (cypermethrin) were reported by Egho (2009 and 2010d). Neem extracts (biopesticide) and neem based insecticides are reported effective on a wide range of insect pests on field crops (Schmutter, 1985; Baidoo *et al.*, 2006). Furthermore, neem powder has been used to control storage insect pests such as *Callosobruchus maculatus* on cowpea grain (Ivbijaro, 1983; Sowunmi and Akinnusi, 1983). However, Jackai (1993) stated that, though reports from many parts of the world are in favour of neem as reliable botanical for insect pest management and free of danger, neem products/extracts are yet to be extended to the field on insect pests of arable crops in Nigeria. Recently, evidences on neem efficacy on insect pests of cowpea and some other crops in Nigeria have mounted and many cowpea researchers have given useful information on the potentials of neem in insect pest's control (Amatobi, 2000; Oparaeke *et al.*, 2000; 2003; Oparaeke, 2005).

Insect pests control under neem extract application in the two study areas – Asaba and Abraka – two widely apart agro-ecological locations with sharply different climatic conditions have further provided the evidence that neem extracts are effective biochemicals. The study showed that at 5 percent neem concentration, *Aphis craccivora*, *M. sjostedti* and *Maruca vitrata* all major insect pests on cowpea earlier reported (Egho, 2009; 2010d) were controlled and grain yield of 1630.70 kg ha⁻¹ and 404.90kg ha⁻¹ are possible at Abraka and Asaba respectively. However, it was observed in the field that neem extracts retarded and delayed cowpea copious flowering leading to less grain yield at 5 percent concentration. Lower concentration may be more tolerable to the crop. The grain yield obtained at both locations in the early cropping season were quite encouraging; the yield compare favourably with grain yield from some of the major cowpea growing areas of Nigeria such as Bauchi, Northern Nigeria (Degri and Hadi, 2000) and Bida and Mokwa (Afun *et al.*, 1991) and Calabar (Emosairue *et al.*, 1994).

Comparing the two locations – Asaba recorded more insect pests than Abraka and in terms of grain yield, Abraka produced grains (1630.70kg ha⁻¹) that were significantly higher compared to Asaba (404.90 kg ha⁻¹). Yield differences due to locational effect have been reported earlier for some other crops such as cassava (Akparobi *et al.*, 2002); maize (Agbogidi, 2006) and yam (Tobih, 2007).

The present study indicated that in Delta State Abraka agro-ecological region is more suitable for cowpea cultivation than Asaba.

5. Conclusion

Neem seed extract at 5 percent concentration is an effective biochemical in the management of insect pests of cowpea especially *A. craccivora* and *M. sjostedti*. Grain yield is quite attractive under neem extract application. However, the biochemical causes delay and reduction in cowpea flowering. Abraka agro-ecological zone is more favourable to cowpea production compared to Asaba.

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Table 1. Scale for rating aphid infestation on cowpea

Rating	Number of aphids	Appearance
0	0	no infestation
1	1-4	a few individual aphids
3	5-20	a few isolated colonies
5	21-100	several small colonies
7	101-500	large isolated colonies
9	>500	large continuous colonies

Source: Litsinger *et al.* (1977)

Table 2. Scale for rating flower bud thrips infestation on cowpea

Rating	Appearance
1	no browning/drying (i.e scaling) of stipules, leaf or flower buds; no bud abscission
3	initiation of browning of stipules, leaf or flower buds; no bud abscission
5	distinct browning/drying of stipules and leaf or flower buds; some bud abscission
7	serious bud abscission accompanied by browning/drying of stipules and buds; non elongation of peduncles
9	very severe bud abscission, heavy browning, drying of stipules and buds; distinct non-elongation of (most or all) peduncles.

After Jackai and Singh (1988)

Table 3. Scale For rating *Maruca vitrata* damage to cowpea

Pod load (PL)		Pod damage (PD)	
Rating	Degree of podding	Rating	%
1	most (<60% peduncles bare (i.e. no pods)	1	0-10
3	31-50% peduncles bare	2	11-20
		3	21-30
5	16-30% peduncles bare	4	31-40
		5	41-50
		6	51-60
7	Up to 15% peduncles bare	7	61-70
		8	71-80
9	Occasional bare peduncles	9	81-100

After Jackai and Singh (1988)

Table 4. Effect of calendar and monitored application of neem seed kernel extract on the major insect pests of cowpea in the early season at Asaba

Treatments	<i>Aphis craccivora</i> (rating)**	<i>Megalurothrips</i> <i>sjostedti</i> (rating)	Flower bud thrips* (actual counting)	<i>Maruca vitrata</i> * (actual counting)	PSB** (actual counting)
CONTROL		1.66	3.23	0.13	0.00
CA.S7		1.13	3.08	0.13	0.44
CA.S10		1.81	2.63	0.11	0.11
MOS		1.77	2.71	0.09	0.00
LSD(0.05)		0.34	NS	NS	NS

N.S - Not significant, CA.S7 - Calendar spray at 7 days' intervals,

CA.S10 - Calendar spray at 10 days' intervals, MOS - Monitored spray

* Means of 20 flowers

** Number per 2-middle rows

Source: Egho and Emosairue (2010a)

Table 5. Effect of calendar and monitored application of neem seed kernel extract on the major insect pests of cowpea in the early season at Abraka

Treatments	<i>Aphis craccivora</i> (rating)**	<i>Megalurothrips sjostedti</i> (rating)	Flower bud thrips* (actual counting)	<i>Maruca vitrata</i> * (actual counting)	PSB** (actual counting)
CONTROL	2.17	1.00	0.04	0.03	0.00
CA.S7	1.33	1.00	0.04	0.02	0.00
CA.S10	1.17	1.00	0.05	0.02	0.00
MO.S	2.50	1.00	0.05	0.04	0.00
LSD(0.05)	0.87	NS	NS	NS	NS

N.S - Not significant, CA.S7 - Calendar spray at 7 days' intervals,
CA.S10 - Calendar spray at 10 days' intervals, MOS - Monitored spray

* Means of 20 flowers

** Number per 2-middle rows

Source: Egbo (2011a)

Table 6. The location effect of the application of neem seed kernel extract on the major insect pests of cowpea in early season at Asaba and Abraka

Season	<i>Aphis craccivora</i> (rating)	<i>Megalurothrips sjostedti</i> (rating)	Flower bud thrips* (actual counting)	<i>Maruca vitrata</i> * (actual counting)	PSB** (actual counting)
Asaba Early	0.00	1.59	2.91	0.11	0.14
Abraka Early	1.79	1.00	0.04	0.03	0.00
LSD (0.05)	0.24	0.05	0.50	NS	NS

NS-Not significant

* Means of 20 flowers

** Number per 2 middle rows

Table 7. Effect of (NSKE) on the yield and yield related components from cowpea in the early season at Asaba

Treatments	Dry Grain yield (kg ha ⁻¹)	100 seeds wt(g)	Number of pods/ plant (approx)	Pod length (cm)	Number of seeds/pod	Pod load	Pod damage	Pod evaluation index	Aborted seeds/pod	Wrinkled seeds/pod	Seeds with feeding lesions
CONTROL	442.10	13.47	4.28	14.78	14.10	7.67	2.33	52.00	2.68	1.93	0.48
CA.S7	405.10	13.60	3.10	14.05	12.88	5.67	3.67	30.67	3.13	2.98	0.33
CA.S10	367.40	12.97	3.77	14.32	12.65	5.67	3.00	37.33	2.05	1.68	0.18
MO.S	405.10	12.83	4.19	14.20	13.18	6.33	3.00	38.00	2.65	1.80	0.32
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.75	NS	NS

N.S - Not significant, CA.S7 - Calendar spray at 7 days intervals, CA.S10 - Calendar spray at 10 days intervals, MOS - Monitored spray

Source: Egbo and Emosairue (2010a)

Table 8. Effect of (NSKE) on the yield and yield related components from cowpea in the early season at Abraka

Treatments	Dry Grain yield (kg ha ⁻¹)	100 seeds wt(g)	Number of pods/plant (approx)	Pod length (cm)	Number of seeds/pod	Pod load	Pod damage	Pod evaluation index	Aborted seeds/pod	Wrinkled seeds/pod	Seeds with feeding lesions
CONTROL	1636.40	14.10	13.27	12.59	12.43	8.67	2.33	60.67	2.50	0.18	0.07
CA.S7	1732.10	14.03	11.96	18.02	12.67	9.00	2.00	63.00	3.42	0.25	0.15
CA.S10	1515.70	14.53	11.51	12.11	11.62	9.00	2.33	60.00	3.00	0.78	0.27
MO.S	1638.40	14.23	9.95	12.61	11.77	9.00	1.67	66.00	1.93	0.67	0.03
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

N.S - Not significant, CA.S7 - Calendar spray at 7 days intervals, CA.S10 - Calendar spray at 10 days intervals, MOS - Monitored spray

Source: Egho (2011a)

Table 9. The effect of locations on cowpea yield and yield related components under the application of NSKE at Asaba and Abraka in the early cropping season

Season	Dry Grain yield (kg ha ⁻¹)	100 seeds wt(g)	Number of pods/plant (approx)	Pod length (cm)	Number of seeds/pod	Pod load	Pod damage	Pod evaluation index	Aborted seeds/pod	Wrinkled seeds/pod	Seeds with feeding lesions
Asaba Early	404.90	13.22	3.84	14.34	13.20	6.33	3.00	39.50	2.63	2.10	0.33
Abraka Early	1630.70	14.23	11.67	12.59	12.12	8.92	2.08	62.42	2.71	0.35	0.13
LSD(0.05)	310.86	0.55	1.91	0.48	0.76	0.89	0.92	9.93	NS	0.67	0.10

NS = Not significant