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Effect of neem seed kernel extract on major insect pests of Cowpea (*Vigna Unguiculata* (L.) Walp and influence on yield under calendar and monitored sprays

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Abstract

The present study tested 5% aqueous extract of the seeds of Dogoyaro tree, Azadirachta indica, neem seed kernel extract (NSKE) for insecticidal property in the control of four major insect pests of cowpea - the cowpea aphid, Aphis craccivora Koch, legume bud thrips Megalurothrips sjostedti Tryb, legume pod borer, Maruca vitrata Fab. and pod sucking bugs. The experiments involved calendar spray at 7 days' intervals (CA.S7) carried out 5 times, calendar spray at 10 days' interval (CA.S10) carried out 4 times and monitored spray (MOS)involving monitoring of insect pest infestation/damage before chemical application. The results showed that CA.S7 significantly reduced ($P<0.05$) M. sjostedti damage when compared to control in the early season. All the treatments slightly controlled flower bud thrips. Similarly, M. vitrata population was slightly reduced at CA.S10 and MOS. In the late season, CA.S7 slightly suppressed M. sjostedti. Population of flower bud thrips were significantly ($P<0.05$) controlled by the NSKE treatments. CA.S7 and CA.S10 slightly controlled M. vitrata. Grain yields in the early season were highest in CA.S7 (405.10kg ha^{-1}), followed by MOS (405.10kg ha^{-1}) and CA.S10 (367.40kg ha^{-1}) had the least. In the late season, grain yields were highest in CA.10 (549.80kgha^{-1}); this was followed by CA.S7 (398.90kgha^{-1}) and MOS, (297.90kgha^{-1}) of the neem seed extract treatments. Control had the least yield (266.40kgha^{-1}). Generally, there was no significant difference in grain yield among the NSK treatments. The study provides (1) evidence that insect pest control in calendar spray at 10 days' intervals and monitored sprays are as beneficial as calendar spray at 7 days' intervals, since this would reduce the number and cost of chemical application (2) that NSKE can form component of the integrated pest management in cowpea cultivation.

Keywords: Cowpea, insect pests, calendar and monitored sprays, Asaba, Southern Nigeria.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L) Walp) is a widely recognised legume whose grains are consumed by man as cheap plant protein [1] particularly people in the low income group who cannot afford protein from meat, fish and eggs because of high cost. The young green leaves and pods are edible vegetable materials, in certain African communities and it is a fodder crop for livestock [2]. Generally, it is a stable food crop for many people in several parts of Africa.

Cowpea is cultivated in the humid and semi-arid regions of Africa [3] and the crop is grown in diverse soils and climate conditions [4]. In Nigeria, it is grown intensively in the Northern region and the bulk of it is produced from this agro ecological zone [5]. Recently, however, its cultivation has spread to the West and East of Southern Nigeria [6-7].

Though intensively grown, yields from Africa are generally low [8-9]. Insect pests and diseases attack the crop while in the field [10] and insect pest infestation alone have been reported to reduce yields by well over 60 percent [11]. A wide range of insect pests have been clearly identified as agents which decimate the crop at various growth stages [12] and these include the cowpea aphid, *Aphis craccivora*, Koch which attacks young cowpea leaves, flowers, and pods; the flower bud thrips, *Megalurothrips sjostedti* Trybom which attacks the flower buds; the legume pod borer *Maruca vitrata* Fab which feeds on pods, flowers and young stems and a complex of pod and seed sucking bugs among which were - *Clavigralla tomentosicollis* Stal. *Anoplonecmis curvipes* Fab., *Nezara viridula* L., *Aspavia armigera* Fab. and *Riptortus sp* [13-14].

Meaningful cowpea yield is obtained only with control of pests in farms [15-16. Various control measures are now available but the most effective and reliable control is the use of synthetic chemicals [17-18] and tripled yield have been recorded with the application of insecticides [18].

In desperate efforts to control cowpea pests, farmers have sometimes, over sprayed their crops for 8 to 10 times with insecticides. While this will increase production cost, the large number of sprays is hazardous to farmers' health as well as consumers and can also destroy non target beneficial insects (e.g. insect pollinators, predators) in the environment [1]. The use of chemicals to suppress insect pest species though with adverse side effects, is most common. However, chemicals cannot be abandoned [19] but with caution, they can be applied so as to minimize their negative impact on the environment particularly pollution.

Other control measures which are effective with little or no adverse effect are presently being explored for their efficacy and suitability in agricultural production. One of such control avenues is the use of chemicals of plant origin which when applied may, unlike the conventional chemicals (systematic insecticides) have no side effects [20]. This paper reports on the impact of neem seed kernel extract (an insecticide of plant origin) on major insect pests of cowpea and influence on yield; it also examines differences in calendar and monitored application of chemical on insect number and yield in the early and late cropping seasons at Asaba, Southern Nigeria.

MATERIALS AND METHODS

The experiments were conducted during the early and late planting seasons of 2005, in the Teaching and Research Farms of the Agronomy Department, Asaba Campus, Delta State University, Oshimili South Local Government Area, Delta State, Nigeria.

In the early season, the land was ploughed and harrowed while it was prepared manually with shovels and hoes during the late season. The experimental plot size was 5m x 3m with 1.5m in-between plots. Ife brown cowpea variety planted were got from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Planting of seeds took place on the 29th May in the early season and 17th September for the late season, 2005. Three seeds were planted per hole and planting space was 60cm x 30cm [21]. Seeds that failed to sprout were replaced four days after planting. Thinning to two plants per stand took place 10 days after planting. Each plot consisted of 6 rows of 36 cowpea stands. The chemical (botanical) applied on the crops was 50% of neem seed kernel extract (a non-conventional chemical). The chemical was prepared following the methods reported by Rezual Karim *et al*. [22] Application commenced 25 days after planting (DAP). Regular farm weeding was done throughout the experimental period.

The experiment was organised into a randomised complete block design with 4 treatments and 3 replications. The treatments were (i) calendar spray at 7 days' intervals (carried out 5 times) (ii) calendar spray at 10 days' intervals (carried out 4 times) (iii) monitored spray (carried out only when insect pests damage/infestation reached or exceeded the action threshold) and (iv) plots without chemical (botanical) protection. The impact of chemical (botanical) application on four major insect pests and influence on yield was assessed. The key insect pests observed were the cowpea aphid (*Aphis craccivora*, Koch), the legume flower bud thrips (*Megalurothrips sjostedti*, Trybom), legume pod borer (*Maruca vitrata*, Fab.) and pod sucking bugs such as *Clavigralla spp*. *Anoplocnemis spp, Mirperus spp, Nezara viridula*.

Observation and data collection

Insects

Aphis craccivora: Infestation of cowpea by *A. craccivora* was determined weekly from the 2 middle rows of cowpea stands, beginning from 26 DAP between 8-10 a.m. Twenty stands were randomly selected and tagged. The colony size of *A. craccivora* on each was visually scored on a 10 point scale [23]. The mean score was then calculated. Six observations were made.

Megalurothrips sjostodti. Damage was assessed when the crops were 30 days after planting (DAP). Twenty randomly tagged stands in the 2 central cowpea rows, were inspected each for *M. sjostedti* damage and visually rated on a 1-9 point scale [12]. This was based on known symptoms of *M. sjostedti* such as browning or drying of stipules/leaves, bud abscissions, etc. The rating was carried out at 6 days' intervals. Four observations were made. Also, the population of *M. sjostedti* in each flower was determined by counting when the flowers were opened.

Maruca vitrata: Damage to cowpea flowers by *M. vitrata* was assessed in the field between 3-5 p.m. at intervals of 5 days when the crops were 45 DAP. From the two outer rows of each plot, twenty flowers were randomly selected, carefully opened and examined on the spot for *Maruca* larva/damage. The mean score was then recorded. Four observations were made.

Pod sucking bugs: The population of pod sucking bugs on cowpea was determined by counting from the 2 central rows of each plot between 8-10 a.m, when the crops were 45 DAP at the intervals of 5 days. The mean score was calculated and recorded. Four observations were made.

Yield related components

(i) Pod load and pod damage: Pod load and damage were assessed by visual rating in the field on a scale of 1-9 points [12] when the plants were 60 DAP. From the 2 middle rows of each plot, the presence of frass on pods and sticking together of pods were used as damage index by *Maruca*.

(ii) Pod evaluation index (1pe) was determined with the formula below:

PL x (9 - PD) where PL is pod load and PD was pod damage.

(iii) Number of pods per plant. At 60 DAP, the number of pods per plant was assessed from the 2 central rows of each plot. One metre length of cowpea row was taken with a 1 metre ruler. The length was marked with 2 sticks and the cowpea pods and their stands that fell within this distance were counted. The number of pods was then divided by the number of stands.

(iv) Pod length/pod and seed damage: Pod and seed damage by pod sucking buds (PSBs) were assessed by examining the pods and seeds in the laboratory. From the 2 middle rows of each plot, the pods, at 65DAP were hand-harvested into black polythene bags according to treatments. The pods were sun-dried for 2 weeks and from each bag, 20 pods were randomly selected. Each pod was carefully measured with a white flexible thread to determine the length. The pod was then carefully opened with hand. The number of seeds per pod, aborted seeds per pod, wrinkled seeds per pod were observed, recorded and the mean calculated.

Yield

(v) Yields were determined when the pods were 65 DAP. The pods were harvested with hands into black polythene bags, according to treatments. They were sun-dried for two weeks and shelled with hands. The grains were weighed according to treatments with Tripple Beam Balance (Haus Model) and the yields extrapolated to kg ha^{-1}. One hundred seeds were hand-picked from the grains in each bag (plot); they were weighed and the weight recorded.

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

RESULTS

The effect of neem seed kernel extract for the control of major insect pests on cowpea under calendar and monitored application during the early and late seasons at Asaba are presented in Table 1. All the major insect pests except *A. craccivora* were recorded in the early season experiment in the study area. The calendar spray at 7 days' intervals was significantly ($P< 0.05$) more effective in reducing cowpea damage by *M. sjostedti* when compared to the control, 10 days' calendar spray intervals and monitored spray. On flower bud thrips, the different treatments did not significantly ($P > 0.05$) reduce the population compared to the control. However, the control plots recorded slightly higher thrip population than plots with botanical (insecticide) protection.

Botanical (insecticide) protected plots were not significantly different in reducing the infestation/damage of *M. vitrata* and PSBs when compared to the control plots.

In the late season, all the major insect pests were recorded on the crop in the study area (Table 1).

Botanical (insecticide) protected plots did not significantly ($P > 0.05$) reduce *A. craccivora* population when compared with plots without botanical (insecticide) protection. However, the 10 days calendar sprays and monitored spray were slightly more effective in reducing *A. craccivora* population than 7 days sprays.

All treatments did not significantly reduce damage by *M. sjostedti* to cowpea compared with the control. The various treatments however significantly ($P < 0.05$) reduced the thrip population compared to the control. The 7 and 10 days' calendar and monitored sprays were not at par in their effectiveness. For *M. vitrata*, the various treatments did not significantly ($P > 0.05$) reduce *Maruca* damage and differences among the two calendar schedules (7 and 10 days' intervals) and monitored spray were not significant in their effect on *Maruca* damage. Similar trend was recorded for PSB - with the different treatments not significantly reducing PSB population.

The seasonal effect of the application of NSKE for cowpea insect pests control in Asaba is presented in table 2.

Populations of *A. craccivora* flower bud thrips and pod sucking bugs were significantly ($P < 0.05$) higher in the late season when compared with the early season. Conversely, damage to cowpea by *M. sjostedti* was significantly ($P < 0.05$) higher in the early season than late season. On damage to cowpea flowers by *M. vitrata* there was no significant ($P > 0.05$) difference in the two seasons. However, early season damage was slightly higher than the late season.

The effect of neem seeds kernel extract on cowpea yield and yield components, in the early and late seasons in Asaba is presented in Table 3. Grain yield in botanical (insecticide) protected plots in the early season, were not significantly ($P > 0.05$) higher when compared to the control. Grain yield from the control were slightly more than yield from insecticide protected plots. Calendar spray at 7-days' intervals and monitored spray were slightly higher in yield than calendar spray at 10 – days' intervals. Yield related components namely seed weight, number of pods/plant, pod length, number of seeds/pod, pod load, pod damage, pod evaluation index, wrinkled seeds/pod and seeds with feeding lesions, showed no significant difference between the botanical (insecticide) treated plots and control (Table 3). For aborted seeds CA.S10 spray significantly ($P <0.05$) reduced abortion of seeds in pods when compared with calendar spray at 7 days' intervals, but all other treatments were not significantly different.

In the late season, yields were not significantly ($P > 0.05$) different in the various treatments and when compared to control. The botanical (insecticide) protected plots, however had yields that were slightly higher than the control. Calendar sprays at 7 and 10 days' intervals had slightly more yields than monitored spray. Yield components such as 100 seed weight, number of seeds per pods, pod load, pod damage, pod evaluation index, wrinkled seeds per pod and seeds with feeding lesions showed no significant difference among botanical (chemical) treatments and when compared to control (Table 3).

On the other hand, yield components such as number of pods per plant, pod length and aborted seeds per pod showed significant difference among the treatments and when compared with control. With respect to number of pods per plant, all insecticide protected plots had significantly ($P < 0.05$) higher number of pods per plant, when compared with the plots without insecticide protection, except CA.S7 which was not different from the control. In the case of pod length, calendar spray at 7 days' intervals had longer pods and were significantly ($P<0.05$) longer when compared with the MOS. All other treatments were not significantly different. For aborted seeds per pods, calendar sprays at 7 day's intervals had less aborted seeds and seed abortion was significantly ($P < 0.05$) reduced when compared with control and monitored spray.

The season effect on cowpea yield and yield related components under the calendar and monitored application of neem seed kernel extract during the early and late seasons in Asaba is presented in Table 4.

Grain yields in the two seasons did not differ significantly, although early season had slightly higher yields than the late season. For 100 seeds weights, late seeds weighed significantly ($P < 0.05$) more than early and so also for number of pods per plant. With pod length, early season length were significantly ($P < 0.05$) longer than late and so also with number of seeds per pod. There was no significant difference in the two seasons in terms of pod load. However, late season had more load than early. Similar trend was encountered in the case of pod damage. With pod evaluation index, significant difference did not exist in both seasons, though early season had higher Ipe. value than late. Early season cowpea had more aborted seeds per pod and was significantly ($P < 0.05$) higher than late cowpea season. For wrinkled seeds per pod, the two seasons did not differ significantly. However, seeds were more wrinkled in the early season than late season. Seeds with feeding lesions were more in the early season and were significantly ($P < 0.05$) more compared with late season cowpea seeds.

Table 1: Effect neem seed kernel extract on the major insect pests of cowpea under calendar and monitored application in the early and late seasons at Asaba.

	Treatments	*Aphis craccivora* (rating)**	*Megalurothrips sjostedti* (rating)	Flower bud thrips* (actual counting)	*Maruca vitrata** (actual counting)	PSB** (actual counting)
Early season	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
	MO.S		1.77	2.71	0.09	0.00
	LSD(0.05)		0.34	NS	NS	NS
Late season	CONTROL	0.00	1.33	8.52	0.13	6.00
	CA.S7	0.61	1.17	5.67	0.10	4.33
	CA.S10	0.00	1.50	5.83	0.09	5.67
	MO.S	0.11	1.33	5.50	0.37	4.89
	LSD(0.05)	NS	NS	1.66	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

Table 2: The seasonal (early and late) effect of the application of neem seed kernel extract on the major insect pests of cowpea at Asaba.

Season	*Aphis craccivora* (rating)**	*Megalurothrips sjostedti* (rating)	Flower bud thrips* (actual counting)	*Maruca vitrata** (actual counting)	PSB** (actual counting)
Early	0.00	1.59	2.91	0.11	0.14
Late	0.43	1.33	6.38	0.17	5.22
LSD (0.05)	0.32	0.19	0.63	NS	1.26

* Means of 20 flowers ** Number per 2-middle rows NS-Not significant

Table 3: Effect of NSKE on yield and yield related components from cowpea in the early and late seasons 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
Early season	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
Late season	CONTROL	266.40	16.47	3.83	12.48	10.58	6.33	5.00	27.33	1.70	1.40	0.00
	CA.S7	398.90	16.90	5.23	12.74	11.10	7.00	3.00	42.00	1.35	1.33	0.00
	CA.S10	549.80	16.97	8.79	12.57	11.62	7.67	3.00	46.67	1.40	1.32	0.00
	MO.S	297.90	16.67	7.78	12.28	10.63	5.00	5.00	23.33	2.07	2.03	0.00
	LSD(0.05)	NS	NS	3.52	0.37	NS	NS	NS	NS	0.70	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

Table 4: The effect of early and late seasons on yield and yield related components from cowpea under the application of neem seeds kernel extract at Asaba

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
Early	404.94	13.22	3.84	14.34	13.20	6.33	3.00	39.50	2.63	2.10	0.33
Late	378.24	16.75	6.41	12.51	10.73	6.50	4.00	34.83	1.63	1.52	0.00
LSD(0.05)	NS	0.44	1.50	0.51	0.90	NS	NS	NS	0.41	NS	0.11

NS = Not significant

Discussion

The 5% aqueous extract of neem seed kernel applied on cowpea proved an effective bio-pesticide for the control of *M. sjostedti* in the field at Asaba in the early season. The study indicated that 7 days' spray interval, offered protection to cowpea damage better than 10 days' spray intervals and the monitored spray. The aqueous extracts was not applied on the monitored plots since the damage did not build up to the action threshold. The weekly application of this plant derived insecticide could have contributed to reducing thrip damage probably because of sustained residual activity of the insecticide on the crop compared with the 10 days' spray intervals and monitored spray. These observations are consistent with report of Karungi *et al.* [24] who observed that plots sprayed weekly with neem products had the lowest infestation of insect pests. On thrip population, the biopesticide was also effective. A number of earlier reports which have shown neem products as efficient against pests of crops such as rice [25], groundnut [26], cassava [27] and on dried fish [28] have been given. The findings also agree with the reports of Jackai [18] that neem products are reliable biopesticides which can be extended to control a wide range of insect pests of cowpea in the field. Epidi *et al.* [29] similarly reported that *M. vitrata, A. curvipes* and *C. shadabi*, could be controlled with extracts from neem seeds. Furthermore, Emeasor *et al.* [30] showed that seed powder from *Azadirachta indica* was effective on the control of *C. maculatus* - a pest of cowpea grains. Moreover, Jackai [18] reported reduced damage on cowpea by these pests using different neem formulation. The effect of the NSKE on *Maruca* damage and PSB population in this study is at variance with the above reports. This may not be unconnected with the behaviour of *Maruca* larva as a stem borer and PSB as smart fliers which could easily move away during spraying.

In the late season, the non effectiveness of neem seed kernel extract on *A. craccivora* is attributed to a washing away of the chemicals by rain. The monitored plots received two sprays and this number may not have been sufficient to protect the plants against aphid attack as compared with 7 days' sprays (5 times) and 10 days' sprays (4 times) which probably gave enough protection. The result indicated that 10 days' spray interval can be reliable in cowpea aphid management. From the result, the botanical (chemical) was not effective against *M. sjostedti* and this observation differs from Oparaeke *et al.* [31] and the general trend of thrips damage control by the use of insecticides. Most probably the repellent effect of the chemicals on the insect should have been reduced by rains. The result further suggests that the aqueous extract of neem seed could have acted as contact insecticide to bring down the population of thrips before the insecticide was diluted or washed away by rain. Damage by *M. vitrata* was not prevented by the aqueous extract probably because of the lowering of the residual activity of the chemical due to rain or behaviour of the insect. This result again suggests and give support that 7 days' and 10 days' spray and monitored spray (which was once), would give the same protection to the crop.

A higher population of *A. craccivora* was encountered during the late season under the application of the aqueous solution of neem seed kernel extract. The higher population was probably due to less rain to knock off the aphid colonies, and warmer periods could possibly have favoured aphid breeding, resulting in higher population. The damage of *M. sjostedti* being higher in the early season than late, presents a difficult explanation because damage to crops is more often a function of insect population (insect number). Since the insect population was less in the early season, one would have expected less damage. It is possible that the NSKE efficacy was highly reduced by rains. For the higher thrip population in the late season, though it was expected that the insecticide would have been more effective on its control, prevalent sunshine at the late season could have enhanced breeding of the insect which possibly led to population

increase. However, an interesting area to investigate though contrary to Jackai (1993) is whether, the insecticide affected the thrip predators (natural enemies) in the ecosystem. For *M. vitrata*, Jackai *et al.* [32] reported that *Maruca* population and (hence damage) is more in the wet season (early season) than drier season. This study however, observed a slightly higher *Maruca* population in the late than early season. Possibly, there was a decrease in the actual breeding season which have reduced the population of *M. vitrata*. The study has shown that NSKE has some inhibitory property on the larvae of *Maruca* as contact insecticide and agree with Epidi *et al*. [29] who reported the efficacy of neem on *M. vitrata* and Emosairue and Ubana [33] who observed reduced pod and seed damage by *M. vitrata*. The higher PSB population in the late season as indicated in this study confirmed the previous reports.

In the early season , the results suggested that aqueous extract of neem seed at 5% is an effective botanical (insecticide) on cowpea insect pests and the crop can be productive, as revealed by the moderate yields from the different treatments - CA.S7 (405.10 kg ha^{-1}), CA.S10 (367.40 kg ha^{-1}), MO S (405.10 kg ha^{-1}) . The yield figures are almost comparable with yield figures from else where in Nigeria - Samaru Kano and Ilora [34]; Bauchi [35]. The results confirm findings of Afun *et al*. [36] that grain yields from calendar schedules 7days and 10 days' intervals and monitored spay were similar while 10 days' and monitored sprays could reduce cost.

Grain yields in the late season were slightly lower than yields in the early season. . Probably, the light PSB load on the crop and more nutrients in the soil can be responsible for the higher yield in the early season. Yields in control were the least (266.40 kg ha^{-1}). This is what is usually expected in cowpea production [24], [37] while the highest was in CA.S10 days intervals (549.80 kg ha^{-1}), followed by CA.S7. (398.90 kg ha^{-1}), MO.S was moderate (279.90 kg ha^{-1}). The data support earlier reports that significant differences did not exist in grain yields between the calendar schedules and monitored sprays. Most of the yield related components had higher values in botanically (chemically) treated plots than the control plots, suggesting the botanical (insecticide) as reliable

Grain yield in the early season was 404.94 kg ha^{-1} and in the late season, 378.24 kg ha^{-1} at Asaba. Both figures were statistically similar. The data showed that grain production is only moderate under the application of neem seed kernel extract. The data suggest that cultivation in both seasons is possible but for better seed quality, cultivation should be carried out in the late season. This is because of the bright sunshine which usually characterizes the season and also seeds suffered less insect feeding activities. Late season cowpea had better values for seed weight, number of pods per plant, aborted seeds per pod and seeds with feeding lesions which probably contributed to better seed quality.

CONCLUSION

Results of these experiments reported, reveal that neem seed kernel extract at 5% is a reliable bio-pesticide in the management of cowpea insect pests. The study recommend to farmers the practice of calendar spray at 10 days' intervals and monitored spray because these would reduce the number of chemical application and cost.

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