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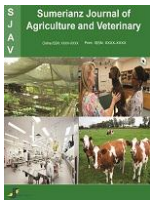

Original Article Open Access

Insecticidal Effect of Neem (*Azadirachta Indica*) Extracts Obtained From Leaves and Seeds on Pests of Cowpea (*Vigna Unguiculata*)

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Abstract

Insecticidal effect of two extracts of neem (*Azadirachta indica*) (leaves and seeds) in comparison with cymethoate and a control on pests and yield of cowpea was studied at the Research and Students' Demonstration Farm, Kogi State University, Anyigba, Kogi State, Nigeria in 2015. The treatment consisting of leaves and seeds extracts, cymethoate and a control were replicated four times in a Randomized Complete Block Design (RCBD). Effect of these treatments on the population dynamics of the insect pests, number of pods, pod weight, number of damaged pods and grains, 100-grain weight (g) and grain yield / ha were evaluated statistically as required for RCBD while significant means were separated using the Least Significant Difference (LSD) Test. Analysed results indicate that cymethoate effectively controlled field pests of cowpea such as whiteflies, aphids and pod borers resulting in less damaged leaves, less number of damaged pods and grains, higher pod numbers, 100-grain weight, better crop yield, among others. However, neem extracts also gave promising results compared with cymethoate, on population reduction in whiteflies, aphids and pod borers and comparable yield, though a little lower. Since better pest control and cowpea yield was obtained with neem extracts than the control, it can be concluded that these extracts exhibited reasonable insecticidal activities. Thus extracts from neem leaves and seeds can be employed as botanical in a more environmentally friendly and safe means of cowpea pest control, which is less expensive in comparison with synthetic herbicides.

Keywords: Aphids; Whiteflies; Plant leaves; Pod yield; Pod borer; Grain weight and botanical.

1. Introduction

Singh [1], reported that cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important leguminous crops grown extensively in the tropics, particularly the savannah zone of West Africa. It is nutritious, highly palatable, providing plant protein for humans and animals alike [2, 3], and relatively free of anti-metabolites. In West Africa, where cowpea are consumed in different forms [4-10], it is a major source of protein, carbohydrate-based diet [2].

Cowpea are prone to field and storage pests. These insect pests infest cowpea and severely reduce the quantity and quality of both the grains and fodder yields; implying losses in both grain and fodder. It is reported that the major insect pests which severely damage cowpea during all growth stages are the cowpea aphids (*Aphis craccivora* Koch), foliage beetles (*Ootheca spp, Medythia spp*), the flower bud thrips (*Megalurothrips sjostedti* Trybom) the legume pod borer (*Maruca vitrata* Fabricius) and the sucking bug complex, of which *Clavigralla spp, Anoplocnemis spp, Riptortus spp, Mirperus spp, Nezara viridula* Fab and *Aspavia armigera* L are most important and are prevalent. Without adequate control, reasonable grain yield cannot be obtained [11, 12]. Several control measures are, however available [13], but chemicals are most effective, giving several fold increase in grain yield as Jackai [14], observed.

Other measures used to reduce insect damage to cowpea are bio-intensive approaches that rely more on manipulating the plant or its environment. These include the use of resistant varieties, habitat modification, cultural and biological control. In spite of the use of these methods, Jackai [14], observes that control may not be optimal because of great diversity of pests involved.

In the West African sub region, low levels of cowpea yield (200 - 350 kg/ha) obtained by some farmers are directly attributed to insect pest damage in the field [15]. Grain yield, however varies with variety and the method of field insect pests' control [16].

Botanical insecticides are naturally occurring chemicals, extracted from plants which break down readily in the soil and are not stored in plant or animal tissue. Often their effect are not long lasting as those of synthetic pesticides [17]. Botanical insecticides are generally pest–specific and are relatively harmless to non-target organisms. These natural insecticides especially those of plant origin have proved to be effective, bio-degradable, low cost, low technological base, selective and environmentally friendly [18]. Also, the possibility of insect developing resistance to botanical insecticide is less [19]. Furthermore, plant extracts act as mortality agents, repellents, anti-feedants, attractants, oviposition deterrents and sterility agents [20].

The overall objective of this study is to assess the insecticidal property of a botanical (neem leaves and seeds) on cowpea field pests and cowpea yield. The specific objectives are to determine:

i. The extent (%) of damage to leaves, pods and grains caused by the study insects;

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ii. The effect of extracts of the botanical (neem leaves and seeds) on field insect pests of cowpea.
iii. The effect of the treatments on the yield of cowpea (means number and weight of pods and subsequently grain weight.

2. Materials and Methods

The study was conducted at the Students' Research and Demonstration Farm, Kogi State University Anyigba, during the minor rainy season (September to December, 2015). The site is located on latitude 7^0 41^1N and longitude 8^0 37^1E. The rainfall is about 1, 200 mm falling in two cropping periods; major: April to mid-July and minor: early September to mid-November. Relative humidity in the study area for the night time to early hours of the day ranges from 70 to 100 per cent.

Randomized Complete Block Design (RCBD) with four replications was employed for the trial. Four treatments were investigated: neem seed extract, neem leaf extract, borehole water, and synthetic chemical (cymethoate) (SC). Sup plot size measuring 5m x 3m with 2m between replicates and 1m alley between plots giving a total land area of $360m^2$ was employed. The cowpea variety used was Sampea-6 (S.1696), which was chosen for its high susceptibility to insect pests attack. Two kilograms (2kg) of seeds were purchased from IAR (Institute of Agricultural Research) Zaria, Seed Production Unit. Knapsack sprayer was used for application of treatments on the experimental site.

The land was sprayed with glyphosphate (roundup) (360g/1itre SL) on 4th September 2015 at a rate of 35 ml / 15 litres of water, then the land was cleared one week later (11th September, 2015) with the aid of hoes and cutlasses before demarcating into plots size of 5m x 3m across the slope to check erosion and taking into consideration soil fertility and land gradient.

Seeding was done on 18th September, 2015 using a garden line maintaining a planting distance of 60 cm between rows and 20 cm within rows. Two seeds were sown per hole at 5 cm depth, and later thinned to 1 plant/stand, consisting of 150 plant stands/treatment. Pre-emergence herbicide (chemostom 500 E) was applied at the rate of 300 ml/15 litres of water after sowing in order to control the menace of weeds. However, hoe weeding on the farm was carried out twice 4 and 6 weeks after planting (WAP).

For the formulation of the dried neem leaves extract, 1.3 kg of dry neem leaves were weighed using a top loading scale and blended into fine powder in a mortar. The blend was then soaked in 3.3 litres of water held in a plastic bucket for 24 hours, strained (using nylon mesh of 1.5 mm) into a knapsack and then was used to spray on the cowpea plants as described by Oparaeke, *et al.* [21], Oparaeke, *et al.* [22]. The same procedure was used for neem seed extract using seed weight of 1.5 kg seed, while for the cymethoate, 44 ml of cymethoate was measured and poured into a knapsack containing 3.3 litres of water and sprayed onto the cowpea plants as described by Oparaeke, *et al.* [21], Oparaeke, *et al.* [22]. Spraying of the cowpea plants with the above formulations was done at 2, 4, 6, 8 and 10 weeks after planting (WAP).

3. Data Collection

3.1. Scoring of Pests

For the purpose of evaluating the efficacy of the treatments, net plot size measuring 3m x 1.8m was evaluated and from this net plot, ten plants were randomly sampled for data gathering. Before imposition of the treatment, insect pest populations were recorded two weeks after planting (WAP) and there after scoring of pest population was done two weekly; with observations made between 8.00 and 10.00 a.m., as the usual high temperatures that characterize sunny days during the late mornings and afternoons could cause these insect pests to flee the cowpea plants. The crop was monitored for whiteflies, aphids and pod borers two weekly using the grading in table 1.

3.2. Number of Leaves

The leaves of ten randomly sampled plants were counted two weekly and recorded as mean of the ten sampled plants.

3.3. Number of Damaged Leaves

The number of damaged leaves by the insect pests under study were counted and recorded as means of 10 plants at 2, 4, 6, 8 and 10WAP.

3.4. Numbers of Pods and Harvested Pod Weight

Records were also kept on number of pods per plant, which was recorded as means of the ten randomly sampled plants / treatment. Subsequently, pod weights were determined after air drying harvested pods in shade to between 12 and 15% moisture content.

3.5. Number of Damaged Pods and Number of Damaged Grains

Records of pods damaged by pod borers were kept at 2, 4, 6, 8 and 10WAP and recorded as means of ten sampled plants. Subsequently, grain quality estimation was done using a visual grain damage rating scale of 1 – 6 (Table 2). Damaged grains counted include all cowpea grains whose quality has been reduced as a result of the infestation by pod borers.

3.6. 100 Grain Weight

Three batches of one hundred grains were randomly selected from the lots of each net plot harvests and weighed and their weights in grams (g) recorded as means of the three batches.

Table-1. Scale of rating insect infestation on cowpea

Rating	Number of insect pests	Appearance
0	0	No infestation
1	1-4	A few individual aphids
3	5-20	A few individual colonies
5	21-100	Several small colonies
7	101-500	Large isolated colonies
9>	500 large	Continuous colonies

Adapted from [23]

Table-2. Scale of 1 – 6 rating of grain damage of cowpea by pod borers

Rating	Percentage (%) Grain Damage
1	1-5% damage grains
2	6-25% damage grains
3	26-50% damage grains
4	51-75% damage grains
5	76-95% damage grains
6	>95% damage grains

Scale of Rating after [24]

3.7. Grain Yield

Grain yields per net plot were weighed on a digital scale extrapolated to yield/ha and thus recorded.

3.8. Analysis of Data

The means of whiteflies, aphids and pod borers population, total weight of pods, number of pods, number of leaves, number of damaged leaves, number of damaged pods and grains, 100 grain weight (g) and grain yield (Kg/ha) among treatments were subjected to Analysis of Variance (ANOVA). Statistically significant means at 5% level of probability were separated using the least significant difference (LSD) test. Pest data were, however transformed using the square root transformation before analysis.

4. Results

4.1. Insecticidal Effect of Neem Extracts Obtained From Leaves and Seeds on Pests of Cowpea

4.1.1. Pest Data

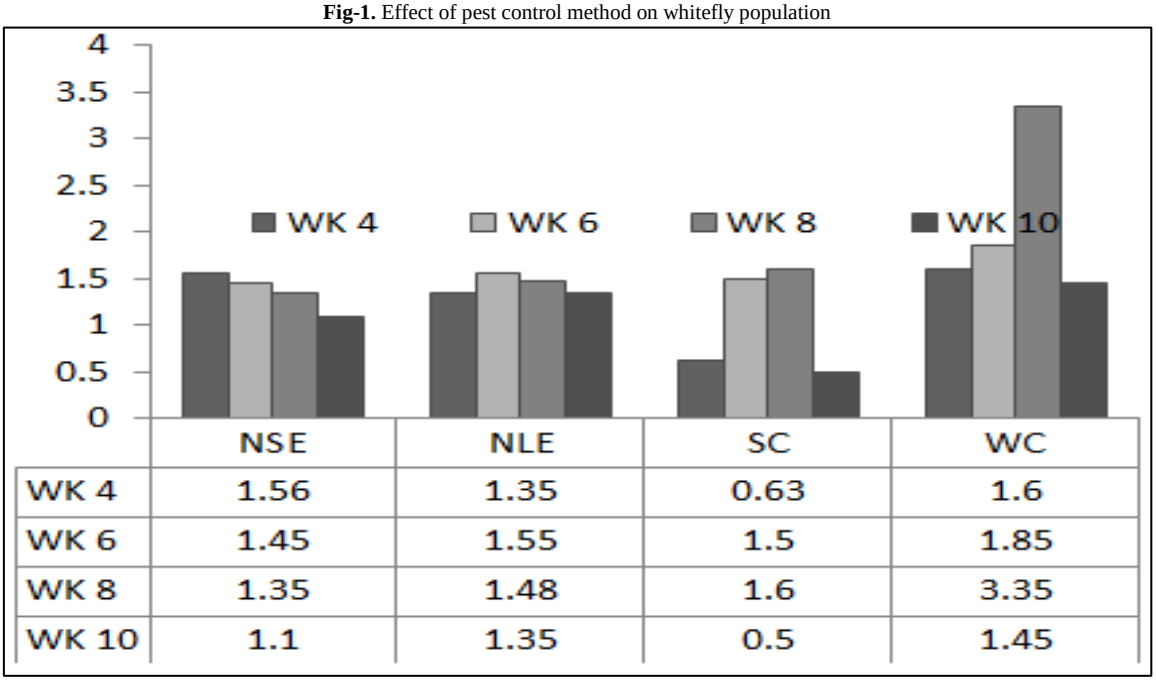
Analyzed data show statistical significance ($p \leq 0.05$) for insecticide treatments on whitefly, aphids and stem borer populations (Fig. 1, 2 and 3), with the best performance obtained in cymethoate (SC) treated plants, while the control gave the least effects. In most of the data obtained, neem seed extract (NSE) gave better pest control than what was obtained in neem leaf extract (NLE). Results of the insecticide treatment on the control of whiteflies population in the cowpea crop at 2 to 10WAP presented in Fig.1 shows that the control (borehole water) recorded the highest whiteflies population throughout the period under study, while cymethoate treated crops recorded significantly the lowest whiteflies population, with highly significant differences ($p \leq 0.05$) among the various treatments at 4, 8 and 10WAP.

Fig. 2 shows low aphids population per plant were recorded during the period of data collection, with cymethoate effectively controlling the aphids' population at 4, 6 and 8 WAP, with the least control observed in the control treatment. There were significant differences in aphids' population between the different treatments at 4, 6 and 8WAP. NSE in most weeks of data collection gave better performance than NLE on aphids' populations.

4.2. Leaf Data

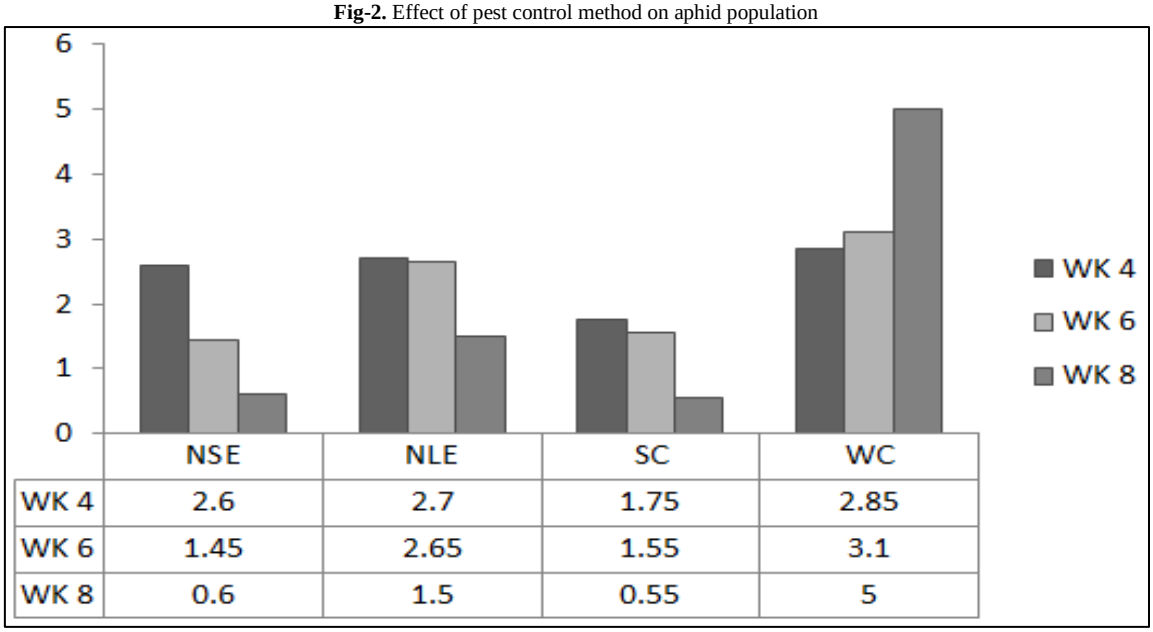
Cymethoate treated crops recorded the highest leaf numbers followed by NLE and then NSE treatment, while the least leaf numbers were witnessed in the control, however no statistical significance ($p \geq 0.05$) were observed in leaf numbers at 2 and 4WAP (Fig. 4). From (Fig. 5) the result on number of damaged leaves, cymethoate recorded the least numbers of damaged leaves, whereas the control recorded the highest, while NSE performed better than NLE. The differences in the numbers of damaged leaves were statistically significant ($p \leq 0.05$) among the treatment at 2 and 6WAP, but not at 4WAP ($p \geq 0.05$).

Fig-1. Effect of pest control method on whitefly population



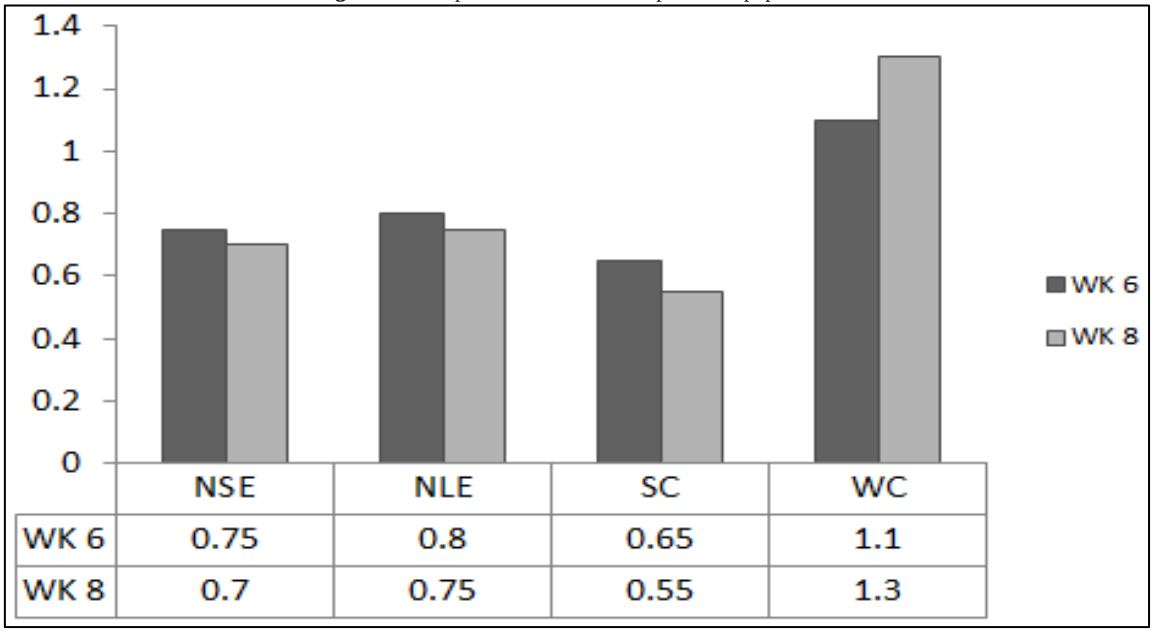
	NSE	NLE	SC	WC
WK 4	1.56	1.35	0.63	1.6
WK 6	1.45	1.55	1.5	1.85
WK 8	1.35	1.48	1.6	3.35
WK 10	1.1	1.35	0.5	1.45

Fig-2. Effect of pest control method on aphid population



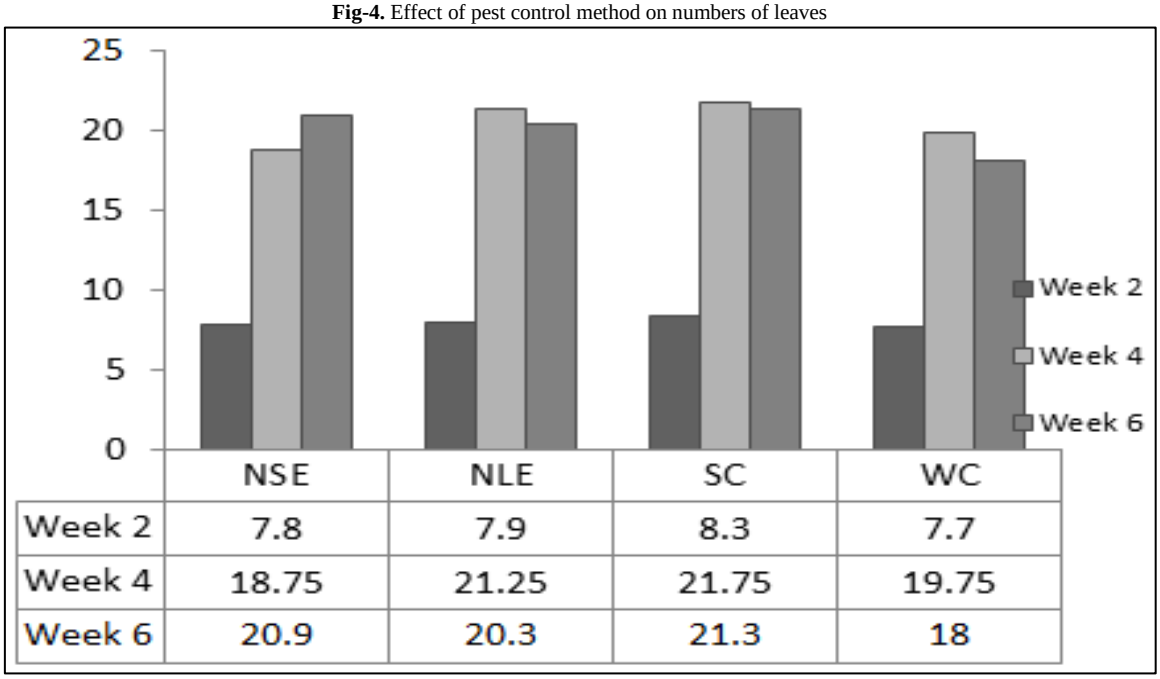
	NSE	NLE	SC	WC
WK 4	2.6	2.7	1.75	2.85
WK 6	1.45	2.65	1.55	3.1
WK 8	0.6	1.5	0.55	5

Fig-3. Effect of pest control method on pod borer population



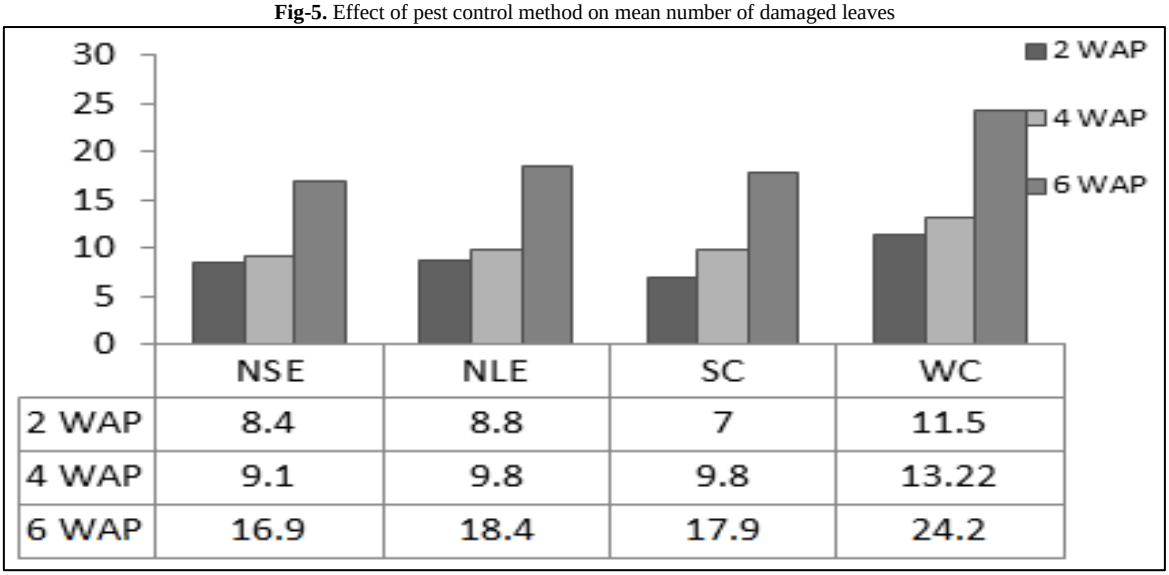
	NSE	NLE	SC	WC
WK 6	0.75	0.8	0.65	1.1
WK 8	0.7	0.75	0.55	1.3

Fig-4. Effect of pest control method on numbers of leaves



	NSE	NLE	SC	WC
Week 2	7.8	7.9	8.3	7.7
Week 4	18.75	21.25	21.75	19.75
Week 6	20.9	20.3	21.3	18

Fig-5. Effect of pest control method on mean number of damaged leaves



	NSE	NLE	SC	WC
2 WAP	8.4	8.8	7	11.5
4 WAP	9.1	9.8	9.8	13.22
6 WAP	16.9	18.4	17.9	24.2

4.3. Pod Yield Data

Cymethoate recorded significantly ($p \leq 0.05$) the highest total pod weight (Fig. 6), followed by NLE, then NSE, with the control giving the least pod weight. In addition, Cymethoate recorded significantly ($p \leq 0.05$) the highest number of pods, followed by the NLE, then NSE (Fig. 7). Also, cymethoate gave significantly ($p \leq 0.05$) the least number of damaged pods, while the control gave the highest numbers of damaged pods (Fig. 8). The mean number of damaged grains is indicated in Fig. 9. The control recorded the highest mean number of damaged grains, while cymethoate gave the least, although no significant ($p \geq 0.05$) differences existed among the treatment means. Cymethoate treated crops recorded significantly ($p \leq 0.05$) slightly heavier 100-grain weight (Fig. 10), with NLE and NSE being at par, while control recorded the least 100-grain weight. Finally, the study reveals that cymethoate treated crops gave significantly ($p \leq 0.05$) the highest grain yield/ha followed by NLE, then NSE, while control treatment gave the least yield/ha (Fig. 11).

5. Discussion

Whiteflies, aphids and pod borers were not noticed 2WAP (before treatment imposition), probably due to the age of the crop. However, cymethoate (SC) effectively controlled whiteflies, aphids and pod borers' population at 4, 6, 8 and 10WAP compared to neem seed and leaf extracts. This finding agrees with Jackai and Oyediran [25], and Jackai [14], who reported that synthetic insecticide effectively controls whitefly pests on cowpea. The same observation was made by Agona, *et al.* [26] where synthetic insecticides were reported to be more effective than botanical insecticides when both were applied under the same field conditions.

The better performance of the botanical extracts in comparison with the control agrees with the findings of Saxena [27], Jackai and Oyediran [25], Jackai, *et al.* [28], Jackai [14], Zongo, *et al.* [29], and Agona, *et al.* [26] who reported that neem products showed efficacy against the pod borer (*Marucavitrata*), pod sucking bug complex

(*Clavigralla tomentosicollis*) and other insect pests. They also agree with reports by William and Ambridge [30], Fuglie [31], and Gaby [32], that plant extracts from neem were known to possess toxic organic components that were effective in reducing insect pest population on cowpea including pod borers.

The superior number of leaves obtained in crop treated with cymethoate is an indication of better control of the studied pests, with NLE and NSE also showing potentials for these pests control. This agrees with the findings of Saxena [27], Jackai and Oyediran [25], Jackai, *et al.* [28], Jackai [14], Zongo, *et al.* [29], and Agona, *et al.* [26] who reported that neem products showed efficacy against the pod borer (*Marucavitrata*), pod sucking bug complex (*Clavigralla tomentosicollis*) and other insect pests.

Fig.-6. Effect of pest control method on mean weight of cowpea pods

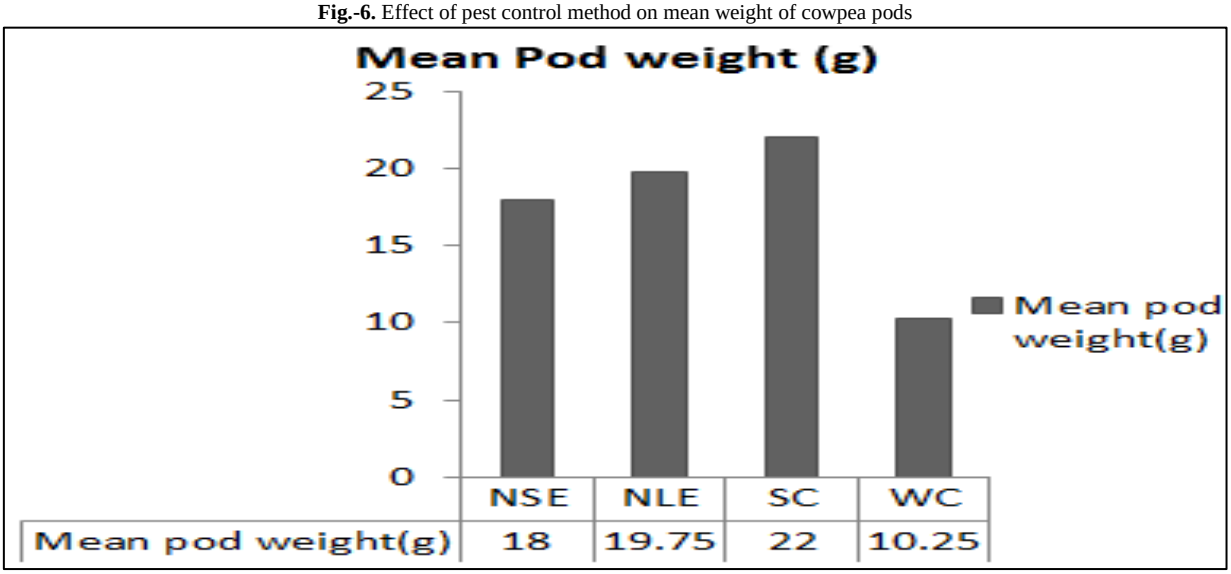


Fig-7. Effect of pest control method on mean number of cowpea pods

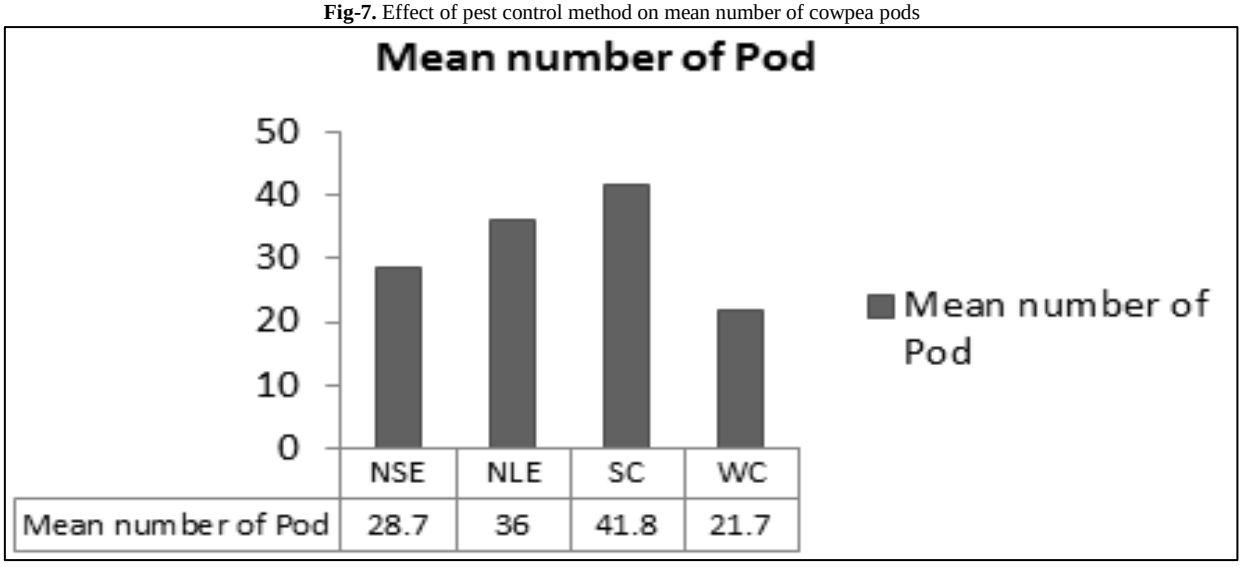


Fig-8. Effect of pest control method on mean number of damaged pods

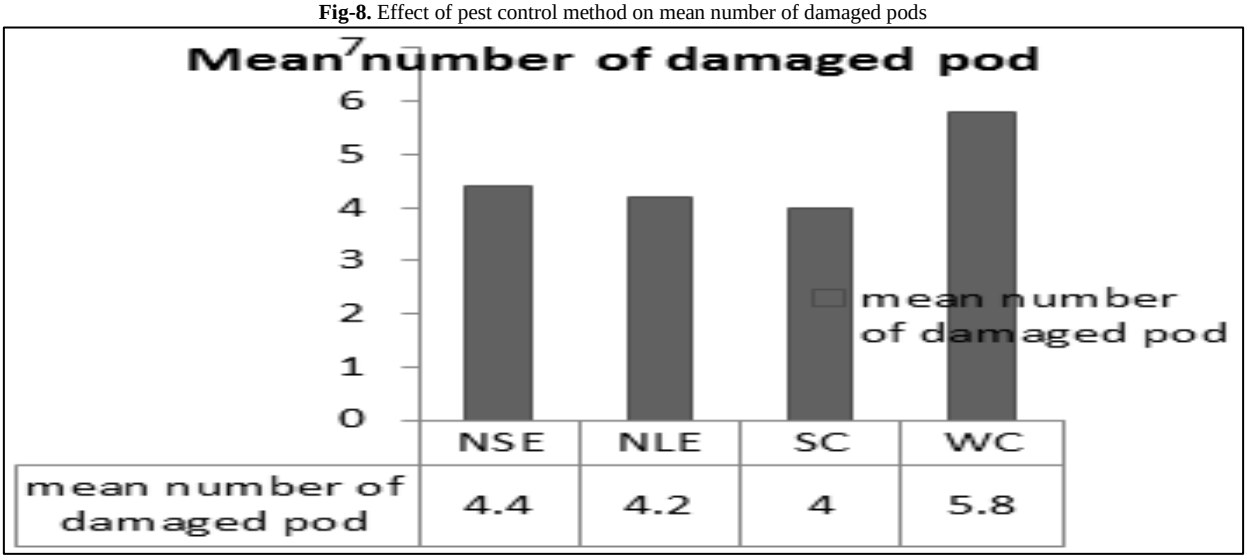


Fig-9. Effect of pest control method on mean number of damaged grain

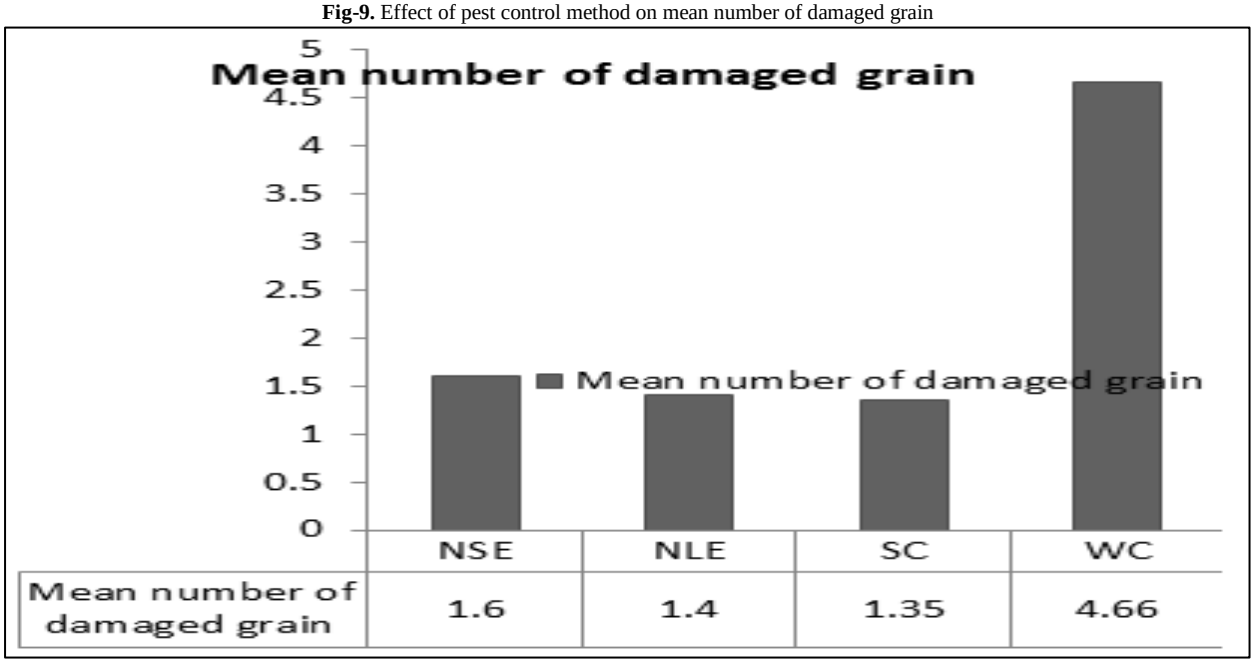


Fig-10. Effect of pest control method on 100 grain weight

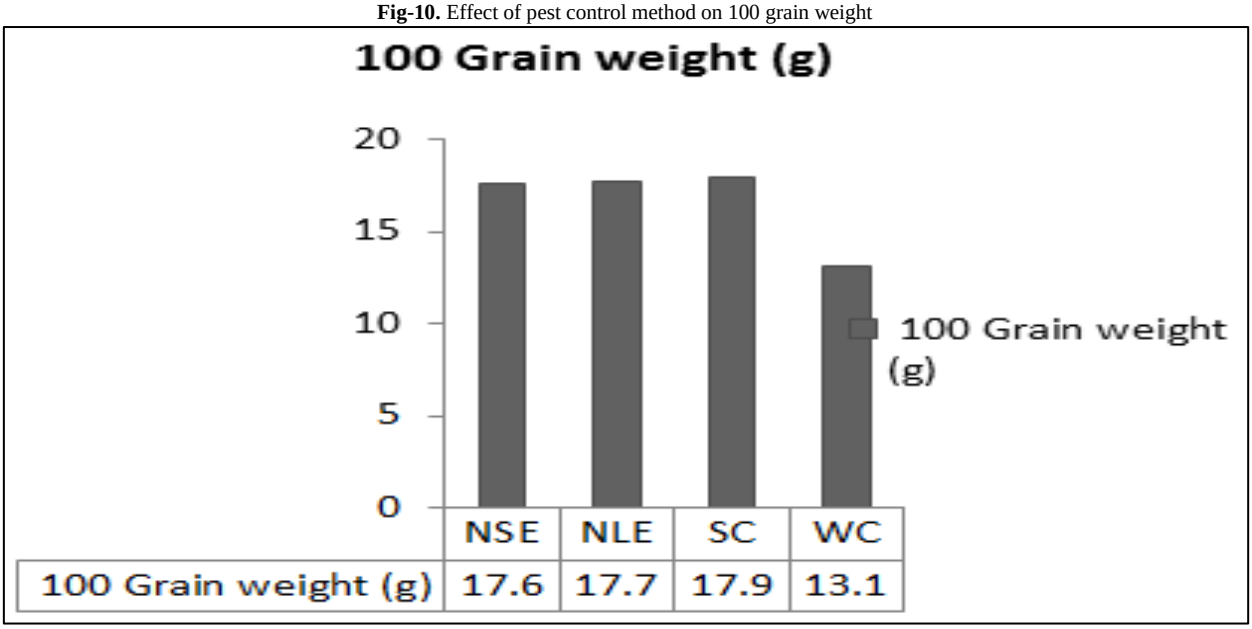
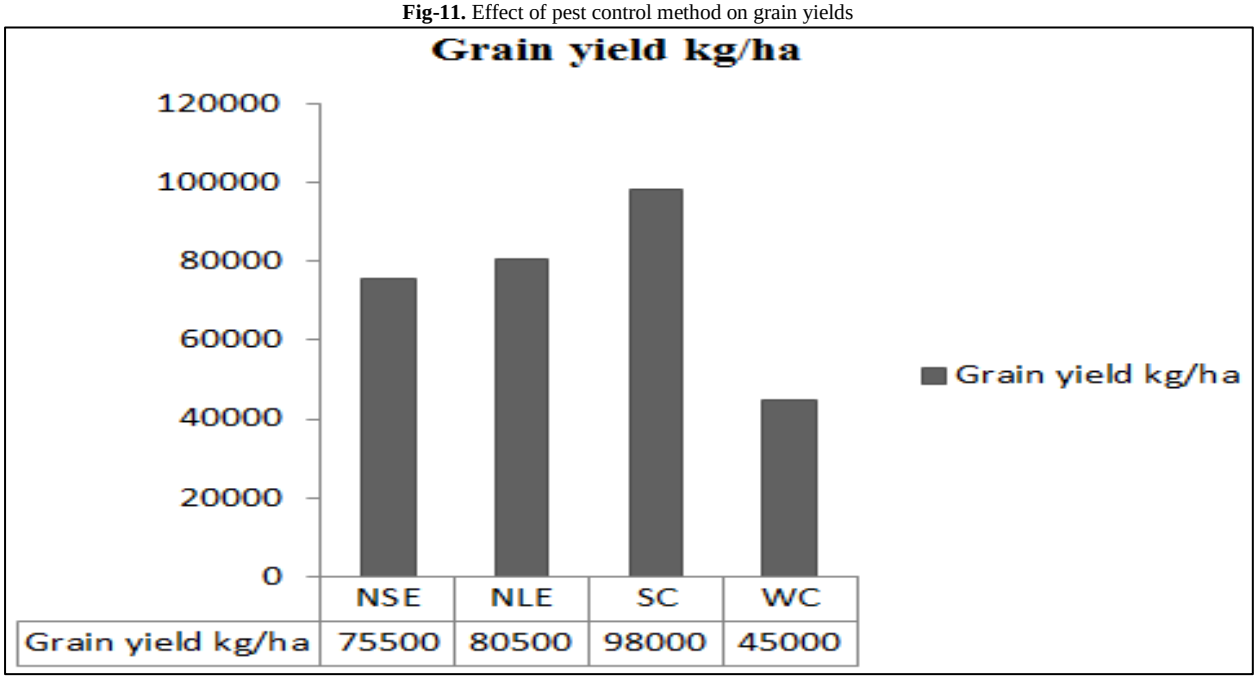


Fig-11. Effect of pest control method on grain yields



5.1. Background Information

The study on botanicals is relevant to cowpea producing farmers in the study area where the smallholder farmer engaged in the enterprise is constrained by inadequate resources to purchase synthetic insecticides to control cowpea pests. This is further compounded by inability of most farmers to use synthetic insecticides effectively. Yet over 2000 species of plants are known to possess insecticidal activities [17]. Such plant materials include powders, water extracts, oil and wood ash from plants like neem tree (*Azadirachta indica*), groundnuts (*Arachid hypogeal*), nutmeg (*Myristica fragrans*) and coconut; leaf extracts of fish bean (*Toprasla vogelli)*, ginger (*Zingiber offficinale*) garlic (*Allium sativum)*, African black pepper *(Piper guineensis)* tobacco (*Nicotiana tabacum*), cashew (*Anacadium occidental*) [21, 22, 33-35].

6. Conclusion

Although, cymethoate had a better control of the field insect pests of cowpea, its well known health concern to human beings, wildlife, environment, water bodies and livestock may have negative effect on its prolonged usage. However, since neem extracts, gave promising results compared with cymethoate, on population reduction of whiteflies, aphids and pod borers and grain yield, it can be conjectured that its prospect for use as the control agent of insect pests of cowpea is very high. Since better yield was also obtained with neem extracts in comparison with the control, it can be concluded that they exhibited reasonable insecticidal activities.

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