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Field study of growth and yield enhancement of insect-infested garden eggplant, *Solanum melongena* (L.), using organo-mineral fertilizer in Obio Akpa, Akwa Ibom State

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ABSTRACT

A field study of the growth and yield enhancement of an insect-infested African eggplant, Solanum melongena (L.) using organo-mineral fertilizer, was under-taken at the Teaching and Research farm of Akwa Ibom State University Obio Akpa Campus in 2023. Three levels of fertilizer application (0, 2, and 4 tha-^{1}) which served as treatments were replicated three times and with the entire experiment laid out in a Randomized Complete Block Design. Eggplant seedlings were raised in a nursery and transplanted to the field at five weeks old. The results showed that Zonocerus variegatus was the predominant and most widely distributed insect pests. Other identified insect pests were Ootheca mutabilis, Acraea egina, Epilachna beetle, and Anoplocnemis curvipes. The presence of these insects had no evidence of a negative effect on eggplant performance even though their population increased as a result of organo-mineral fertilizer application. Generally, all the major insects collected had their highest number at 4t/h organo-mineral fertilizer treated plots. Effect of fertilizer level on eggplant was significant ($p<0.05$) in all the growth and yield parameters considered. The study also showed a significant negativecorrelation with r = -0.512, -0.546, and – 0.508 for 2t/ha-1, 4tha-1 and the control respectively, between the number of fruits and pest frequency under the different rates of fertilizer application. Conclusively, the use of organo-mineral fertilizer at 4tha^{-1} is recommended for growth and increase in the yield of eggplant.

Keywords: *Organo-mineral fertilizer, Eggplant, Major insect pests, Fruit growth and yield*

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1.0 Introduction

Eggplant, *Solanum melongena* (L.) belongingfamily *Solanaceae* is widely cultivated in the tropics [1]. This dicotyledonous, perennial, erect and branching plant is one of the most consumed vegetables in West Africa and Nigeria in particular [2].In South-eastern and South-south Nigeria, these white, yellow or green-pigmented vegetable crop is highly cherished and commonly served alongside kola nuts during traditional and religious ceremonies [3]. In Nigeria different local varieties are in existence and are grown by different ethnic groups for local consumption and other uses. The fruit and leaves can be eaten raw as a vegetable, it could also be boiled, fried and used for soup, stew or African salad [4]. Eggplants are known to provide numerous nutrients such as energy sugars, dietary fibers and are cheap sources of protein, vitamins, antioxidants and minerals [5]. They also contain a wide range of phytochemicals such as polyphenols, useful to diabetic and asthmatic patients. In addition, the alkaloid,solanin extracted from the roots and fruits is also used for therapeutic purposes [6]. Garden egg is economically important crop for small household farmers in African, Asia, and Sub-tropics.

Global sales of organic foods and drinks reached 816 million US dollar and 30.9 million ha in the field of organic farming [7]. The need to embark on large scale production of this vegetable crop has led to efforts geared towards improving soil fertility. Intensive inorganic fertilizer usage in agriculture has created so much health and environmental degradation concerns [8-9].

Today, to eliminate the danger of chemical fertilizer usage, new agricultural practice of applying organic manures with the potential to increase growth and yield of crops has been advocated [10]. There is therefore an urgent need to search for cheap, eco-friendly and commonly available organic substances that will not contaminate food products and environment. The effect of different organic manures and inorganic fertilizer levels in soil were observed on growth performances and yield of eggplant [11]. This research work focuses on field observation of the growth and yield enhancement of an insect-infested garden eggplant, *Solanum melongena*, using organo-mineral fertilizer in Obio Akpa, Akwa Ibom State.

2. Materials and methods

2.1 Study Area

A field experiment was conducted at the Department of Crop Science of Akwa Ibom State University,Obio Akpa farm in 2023. The town is located in the northeast part of OrukAnam Local Government Area on an altitude of 40.00 m/131.23 ft. Geographically, the town lies between latitude 4^0 30 and $5^0$30' N and Longitude 7^0 30' and 8^0 30' E. Its topography is undulating, with gentle hills and slopes which gives it a unique scare.

The area has a tropical rainforest climate, with a distinct wet (April-October) and dry (November - March). The mean annual rainfall in the wet season ranges from 2500-3000mm, mean annual temperature, between 26^0c and 28^0c while relative humidity is between 75-90 % (Slus, Ak, 1989).

2.2 Land preparation

The plot of land was cleared with cutlass and plant residues removed and ploughed manually. Tilling was done using a spade and hole to level the soil and debris. Demarcation of the land was done with the aid of ropes, sticks, measuring tape, and a cutlass.

2.3 Soil analysis

Physico-chemical properties of the soil determination were preceded by a collection of soil samples (surface soil, 0-15cm) from each plot. Samples were air-dried for routine analysis as described by Carter (1993). A 1:2:5 soil/water ratio using a PH meter with a glass electrode was used to determine soil PH. Walkley-Black dichromate digestion method was employed to determine organic matter [12] while total Nitrogen was determined by the Kjeldahl method [13]. Potassium was determined using the flame photo meter, while exchangeable C_a M_g, N_a, K were extracted using Ammonia acetate. Similarly, Phosphorous was determined through Bray-1 method [14].

2.4 Experimental design

The total area of land for the experiment was 14m x14m ($196m^2$). The experiment was laid out in a Randomized Complete Block design with three blocks serving as replicates. Each block consisted of three (3) sub-plots, each measuring 4m x 4m ($16m^2$) giving a total of 9 sub-plots for the three blocks. 1 m apart demarcated each block from another. Treatment replicated three times consisted of different doses of organo-mineral fertilizer at three levels namely 0,2 and 4 tha^{-1} application.

2.5 Nursery preparation/transplanting

Nursery beds measuring 2m x 1.2m in area were prepared. Seeds were sown thinly in rows of 10 cm apart. A local variety *Solanum melongena.* collected from Cross River Basin Authority in Abak Local Government Area was used to raise the nursery in June. Seed-beds were watered and covered with mulch after sowing. After germination, the mulch was removed and shade erected to protect the young seedlings against the heat of the sun. The seedlings were pricked out to avoid overcrowding and watered until they reached transplanting stage. Transplanting commenced when seedlings were five weeks old. Seedlings were watered to soften the ground before uprooting for transplanting at late evening periods and planted at a spacing of 90cm by 90cm.

2.6 Data collection

Data collection focused on the determination of the following: soil particle sizes, textual class, exchange bases and acidity, as well as test of exchangeable Aluminium.

Similarly, four egg plants were randomly selected and tagged for data collection. Data taken on growth parameters included plant height, leaf diameter and number of branches while yield parameters obtained were number of flower, number of fruits, fruit length, fruit circumference and weight. Plant height was measured from 2 weeks after transplanting (2WAT) with a tape at the distance from soil surface to the tip of the topmost leaf. Height measurement continued at 4,6,8,10 and 12 WAT.

The number of branches per plant was carefully counted in each tagged plant at 2,4,6, 8 and 12WAT while leaf area was taken same days. The leaf length (L) and width (W) were measured and multiplied by a constant of 0.8 to get the leaf area (A), A=LxWx0.8 (Abdul *et. al.,* 2014). Similarly, number of matured fruits were counted and weighed (g) using a sensitive balance. Flowers were also counted as they appeared.

2.7 Sampling of insects

The eggplant farm was observed at bi-weekly to examine the larvae, pupae, nymphs and adult insects found on leaves flowers, and fruits of the randomly tagged eggplant per plot and were counted and recorded throughout the growing period of the crop. Counting and recording were done during morning hours (6-7am). Some of the insects, larvae, and pupae were collected and preserved in 70% alcohol or preserved in pampel's fluid. Pamper's fluid was prepared by mixing together 15 parts of 95% Ethyl alcohol 6 parts of 40 percent formaldehyde,4 parts of Glacial acetic acid and 30 parts of distilled water. Immature stages were collected and reared in the laboratory until adult stages emerged for proper identification. Direct visual count of all insect according to [15] on each tagged plant was adopted. Insects collected were identified using key by [16] and species identified,using photographic atlas of Entomology [17]. The field was exposed to natural infestation with no control measure applied.

2.8 Data Analysis

All collected data were analyzed using analysis of variance (ANOVA), and treatment means were compared using Duncan's Multiple Range Test (DMRT) at a 0.05 level of significance. Insect count data were rounded to the nearest whole number after statistical analysis.

3. Results

Table 1 shows the initial soil physico-chemical properties of the experimental plot before planting. The soil was dominated by high sand with loamy clay and silt fraction. Organic matter content was low (2.79 %), while PH was 5.80. Total Nitrogen and available Phosphorous recorded 0.07% and 6.03mg/kg respectively. Electrical conductivity (EC) and exchangeable Na and K were rated low. The highest exchange acidity and Aluminium recorded 1.0. and 0.83cmol/kg respectively. B/salt was 73.01% while effective cation exchange capacity (ECEC) was 6.78%

Table1: Soil physico-chemical properties of the field before planting

Particle size analysis of soil properties	Values
Sand(%	87.60
Silt(%)	3.88
Clay(%)	8.52
Textural class	
PH (%)	5.80
EC (%)	0.09
Organic matter (%)	2.79
Total nitrogen (%)	0.07
Available P ($mgkg^{-1}$)	6.93

Exchange bases	
Ca (cmol/kg)	3.20
Mg (cmol/kg)	1.60
Na (cmol/kg)	0.05
K (cmol/kg)	0.10
Exchange acidity (cmol/kg)	1.0
Exchange aluminium (cmol/kg	0.83
ECEC (cmo1/kg)	6.78
B/salt (%)	73.01

The elemental analysis of the organo-mineral fertilizer applied is presented in table 2. Nitrogen and Potassium recorded the highest percentage, 2.8 and 2.2 respectively. Moisture recorded 1.4 and Phosphorous content, 1.2 was the least.

Table 2: Chemical properties of organo-mineral fertilizer used in the study

Properties	Values (%)
Nitrogen (N)	2.8
Phosphorous (P)	1.2
Potassium (K)	2.2
Moisture	1.4
Total	4.0

Table 3 shows the mean number of major insect pests and their frequencies. Five (5) of these insects in the following of increasing order *Zonocerus variegatus* > *Ootheca mutabolis (*Sah*) >Acraeaegina>Epilachna* beetle *>Anoplocnemiscurvipes (*Fab.*)* caused severe degrees of damage to the eggplant (plate; 1,2,3).

Table 3: Major insect pests of garden eggplant and their frequencies

Treatment	*O.mutabilis*(Sah)	***Epilachna***beetle	*A.curvipes*	*A.egina*	*Z.variegatus*	Total
2tha^{-1}	3^{b}	3^{ab}	2^{b}	4^{a}	3^{b}	15^{b}
4tha^{-1}	5^{a}	4^{a}	4^{a}	3^{b}	6^{a}	22^{a}
Control	2^{c}	1^{c}	1^{c}	2^{c}	3^{b}	9^{c}
Total	10	8	7	9	12	46

Plate 1: Larvae of Acraeeginafeeding on garden egg leaves

Plate 2: Larvae of Epilachnabeetle, showing skeletonized leaf

Plate 3: Garden eggplant and fruits attacked by shoot and fruit borer

Table 4: Effect of fertilizer treatment on height (growth) of eggplant (cm)

Treatment	2WAT	4WAT	6WAT	8 WAT	10WAT	12WAT
2tha^{-1}	14.13^{b}	24.31^{b}	33.87^{b}	38.56^{b}	53.50^{b}	57.0^{b}
4tha^{-1}	20.58^{a}	30.91^{a}	45.22^{a}	48.24^{a}	56.90^{a}	70.85^{a}
0tha^{-1}	15.28^{b}	19.52^{c}	33.89^{b}	38.19^{b}	47.42^{c}	53.53^{b}

Means with the same superscript in the same column are not significantly different (P > 0.05).

Table 4 shows the effect of fertilizer level on height of eggplant, as a growth parameter. The result shows that the plants were not significantly different in height throughout the growth period except at twelve weeks after planting (12WAT). At 2WAT, 4tha^{-1} of fertilizer recorded, the highest plant height with mean heights of 20.58cm followed by the control with 15.28cm, while 2tha^{-1} had the least (14.13cm). However, there was no significant difference (P>0.05) in plant height among the three rates of fertilizer application at 2WAT. At 4WAT, the highest plant height was obtained at 4tha^{-1}treatments with mean of 30.91 cm followed by 2tha^{-1} treatments with mean of 24.31cm while the control had the least (19.52cm) but withthe difference not statistically significant. The tallest plant at 6WAT was obtained at 4tha^{-1}treatments with mean of 45.22cm, followed by the control with 33.89cm, similar to 2tha^{-1} with mean of 33.87cm. The highest plant height at 8WAT and 10WAT were 48.22cm and 56.90cm respectively with 4tha^{-1}.At the final growth stage (12WAT), the highest plant was recorded in 4tha^{-1}with 70.85cm followed by 2tha^{-1} with 57.0cm while the control had the least mean of 55.53cm and with as significant (p<0.05) difference.

Number of branches of eggplant presented in Table 5. Generally, there was no significant difference in number of branches among the three levels of fertilizer application throughout the growth period. However, there were variations in number of branches produced by each of the fertilizer level. At 2 WAT, the highest number of branches was obtained at 4tha^{-1} (3.33) followed by 2tha^{-1} (1.92) while the control has the least (1.75). At 4 WAT, 4 tha^{-1} had the highest branches per plant (1.58) followed by 2 tha^{-1} (1.42) while the control had the least (1.33). at 6 WAT and 8 WAT, the highest number of branches per plant were 1.50 and 2.08 respectively. At 10WAT and 12 WAT, the highest mean number of branches were 5.50 and 9.0 branches respectively. The result showed that though the difference was not statistically significant, level of application of organo-mineral fertilizer produced effect on branching of garden egg.

Table 5: Effect of Fertilizer level on number of branches (growth) of garden egg

Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
2 tha^{-1}	1.92^{b}	1.42^{a}	1.50^{a}	2.08^{a}	5.50^{a}	8.75^{a}
4 tha^{-1}	3.33^{a}	1.58^{a}	1.33^{b}	1.67^{b}	4.75^{a}	9.0^{a}
0 tha^{-1}	1.75^{b}	1.33^{b}	0.92^{c}	1.42^{b}	3.50^{c}	7.08^{b}

Means with the same superscript in the same column are not significantly different (P > 0.05).

Leaf area, as a growth parameter of the experimental plant is presented in Table 6. There were significant differences in leaf area of the plant among the three fertilizer levels at initial growth stage (2-4 WAT) but no significant difference at the advanced growth stage (6- WAT) and 12 WAT.Mean leaf area obtained revealed that 4 tha-^{1} gave the widest leaf of 2 WAT (90.02 cm^{2}) followed by 2tha^{-1} with 51.63cm^{2} while the control had the least (32.36cm^{2}).
At 4WAT, the widest leaf was obtained still with 4 tha^{-1} (107.36cm^{2}) followed by 2tha^{-1} (75.77cm^{2}) while the control has the least (65.67 cm^{2}). At 6 WAT and 8 WAT with 4 tha^{-1}, 135.02cm^{2} and 136.96cm^{2} leaf area were observed respectively.
At 10 WAT, 4 tha^{-1} recorded the highest (137.55cm^{2}) followed by 2 tha^{-1} (126.81cm^{2}) while the control had the least (106.66cm^{2}) and with a difference that was statistically significant (P<0.05). The trend was different at 12 WAP as 2 tha^{-1} gave the widest leaf (160.76cm^{2}) followed by 4 tha^{-1} with 157.32cm^{2} while the control had the least (122.69cm^{2}).

Table 6: Effect of level of fertilizer on leaf area (growth) of garden egg plants

Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
2 tha^{-1}	51.63^{ab}	75.77^{b}	105.51^{b}	134.50^{a}	126.81^{ab}	160.76^{a}
4 tha^{-1}	90.02^{a}	107.36^{a}	135.02^{a}	136.96^{a}	137.55^{a}	157.32^{a}
0 tha^{-1}	32.36^{b}	65.67^{b}	72.86^{c}	113.59^{b}	106.66^{b}	122.69^{C}

Means with the same superscript in the same column are not significantly different (P > 0.05).

Number of flowers (yield parameter) of garden egg under the three levels of organic fertilizer is presented in Table 7. Egg plants were significantly different in a number of flowers only at initial stage of growth. At 2WAT, 4tha^{-1} level of the fertilizer had the highest number of flowers with mean of 20.58 flowers followed by that of the control with 0.42 flowers, while 2 tha^{-1} level of the fertilizer had the least (0.33). At 4 WAT, the highest number of flowers was obtained in 4 tha^{-1} level with a mean of 3.0 flowers followed by 2 tha^{-1} level with mean of 4.92 flowers while the control had the least (2.67 flowers but with no statistical significant difference. The highest mean number of flowers at 6 WAT and 8 WAT, at 2 tha^{-1}were 6.0 and 8.42 flowers respectively. The control for the former in 4 tha^{-1} was just 3 flowers while the later (8 WAT) had 8.08 flowers. At 10 WAT, the highest number of flowers was obtained in 4 tha^{-1} level with 10.25 flowers followed by 2tha^{-1} with 8.08 flowers while the control had the least with 5.58 flowers but with no significant (P> 0.05) difference. At the final growth stage (12 WAT), the highest number of flowers was recorded in 2tha^{-1} with 12.0 flowers followed by 4 tha^{-1} with 10.92 flowers while the control had the least with 9.50 number of flowers but with no significant (P<0.05) difference.

Table 7: Effect of fertilizer level on number of flower (yield) of garden egg plant

Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
2 tha^{-1}	0.33^{b}	4.92^{b}	6.0^{a}	8.42^{a}	8.08^{a}	12.0^{a}
4 tha^{-1}	1.75^{a}	3.0^{a}	5.50^{ab}	8.08^{ab}	10.25^{a}	10.92^{b}
0 tha^{-1}	0.42^{b}	2.67^{c}	3.00^{b}	8.17^{b}	5.58^{c}	9.50^{C}

Means with the same superscript in the same column are not significantly different (P > 0.05).

The fruit (yield) of garden egg obtained from the three levels of organic fertilizer application is presented in Figure l. The result showed that 2tha^{-1} and 4tha^{-1} level of the fertilizer produced almost similar number of fruits per plant (13.31 and 12.57) but significantly (P>0.05) was higher than the control (7.33 fruits). There was however no significant difference in number of fruits produced by 2 and 4tha^{-1} of the fertilizer used in the study except with control.

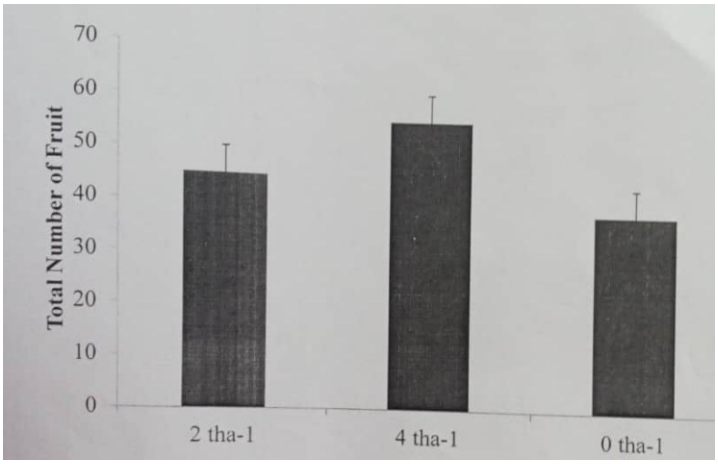

Figure 1; Effective of level organo-mineral fertilizer on the total number of fruit

Weight of the garden egg (yield) obtained from the study is presented in Figure 2. The result showed that 4 tha-^{1} level had the highest fruit weight (95.442g) followed by 2 tha^{-1} with 48.58g, slightly higher than the control which had the least (7.07g). However, there was no significant difference (P>0.05) in fruit weight of garden egg of 2tha^{-1} and the control, whereas fruit yield of 4tha^{-1} was significantly higher than that of 2 tha^{-1} and the control.

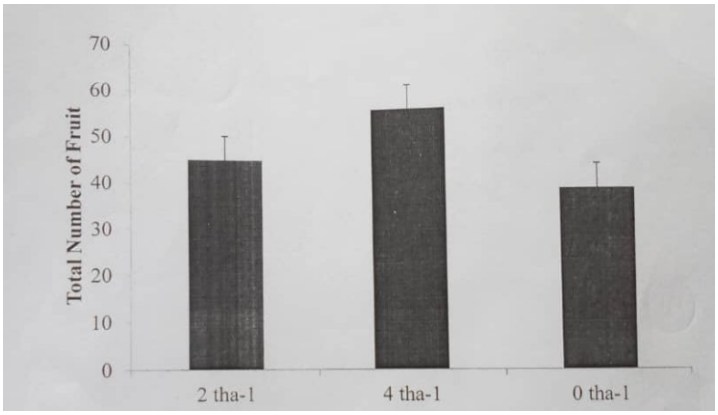

Figure 2; Effectof level of organo-mineral fertilizer onfruit weight

The circumference of garden egg (yield) obtained in this study is presented in Figure 3. The result showed that 4tha^{-1}level had the widest fruit circumference (3.4cm) followed by 2tha^{-1} with 2.7cm higher than the control which had the least (1.8cm). there was a significant difference (P<0.05) in fruit circumference of garden egg obtained from the three levels of fertilizer application.

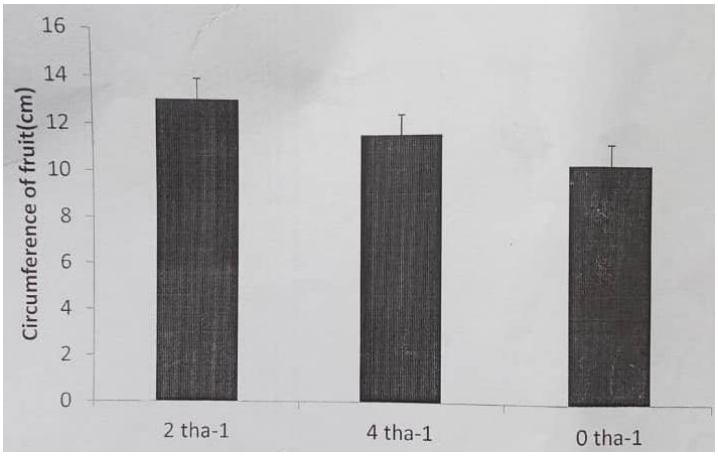

Figure 3; Effect of level of organo-mineral fertilizer on circumference of fruit

The length of fruit (yield) is presented in figure 4. The result shows that 4tha^{-1} level had the highest mean fruit length (17.24cm) followed by 2tha^{-1} with 15.23cm which was slightly higher than the control which had the least (15.05cm). however, there was no significant difference in fruit length of 2tha^{-1} and the control, whereas fruit length of 4tha^{-1} was significantly higher than that of 2tha^{-1} and the control.

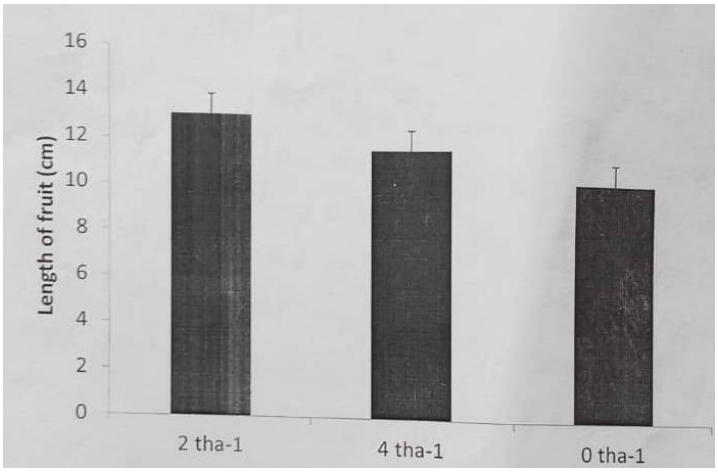

Figure 4; Effect of level of organo-mineral fertilizer on length of fruit

Table 8 shows correlation coefficient between pest frequency, growth characteristics and yield of garden eggplant. Frequency of insect pests correlated negatively under the three treatments but significant with plant height at 4tha^{-1} only with correlation coefficient r of -0.370, – 0.896 and -0.430 for 2tha^{-1} and the control soils respectively. The frequency of insect pest also had a negative correlation with number of branches across the treatments with r = -0.565, - 0.690 and -0.285. Significant (P<0.05) association was obtained only in 2tha^{-1} and 4tha^{-1} plots. The relationship between pest frequency and leaf area of gardeneggplant was generally negative (r = -0.157, -0.534 and 0.432) but a significant association was obtained in 4tha^{-1} soil. The total number of fruits and pest frequency in the farm correlated negatively, with r = -0.512, -0.546 and -0.508 for 2tha^{-1}, 4tha^{-1} and the control. Pest frequency had mixed correlation with fruit weight under different application rates. Pest frequency correlated negatively in 2tha^{-1} and the control (r = -0.609 and -0.435) but positively and significantly correlated in 4tha^{-1} plot (r = 0.532). Length of fruit had a positive correlation with pest frequency in 2 tha^{-1} and the control (r= 0.237 and 0.249 respectively) and negatively correlated in 4 tha^{-1}plot with however was not significant. Pest frequency had no significant (P>0.05) correlation in any of the treatments.

Table 8: Relationship between the number of insects and Garden eggplant performance under different level of application of the fertilizer

Growth and Yield Parameters		r^2	
	2 tha^{-1}	4 tha^{-1}	Control
Plant height	-0.370	-0.896	-0.43
Number of branches	-0.565	-0.690	-0.285
Leaf Area	-0.157	-0.534	-0.432
Total Number of fruit	-0.512	-0.546	-0.508
Fruit weight	-0.609	0.532	-0.435
Fruit length	0.237	-0.324	0.249
Fruit circumference	-0.297	0.321	0.412

*Significant at p<0.05,** Significant at p<0.01*

4. Discussion

The study revealed a bountiful eggplant harvest. This may not be unconnected with the improved soil condition in Obio Akpa, characterized by dominance of high sand, loamy, clay and silt fraction favorable for eggplant cultivation. The initial chemical properties of the experimental plot before treatment application was low (2.79%) in organic matter content. The values were lower that 10% as provided for soils in south eastern Nigeria [18] suggesting low organic matter content, lack ability to adequately supply essential nutrients and maintain good structure needed for plant growth. The management of this soil therefore requires adequate fertilizer and organic matter application to improve soil condition and crop yield.According to [19] fertilizer is the key factor in soil management and yield increase in crop production. Plants need nutrients in specific proportion in the soil which can be improved with the use of fertilizers [20-21] reported that eggplants like other solanocecousplants take up lots of nutrients which depends on the number of fruits produced. NPK contents of the applied organic fertilizer showed that they are useful materials for boosting crop growth and yield. This also is in agreement with the report of [22] that NPK uptakes of organically grown sweet corn greatly improved the growth and yield.

The presence of a major insect pest complex in the farm was a source of concern. Z. variegatus was observed to be most abundant insect pests found in the farm right from the nursery stage. The result is in agreement with the report of [23-24] who listed a number of the most economically important insect species of eggplant in Nigeria and noted that grasshoppers, crickets and beetles were among the most destructive insect pests found. Other major insect pests found were *O. Mutabilis*, *A. egina*, *Epilachina* beetle. This observation may imply that some insect pests attacked the eggplant from the seedling stage. It could also be deduced that damages done by insect pests on the eggplant depends on growth period of the plant. Most of these insects attacked the crops at the vegetative stage. The importance of organic fertilizer on the growth and yield of solanoceous crops cannot be overemphasized. The result of the present study showed that the height of the eggplant, a growth parameter was significantly influenced by manure level of the soil. This is in agreement with [25] who reported that garden eggs can grow on a wide range of soil, high organic matter and excessive rainfall that will check vegetative growth and flower formation. Similarly, the observation also upholds the findings of [26] who asserted that the crop should be grown on soils that have high organic content and as such, soil deficient in organic matter should have compost or green manure incorporated at least two weeks before planting.[27] also recorded increased *Solanum nigrum* height with fertilizer application. Branching of garden eggplant increases fruit yield which of course is the overall aim of the eggplant farmer as this also increases economic benefit.

The present result showed that, though there was no statistically significant difference, the level of application of organo-mineral fertilizer produced appreciable effects on garden egg branching. Branching of plant is mostly influenced by the variety and nutrients supplied to the plant [28]. This result suggests that application of the fertilizer at higher rate (2-4tha^{-1}) can boost productivity of the eggplant because, branching is boosted with an increased level of organo-mineral fertilizer. The present result also showed that leaves of 4tha^{-1} were generally wider than leaves of 2 tha^{-1} and the control. This observation could be attributed to nutrient level supplied to the plant as they were all of the same genetic composition. The resultshows that the level of application of organic fertilizer has effect on leaf area of the plant. This result confirmed the report of [29] on the influence of organic nutrients on leaf area of eggplants. Leaf area of plants is of great importance to growth and yield of the plant as it is directly relatedto photosynthetic activities, which is the only meansthrough which food is produced for growth, with the excess stored as yield. It is thought that, the level of application of organic fertilizer in this study affected both growth and yield of crops. Eggplants were significantly different in number of flowers only at initial stage of growth. The result clearly showed that flowering of garden eggplant was significantly influenced by manure level of the soil. This observation is in agreement with the findings of [3], that the crop should be grown on soils that have high organic matter content. Eggplants total number of fruits was also used in measuring yield performance. The present result indicated that application of organic fertilizer even at lower level could lead to significant improvement in the yield of garden eggs compared to what would be obtainable without fertilizer application. The result confirmed the findings of [27-29] that application of organic manure can significantly improve growth and yield of the garden egg. Again, fruit yield of 4tha^{-1} was significantly higher than that of 2tha^{-1} and the control, indicating that, lower application of the organic manure may not improve the quality (weight) of fruit compared to higher application of the manure. This result is in agreement with the report of [23] that the amounts of nutrient intake by eggplants depend on the quality of fruits produced. Similarly, fruit length of 4tha^{-1} was significantly higher than that of 2tha^{-1} and the control, further confirming that higher application of the manure gave the highest fruit length and showed eggplannt fruits quality improvement. The study also examined the relationship between pests and crop performance concerning growth characteristics and yield. The result which showed that relationship between number of insects, growth as well as yield parameters of the crop was mostly negative irrespective of level or organio-mineral fertilizer applied could imply that; the sole economic importance of pests on garden eggplant is, reduction in growth and yield of the crop [25]. The mixed correlation between pest frequency and fruit quality is an indication that fruit quality like length, circumference of fruits etc are not majorly determined by the fertility status of the soil, but may be influenced by variety planted. This assertion upheld the findings of [26] that in the tropics, eggplant production is severely contained by several insect pests. The result further confirmed the report of [27] that the quality of fruits produced by eggplant under fertilizer treatments may also be influenced by the genetic makeup of the eggplant varieties and the environment.

5. Conclusion

The study has shown that the organo-mineral fertilizer contains a good amount of N.P.K that can improve garden eggplant production. It has also been shown that the levels of application of this fertilizer increased population of insect pests on garden eggplant. Five major insect pests in increasing order of number and damage done were as follows: *Zonocerus variegatus, Ootheca mutabilis* (Sah.) >*Acraeegina*>*Epilachna*beettle> *Anoplocnemiscurvipes*(Fab.). Also, the best growth and yield of eggplants were obtained at 4tha^{-1} followed by 2tha^{-1} of the manure while that of control had the least. The study further revealed that, relationship between number of insect pests observed and growth, as well as yield parameters of the crop are mostly negative under the three levels of fertilizer application, implying that the sole economic importance of pests on garden eggplant is reduction in growth and yield of the crop, plots amended with organo-mineral fertilizer increased the vegetative growth and yield of garden eggplant.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1. Abdul A., Henry, O. T. Mensah, B., Thomas, A. G., Awudu, A., Israel, Y. B., Caleb, M., &Pearl, K. 2014. Effects of poultry manure and NPK fertilizer on growth and yield of garden eggs *(Solanum Melongena)* in a sandy soil in Ghana. *International Journal of Scientific Research in Knowledge* 2(6), 264-267.

2. Abubakar, D. N. 2017. The potential benefit of African Eggplant, Proceedings of 17th National Annual Conference of Horticultural Society of Nigeria held at Moor Plantation, Ibadan, Oyo State, November. 7-10th pp. 121-125.

3. Ayeni, M. T. Ademiluyi, B. O., & Shittu, R. A. 2016. Effects of Organic and Inorganic fertilizers on the growth performance of *Solanum nigrum L. Journal of Agriculture and Ecology Research International* 5(4), 1-6

4. Bremner, J. M., &Mulvancy, C. S. 1982. Nitrogen- total in methods of soil Analysis part 2, Agromomy Monograph 9(2nd edition) ASA and SSSA, MaidlsonWsc. Pp. 403-430.

5. Castner, J. L. 2000. Photographic Atlas of Entomology and Guide to Insect Identification; Feline Press, Gainesville, FL 3263T5, USA.

6. Chadha, M. L., & Oluoch, M. O. 2023. Home-based vegetable gardens and other strategies to overcome micro nutrient malnutrition in developing countries. *Food Nutrition and Agriculture Journal,* 32(1), 17-23.

7. Critchley, B. R. 2001. Pests of Vegetables. Their Identification and control in Ghana. National Research Institute pp. 288.

8. Culliney, T. W., &Pimentel, D. 1986. Ecological Effects of Organic agricultural Practices on insect populations *Agriculture, Ecosystem and Environment,* 15, 253-256.

9. David-Rogeat, N., Broadley, M. R., & Stavridou, E. 2023.Solanum Crops with a focus on the African Eggplant: the potential of Bio-stimulants to Enhance stress tolerances *International Journal of plant and soil sciences,* 35(18), 1425-1451. https://doi.org/10.9734/ijpss/2023/v35il8341/.

10. Eigenbrode, S. D., & Pimentel, D. 1988. Effects of Manure and Chemical Fertilizers on Insect Pest populations on collards. *Agricultural, Ecosystem, Environment,* 20, 109-125.

11. Emma-Okafor, L. C., Oculi, N. A., Obiefuna, J. C., Algba, R. A., &Keyagha, E. R. (2017). Yield Enhancement in African Eggplant *(Solanum macropon)* production using poultry manure and ash mixture in Owerri, Nigeria. Proceedings of the National Annual Conference of Crop Science Society of Nigeria, held at the University of Uyo, Akwa Ibom State, Nigeria. Pp. 100-103.

12. Esu, I. E. 2010. Soil Characterization, Classification and Survey, HEBN Publishers Plc, Ibadan, Nigeria.

13. Faruki, S. I., Miyanoshita, A., Takahashi, K., Misumi, T., Imamura, T., Naito, H., Goto, M., & Soma, Y. 2005. Susceptibility of various developmental stages of the Maize Weevil, *Sitophilus zeamais*Motschulsky (Coleoptera: *Curculinidae*) to Methyl iodide in brown rice: *Journal of Applied Entomology*, 139, 12-16.

14. Folorunso, J. T., Alao, F. A., &Adebayo, T. A. 2020. Population density of Insect Pests associated with Eggplant varieties *(Solanum species)* in Ogbomoso, Nigeria.*Journal of Entomology and Zoology,* 8(5), 979-982.

15. Joseph, P. O., Ojomah, F. O., & Joseph, P. O. 2017. Effect of Poultry manure and NPK fertilizer on growth and yield of Eggplant *(Solanum melongena). Journal of Agriculture and Rural Research,* 10, 112-117.

16. Lawal, B. A., Adeboye, M. K. A., Usman, A., Afolabi, S. G., & Adekanmbi, A. A. 2015. Rotation Effect of *Aeschynomenehistrix* on Soil Carbon and Nitrogen and Maize Grain yield at Minna in the Southern Guinea Savanna of Nigeria. *Journal of Agriculture and Agricultural Technology* 6(1), 1-9.

17. Mohammad, S. 2013. Population Estimation methods of insects. http://www.slidehare.net/salmonn92/population.estimate.

18. Moursy, F. S., Gad, D. A., Adly, D., & Sadek, I. I. 2021. Study of the effect of two organic fertilizers, methods of fertilization on productivity, Pests and Predatory Insects associated with Eggplant under modified climatic condition. *GSC Biological and Pharmaceutical sciences* 16(1), 170-185. https://doi.org/10.30574/gscbps.2021.16.1.0205.

19. Muktamar, Z., Fahrurrozi, F; Sudjatmiko, S., Setyowati, N., &Chozin, M. 2021. Nitrogen, Phosphorous, and Potassium up takes of organically grown sweet corn on coastal Entisols, *International Journal of Agricultural Technology,* 17(1), 213-226.

20. Murphy, J., & Riley, J. P. 1962. A modified single solution method for determination of phosphorous in natural water, *AnalytricalChimica*, *ACTA* 27, 31-36.

21. Naeem, M. Y., & Ugur, S. 2019. Nutritional content and health benefits of eggplant. *Turkish Journal of Agriculture-Food. Science and Technology,* 7, 31-36.

22. Nelson, D. W., & Sommers, L. S. 1982. Total Carbon, Organic Carbon and Organic matter. In: page, A. L. et al., (Eds). Method of Soil Analysis part 2. Agronomy Monography 9(2nd edition), ASA and SSA W.Sc. pp 539-579.

23. Norman, M. J. T. 1992. Tropical food crops in Environment (2nd edition), Cambridge University press, UK pp. 305-316.

24. Rice, R. P., Rice, L. W., & Tindall, H. D. 1993. Fruits and vegetables production in African. The Macmillan press limited, London and Basingstoke, pp. 227-230.

25. Schivalingaswamy, T. M.,&Satpathy, S. 2007.Integrated Pest Management in Vegetable Crops in Jain Pc., Bhargava M. C. Entomology: Norel Approaches, New India Publishing Agency, New Delhi Pp. 353-375.

26. Subramanyam, B., &Hagstrum, D. W. 2000. Botanicals. In B. Subramanyam and D. W. Hagstrum (Eds). Alternatives to Pesticides in Stored Products *IPM* Boston: Academic Publishers 303-320.

27. Ugwu, J. A., Karem, K. T., & Aluko, J. (2021). Insecticidal Activities of Aqueous Extracts of Five Nigeria Aromatic Species against Garden Eggplant Defoliators and Fruits borer, *Leucinodesorbonalis*Gueniee (Lepidoptera: Cerambicidae). *Tanzania Journal of Science* 47(3), 1322-1329.

28. Vijaya, K. S. &Seethalaksmi, S. 2011. Response of Eggplant *(Solanum melongene L.)* to integrated Nutrient management amended soil. *International Journal of Scientific and Engineering Research,* 2(8) (ISSN 2229-5518).

29. Willer, H.,&Lemoud, J.2017 (Eds). The world of Organic Agriculture. Statistics and emerging trends. IFOAM Organic International Bonn, FIBL, Frick and BONN 02-20.