Evaluation of Liquid Organic Cow-Poultry Manure Fertilizers Inoculated with *Azadirachta indica* (Neem) Extracts for Soil Fertilization and Disease Control in Sweet Corn (*Zea mays* var. Rugosa) Production

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ABSTRACT: The yield and quality of sweet corn at national level is, however, significantly low mainly due to improper fertilization. On the other hand, inorganic fertilizers remain the main yield-augmenting technology in Nigeria. But unwise use of chemical fertilizer in maize production could lead to deterioration of soil health and economic loss to the environments. Adopting low cost agricultural technology is economically, ecologically and socially feasible to ensure sustainable maize production. This project is aimed at evaluating liquid organic cow-poultry manure fertilizers inoculated with *Azadirachta indica* (neem) extracts for soil fertilization and disease control in sweet corn (*Zea mays* var. Rugosa) production. The liquid organic cow-poultry manure fertilizer was prepared from a composted manure using a mixture of cow manure and poultry manure, inoculated with neem leaves extracts and tested on land planted with sweet corn (*Zea mays var. rugosa*). A field experiment was conducted at Research Farm of the Taraba State University, Jalingo, Nigeria to determine the rate and method of liquid organic cow-poultry manure fertilizer application for optimum yield. The experiments consisted of four treatments; Control (no treatment), 100 L/ha liquid organic cow-poultry manure fertilizer, 200 L/ha liquid organic cow-poultry manure fertilizer and 500kg/ha NPK fertilizer. The experiment was laid out using randomized complete block design with four replications. Data on growth and yield parameters were recorded and subjected to analysis of variance ($P \leq 0.05$). The results showed that growth and yield of sweet corn were significantly influenced by different levels of liquid organic fertilizer and NPK compound fertilizer application. The plant growth and yields were increased by application of liquid organic fertilizer and NPK compound fertilizer.

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1. Introduction

Sweet corn (*Zea mays* var. Rugosa) is a popular multipurpose cereal crop belonging to the family *Poaceae* and is cultivated as an annual field crop all over the world. The productivity potential of sweet corn is higher than that of wheat and nutritive status is superior to rice on account of higher sugar percent. Sweet corn is an exhaustive crop and it is harvested at milky stage and requires fertile soils for optimum production. Indiscriminate use of agro-chemicals, continuous cropping, inadequate replacement of nutrients, burning of crop residues and loss of nutrients through erosion degrade the soil physical, chemical and biological properties. In agricultural production practices, fertilizers (organic and inorganic) are used to increase the accumulation of nutrients in the soil to improve the ability of the soil to supply nutrients to crops (Liu *et al*., 2021). Fertilizers have considerably contributed to increase in food production and food security (Choudhary *et al*., 2021; Wang *et al*., 2021). However, misuse and excessive use of chemical fertilizers may lead to loss of soil organic matter, have adverse effects on the environment and can threaten human and animal health as well as in food safety and quality (Dayo-Olagbende *et al*., 2020). The use of large amounts of chemical fertilizers has caused a series of harmful ecological and environmental impacts, such as soil acidification, soil compaction, and soil fertility degradation, which severely restrict the sustainable development of green agriculture (Gosal *et al*., 2018). Therefore, rationally balancing chemical fertilizer input and enhancing crop yields and soil sustainability are the targets that need to be focused urgently in current agricultural production process.

The cost of chemical fertilizers, limited resource reserves and the potential environmental risk like polluted air, water, and soil, the degraded lands, depleted soils and increased emissions of greenhouse gases, posed by overuse have renewed the interest in using soil organic matter amendments such as plant residues, manures and composts (Dayo-Olagbende *et al*., 2020) which are considered economic and environmentally-friendly alternatives (Chemutai *et al*., 2019). Hence, there is a need to develop the organic crop production technology for sustenance of soil health. So organic farming is becoming an increasingly important aspect of environmentally sound sustainable agriculture. Organic materials hold a great promise due to local availability as a source of multiple nutrients and ability to improve soil characteristics.

The beneficial effects of organic composts include increasing water holding capacity and plant water availability, decreasing leaching of nutrients, reducing erosion and evaporation and prevention of plant diseases (El-Farghal *et al*., 2019). Compared to plant residues and manure, composts release nutrients more slowly and have longer-lasting effects. The slow decomposition is more effective increasing organic matter content of the soil which plays a key role in soil fertility by retaining nutrients, maintaining soil structure, and holding water (Dania *et al*., 2018).

Organic fertilizers like organic liquid fertilizers are materials with defined chemical composition and high nutritional value that can provide adequate nutrients for plant growth. Organic fertilizers were mainly made by composting animal manure, human excrement, or plant matter (such as straw and garden waste) under microorganisms fermenting at high temperatures (Chew *et al*., 2019). Organic fertilizers improve the soil structure, provide a wide range of plant nutrients, and add beneficial microorganisms to the soil. Because of the benefits of organic fertilizers on soil structure and crop yield were widely used in the agricultural system.

Many organic materials are produced around the home, or can be obtained at little or no cost from livestock operations, municipal green waste collection centers, and local landfills. Virtually any organic material can be used as a fertilizer; however, materials vary considerably in the concentration of plant nutrients they contain and the rate at which these nutrients are released for plant use. Therefore, some organic fertilizers are better for certain situations than others, and different materials need to be applied at different rates to supply the correct amount of plant nutrients (Chew *et al*., 2019).

This present study is therefore focused on the development and evaluation of an eco-friendly organic liquid fertilizer for sweet corn crop production, using organic wastes (cow dung, poultry wastes and neem leaves) which are abundantly available in Nigeria as feed stocks. Cheap and eco-friendly organic compost extract and its foliar feeding or soil drench application method have demonstrated capability in improving growth and yield as well as reducing the incidence of plant diseases, thus forming the basis of this research (El-Shaieny *et al*., 2022).

2. Materials and Methods

The field work was carried out at Taraba State University Research and Demonstration Farm in Jalingo, Nigeria. The study site is geographically coordinated at latitude 8º 53′ and 34.2672″ North and longitude 11º 22′ and 37.74″ East. The region has a tropical continental type of climate characterized by well-marked wet and dry season. The wet season usually begins around April and ends in October. The dry season begins in November and ends in March. The region has a mean annual rainfall of about 1,200 mm and annual mean temperature of about 29 ºC. Relative humidity ranges between 60-70 percent during the wet season to about 35 - 45 percent in the dry season. Vegetationally, Jalingo is located within the northern guinea savanna zone characterized by grasses interspersed with tall trees and shrubs. The region is among the leading Nigerian producers of some crops such as cassava, rice, maize, guinea corn, beans, yam, melon.

2.1 Research design and treatments

The experiment was conducted in randomized complete block design (RCBD) in four replications with each experimental unit measuring 2 m × 2 m (4 m^2). The experiment consisted of four treatments: (1) control (no treatment); (2) 100 L/ha Liquid Organic Fertilizer; (3) 200 L/ha Liquid Organic Fertilizer and (4) 500kg/ha NPK fertilizer. This gave a total of sixteen experimental plots. A 0.5 m alley was left between plots within a replication and a 0.5 m alley between replications. Figure 1 shows the experimental design field layouts.

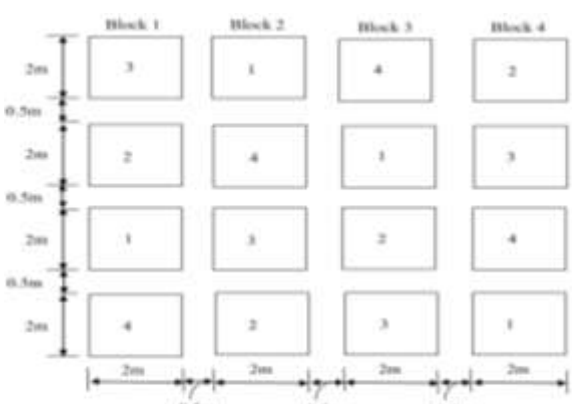


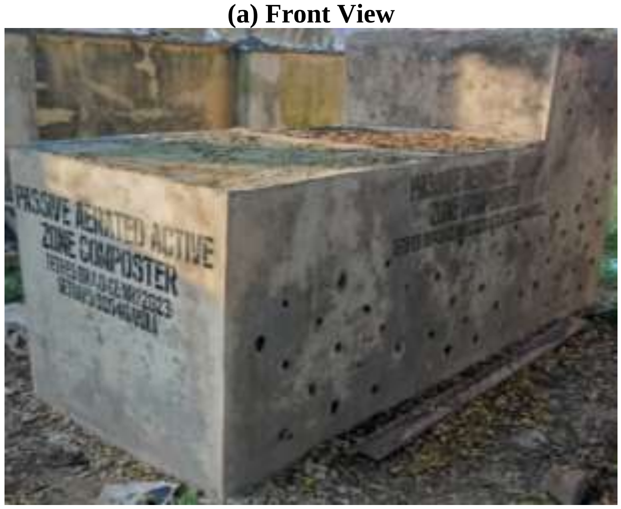
Figure 1: Experimental Design Field Layouts

2.2 Production of liquid organic cow-poultry fertilizer inoculated with neem extracts

Cow dungs, poultry droppings and neem leaves were used as the materials for the liquid fertilizer production. The cow dung, poultry wastes and neem leaves were obtained from the animal farm of the Taraba State University, Jalingo. The production process involves mixing liquid extracts from composted cow - poultry manure and fresh neem leaves.

Composting of cow dung and poultry manure: Composting was carried out using the Active Zone-Yield composter (in-vessel system) (Plate 1), where all or part of composting takes place in a reactor, developed at the Department of Agricultural and Bioresouces Engineering, Taraba State University, Jalingo. The passively aerated composting technique (PACT) was used for the preparation of compost. The materials used include cow dungs and poultry droppings in a ratio 5:5. Turning of the compost was done weekly and water was added when the moisture content level fell below 40 %. This was done to create conducive environment for microbes to hasten decomposition of materials. The process took 40 days for complete digestion of the material.

(a) Front View



(b) Rear View

Plate 1: The Developed Passive Aerated Active Zone-Yield Composter

Preparation of neem leaf extract: The preparation of neem leaf extract was done by weighing 10 kg of fresh neem leaves, chopped into bits using a knife, immersed in a plastic container containing 50 litres of water, kept under a shade tree and properly covered. The solution was stirred every 3 days to allow proper leaching of the nutrients in the leaves into the water until the 14th day. Thereafter, the leaves were carefully removed using sieve of 2 mm to obtain clean neem leaf extract.

Extraction of organic liquid fertilizer: Organic liquid fertilizer was prepared by weighing 10 kg of composted cow-poultry manure into 50 litres of water in a wide plastic container, thoroughly stirred with paddle every 3 days to enhance proper leaching of nutrients. This was continued until the 14th day of setting the experiment. Thereafter, the mixture was sieved using a sieve of 2 mm to obtain clean liquid fertilizer extract. The neem leave extract was mixed with the composted cow-poultry manure extract at the ratio of 1:1 to form the organic liquid fertilizer.

2.3 Establishment of the crop plants

Land preparation: The experimental field was demarcated prior to experimental setup and was cleared using a cutlass and a hoe while ploughing was done using a tractor. The land was levelled and layout manually using human labour. The total land area used is 14.5 m×9.5 m (137.75 m^2).

Planting: The sweet corn (*Zea mays var. rugosa*) seeds used was obtained from the Taraba Agricultural Development Programme (TADP) office, Jalingo. Prior to planting, the experiment field was sprayed with glyphosate, a non-selective herbicide, to kill all weeds to avoid competition. The sweet corn (*Zea mays var. rugosa*) seeds was sown at a planting distance of 30 cm × 30 cm and later thinned two weeks after planting to one plant per stand with a plant population 111,111 plants per hectare. Weeding was done manually using hoe and cutlass thrice at the 2nd, 4th and 6th weeks after planting. Dimethoate 400 g/L emulsifiable concentrate (Dimethoate 400 EC) was applied at the concentration of 1.5 L/ha at the 2nd and 4th weeks after planting to control pests.

Fertilizers Application: The different treatments were applied from the 14th day after planting, then after every 14 days, thus 6 times during the trial. Chemical fertilizer was applied to the soil; but the liquid organic fertilizer was sprayed on the aerial part of the plant.

2.4 Plant data collection

Determination of plant growth parameters: The plant growth data were collected at vegetative phase of plant development. The plant growth data collected are plant height, plant girth, number of leaves and leaf area. Three plants were selected at random from each plot and tagged for growth measurements. Plant height and leaf area were measured using a measuring tape. The plant height was taken from the soil surface to the apical tip of the plant. Plant girth was measured using vernier calipers. The number of leaves per plant was determined by physical counting. The leaf length and breadth were measured to obtain the leaf area. The leaf area was estimated as its length multiplied by its maximum width multiplied by 0.75 (maize leaf calibration factor) (Msibi *et al*., 2014).

Determination of plant yield parameters: At early dough stage (75 to 85 days from planting) the ears were manually harvested. Four ears from each plot were taken randomly at harvest and were husked to measure ear parameters as weight of ear, length of ear and diameter of ear. The sweat corn ear mass was determined using a digital precision balance with accuracy of 0.001 g. The dimensional parameters, i.e. the length and diameter of corn ears, were determined using a ruler gauge and a slide caliper. The corn ear diameter was measured in the middle of the corn ear length.

2.4 Statistical analysis

All the data collected from the field experiments on growth and yield characteristics of maize were subjected to Analysis of Variance (ANOVA) test at $p \leq 0.05$. Treatment means were compared using the Least Significant Difference (LSD) at $p \leq 0.05$. Two statistical packages, SPSS 16 and mini-tab 20 for windows were used for the statistical analysis.

3. Results and Discussion

Table 1 shows the effects of liquid organic cow-poultry manure fertilizer on growth parameters of sweet corn and Table 2 shows the effects of liquid organic cow-poultry manure fertilizer on yield parameters of sweet corn. The results (Table 1) showed that the fertilizer treatments had a significant ($P \leq 0.05$) positive effect on the plant height, stem girth, number of leaves and leaf area. The 200 L/ha liquid organic fertilizer treatment (199.84 cm) had the tallest plant and statistically higher than other treatments while the control (155.68 cm) recorded shortest plant and statistically lower than other treatments. The 200 L/ha liquid organic fertilizer (3.97 cm) treatment had the highest stem girth and statistically higher than other treatments while the control (3.29 cm) recorded lowest stem girth and statistically lower than other treatments. The 500kg/ha NPK fertilizer treatment recorded the highest number of leaves of 14.40 and statistically higher than other treatments while control plots had the lowest number of leaves of 9.38 and was statistically lower than other treatments. The 200 L/ha liquid organic fertilizer (596.58 cm^2) treatment had the highest leave area and statistically higher than other treatments while the control (419.42 cm^2) recorded lowest leave area and statistically lower than other treatments.

This is in agreement with Gani *et al*. (2024) who studied the comparative effects of poultry droppings and cow dung rates on the growth and yield of sweet pepper (*Capsicum annuum*) in Wukari, Southern Guinea Savannah and concluded that the application of organic fertilizers, particularly poultry droppings and cow dung, had a positive effect on the growth and yield of sweet pepper plants and soils of the study area. Thus, liquid organic fertilizer could be used as an agent for promoting plant growth in organic cultivation of crops (Bako *et al*., 2021; Bako *et al*., 2025).

Table 1: Effects of Liquid Organic Cow-Poultry Manure Fertilizer on Growth Parameters of Sweet Corn

Treatment	Sweet Corn Growth Parameters			
	Plant Height (cm)	Stem Girth (cm)	Number of Leaves	Leave Area (cm^2)
Control (no-treatment)	155.68^d	3.29^d	9.38^d	419.42^d
100 L/ha Organic Fertilizer	174.60^c	3.66^c	11.18^c	547.18^c
200 L/ha Organic Fertilizer	199.84^a	3.97^a	13.77^b	596.58^a
500kg/ha NPK fertilizer	196.72^b	3.88^b	14.40^a	572.25^b
p-Value	0.000	0.000	0.000	0.000
F-LSD $_{0.05}$	0.0000	0.0598	0.0218	0.0000

Column means with the same letters are not significantly different (P ≤ 0.05)

The effects of different treatments on yield parameters of sweet corn (Table 2) showed that all the fertilizer treatments produced sweet corn ear with significant ($P \leq 0.05$) differences between them. The 200 L/ha liquid organic fertilizer treatment produced the highest ear mass (324.07 g) and statistically higher than other treatments while the control treatment recorded lowest ear mass (261.43 g) and statistically lower than other treatments. The results showed that the 200 L/ha liquid organic fertilizer treatment produced sweet corn ear length similar to the ear length produced by mineral (NPK) fertilizers without significant differences between them. The 200 L/ha liquid organic fertilizer treatment produced the highest ear diameter (4.98 cm) and statistically higher than other treatments while the control treatment recorded lowest ear diameter (3.22 cm) and statistically lower than other treatments. The superior treatments of 200 L/ha liquid organic fertilizer over 100 L/ha liquid organic fertilizer treatments can be attributed to its superiority in stimulating vegetable growth of plants, resulting in an increase in photosynthesis and better carbohydrate construction, thus improved yield and ear characteristics of sweet corn.

These results are consistent with those obtained by Kim *et al*. (2015) who investigated the effect of aerated compost tea on the growth promotion of lettuce, soybean, and sweet corn in organic cultivation and reported that application of aerated compost tea from organic compost based using MOVR (the mixture of rice straw compost, vermicompost, and Hinoki cypress bark compost) to the root zone increased the plant shoot and root growths and yield of the red leaf lettuce, sweet corn, and soybean. They mentioned that application of compost teas leads to the production of plants vigor growth, higher nutrient uptake, more tolerant of stress conditions, better in the productivity and yield quality. This work is also in line with Bako *et al*. (2024) who studied the effect of compost tea on the quality promotion of sweet corn (*Zea mays* var. Rugosa) in organic cultivation and reported that all the fertilizer treatments produced sweet corn ear with significant ($P \leq 0.05$) differences between them. That the 1 kg of compost per 10 L of water compost tea and mineral (NPK) fertilizer treatments produced the highest ear mass, ear length, ear diameter, number of kernel per row and number of row per ear, which gave the best ear characteristics compared to other treatments. Thus, compost tea could be used as an agent for promoting plant growth and yield in organic cultivation of crops (Bako *et al*., 2024; Bako *et al*., 2026).

Table 2: Effects of Liquid Organic Cow-Poultry Manure Fertilizer on Yield Parameters of Sweet Corn

Treatment	Sweet Corn Yield Parameters		
	Ear Mass (g)	Ear Length (cm)	Ear Diameter (cm)
Control (no-treatment)	261.43^d	17.38^c	3.22^d
100 L/ha Organic Fertilizer	319.17^c	21.46^b	4.64^c
200 L/ha Organic Fertilizer	324.07^a	23.38^a	4.98^a
500kg/ha NPK fertilizer	323.93^b	23.40^a	4.72^b
p-Value	0.000	0.000	0.000
F-LSD 0.05	0.0000	0.0377	0.0129

Column means with the same letters are not significantly different (P ≤ 0.05)

4. Conclusion

From the results it may be concluded that growth and yield of sweet corn were significantly influenced by different levels of liquid organic fertilizer and NPK compound fertilizer application. The plant growth and yields were increased by application of liquid organic fertilizer and NPK compound fertilizer. Liquid organic fertilizer recorded higher growth and yield characteristics of sweet corn plants than NPK compound fertilizer and control (no fertilizer) in decreasing order in the variety of sweet corn used. Consecutively, the sweet corn produced the highest yield with 200 L/ha liquid organic fertilizer treatment, with the highest nutrient use efficiency.

Dosage of the fertilizers at different concentration levels had an increment effect on the plant height, stem girth, average number of leaves, leaf area, ear mass, ear length and ear diameter, this implies the higher the dosage the higher the growth and yield performances which can be attributed to the increased amount of nutrients in higher dosage of fertilizers. Hence, the higher nutrients in higher dosage were used for the development of important parts of the plants such as higher foliage and longer shoot. The reason behind this increment is because in higher dosage of fertilizers, there are more nutrients for the synthesis of various other nutrients, chemicals and antinutrients in the sweet corn.

Further research on different liquid organic fertilizer application rates may be done. This is because the sweet corn responded exceptionally well to liquid organic fertilizer in terms of growth and yield. The quality of sweet corn in terms of taste should be added as a parameter in future researches. This is because most Nigerian people usually go for tasty food over healthy food and having both qualities in the sweet corn will be a leap forward towards promoting healthy eating habits in the country.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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