

EFFECTS OF ORGANIC AND INORGANIC FERTILIZER ON GROWTH, YIELD AND NUTRITIONAL QUALITY OF CUCUMBER (*Cucumis sativus*)

ABSTRACT

The application of organic and inorganic fertilizer on agricultural farming as a management practice has tremendously brought about a great boost to crop yield due to improvement in soil fertility. The thrust of this experiment was to compare the effect of organic and inorganic fertilizer on the growth, yield and nutritional qualities of cucumber (*Cucumis sativus*). The research was conducted at the Teaching and Research Farm of Ekiti State University, Ado-Ekiti in 2019 using a randomized complete block design in three replications. The treatment consisted of sole application of NPK fertilizer, sole application of goat manure, sole application of poultry, NPK + goat manure, NPK fertilizer + poultry manure and control. Parameters assessed include vine length (cm), stem girth (cm), number of leaves, fruit weight (g), length of fruit (cm), fruit diameter (cm) and number of fruit plant-1. The results revealed that poultry manure (PM) significantly influenced all the agronomic parameters and yield of cucumber than other treatments. There were significant differences among the agronomic parameters measured including yield in all the treatments except the number of fruit plant-1. Poultry manure had the highest fruit yield followed by goat manure, NPK fertilizer and poultry manure respectively. For the proximate test, it was observed in the results that there were slight differences in the composition of the proximate of cucumber based on the treatments, suggesting that fertilization can influence the proximate of fruit and vegetables. The overall assessment of the research suggested that poultry manure is the best fertilizer for cucumber growth and yield performance.

Keywords: Cucumber, Organic manure, Inorganic fertilizer, Nutritional quality.

1. INTRODUCTION

Cucumber (*Cucumis sativus*) is a vegetable crop cultivated for its fruits, an important member of Cucurbitaceae family [24]. Cucumber is a plant belonging to the most genetically diverse groups of plants [27]. In Asia, Cucumber ranks fourth after tomatoes, cabbage and onion in terms of economic importance [10]. The importance of cucumber has not been recognized in tropical Africa unlike Europe and Asia due to its limited uses. Cucumber fruit have a cooling effect, prevent indigestion and constipation. Cucumbers are good sources of phytonutrients which include flavonoids, lignans, triterpenes that offer antioxidant,

anti-inflammatory and anti-cancer benefits [26]. According to [22], it was reported that cucumber fruits are a good source of fisetin that is helpful in improving memory. Cucumber is gradually gaining importance in Nigeria as it is grown and consumed across the country. It produces well under intensive care and is adapted to varied soil types and conditions, but optimal performance requires well fertile drained soil with high moisture-holding capacity.

Cucumber is a shallow-rooted crop that requires adequate moisture at all its various growth phases to optimize metabolic processes and effective soil nutrient uptake.

Fertile soils are essential in cucumber production in order to have a good yield. Poor and infertile soils result in bitter fruits, hence consumers are bound to reject them [9]. However, Nigeria's soils are naturally low in Nitrogen which is essential for the growth and development of crops [14].

To avoid bitterness in cucumber fruits due to poor soil fertility, available soil nutrients must be supplemented with either organic or inorganic fertilizer or a combination of both. Chemical fertilizers have been used to supplement soil available nutrients [4,20], owing to their quick release of nutrients and also due to the fact that they can easily be handled [3]. However, the use of inorganic fertilizers have some limitations such as high purchase costs, scarcity, pollution and deterioration of soil properties [13].

Several studies have shown that supplementing soil nutrient with organic manure could be a better alternative to using chemical fertilizers [1,17,21]. Organic manure is eco-friendly, cheap and not easily washed away. However, it is encountered with the problem of bulkiness, transportation cost, handling, high risk of infection if not well prepared and slow release of nutrients [3]. Studies have affirmed that the mixture of organic and inorganic fertilizer in a sustainable ratio increases nutrient use efficiency in plants and serve as a strategy to combat low available soil nutrients in the tropics [23,16].

Considering the economic value, nutritional and health importance of cucumber, it becomes imperative to conduct research on. The experimental area was 12.5m by 9.8 m. A randomized completely block design was used as an experimental design and replicated three times. Treated cucumber seeds planted was Darina variety obtained from a licensed and registered Agro-based

how its products can be enhanced to meet the vegetable requirement of the ever-increasing population and see if the soil amendment can influence the nutritional quality of the fruit produced. The objective of the research work is therefore to determine the effects of soil amendments using different organic manure sources, inorganic fertilizer as well as their combinations on cucumber growth, fruit yield and nutritional quality with the aim of making an appropriate recommendation(s) to cucumber growers in Nigeria.

2. MATERIALS AND METHODS

2.1 Experimental Site and Treatments

The research was carried out at the Teaching and Research Farm of Ekiti State University, Ado- Ekiti, Ekiti state. The location of the research station lies between latitude 7° 31' and 7° 94' N. The location falls under the forest agro-ecological zone of Nigeria. The location was manually cleared with cutlass and flatbeds were made using hoes. A compost topsoil sample (0-30cm) of the experimental sites was collected with a soil auger immediately after clearing.

The soil samples were air-dried and packed inside a polythene bag. The polythene bags were well labeled for physiochemical analysis. The poultry and goat manure used for the experiment were collected from the Teaching and Research Farm of Ekiti State University, Ado- Ekiti. The soil sample and the manure were analyzed at the laboratory of Crop, Horticulture and landscape design, Ekiti State University, Ado-Ekiti.

store in Ado-Ekiti. The seeds were sown at a rate of one seed per hole at the depth of 2 cm. The spacing adopted was 0.5m by 0.5m.

The treatments used were NPC 15-15-15 (NPK), Goat manure (GM), Poultry manure

(PM) and Poultry + NPK 15-15-15 (PM+NPK), Goat manure + NPK 15-15-15 (GM+NPK) and a control. The PM and GM were applied to the field two weeks before planting (2WBP) at the rate of 40t/ha and NPK was applied at 2 weeks after planting (2WAP) at the rate 150kg/ha by side dressing. Also, Poultry and Goat manure were applied at the rate of 20t/ha at 2WBP and side dressed with NPK (15-15-15) fertilizer, 2 WAP at the rate of 75kg/ha for both PM + NPK and GM+NPK.

Staking was done to train the vines of cucumber. Training maximizes the plant's ability to get the light needed for growth, a dense canopy will shade fruits from sunlight. Trained cucumbers have greater productivity and prevent fruit damage.

2.2 Data Collection and Analysis

Data were collected on a number of leaves plant⁻¹, vine length (cm) and stem girth (cm) at 3, 4 and 5 WAP, number of fruit plant⁻¹, fruit length (cm), fruit diameter (cm) and fruit yield. All data collected were subjected to analysis of variance (ANOVA) using Statistical Package for the Social Sciences SPSS and Duncan multiple range tests were used to separate the mean at P=0.05.

3. RESULT

Table 1 shows the result of the analysis of the soil used for the experiment.

The pH of the soil was 5.14 which was slightly acidic, available phosphorus is moderate with a value of 10.085mg/ while total nitrogen content is low with a (value) of 0.32g/kg. The textural class of the soil is loamy sand.

Table 1. Physical and chemical properties soil sample collected from experimental site.

Soil properties	Values
Soil pH	5.14
Organic matter (%)	2.36
% C	1.37
E conductivity (dS)	0.105
Available P (mg/Kg)	10.085
Nitrogen (g/Kg)	0.32
Exchangeable bases	(cmol/Kg)
K	0.069
Ca	1.725
Na	0.413
Mg	0.242
Particle size	(%)
Sand	59.20
Clay	21.16
Silt	19.64
Textural Class	Sandy Loam

Table 2 shows chemical and physical properties of the manure used, the result shows that nitrogen content of poultry and goat manure was 3.78 and 2.52 (g/kg)

respectively, the pH of the manure is neutral which were 7.69 and 7.92 respectively.

Table 2: Physical and chemical properties of the goat manure and poultry manure

Chemical and physical properties	Poultry manure	Goat manure
Ph	7.69	7.92
Organic matter (%)	15.62	16.95
%C	9.06	9.83
E conductivity (dS)	9.21	21.2
Available P (mg/kg)	290.5	255
Nitrogen (g/kg)	3.78	2.52
Exchangeable bases	(cmol/kg)	
K	26.35	28.85
Ca	58.5	95.75
Na	1.86	0.86
Mg	6.20	5.87

3.1 Growth Parameters

3.1.1 Vine length

The vine length of the cucumber at 3, 4 and 5 WAP as influenced by the different treatments used are shown in table 3. At 3 WAP, the vine length range from 20.5-28.9cm. The cucumber treated with PM produced the longest vine (28.9cm), followed by PM + NPK (24.0cm). There were no significant differences among the plots treated with NPK, GM, PM+NPK, and control at 3 weeks after sowing, but there

was a significant difference ($p < 0.05$) between PM and other treatments. At 4 WAP, the plot treated with PM produced the longest vine, followed by the plot treated with PM + NPK (66.9cm), and there was no significant difference among some of the treatments such as NPK, PM+NPK and control. At 5 WAP, the cucumber treated with PM produced the longest vine length of 139.7cm, followed by the plot treated with PM+NPK (125.8cm), while the control treatment gave the lowest vine length.

Table 3: Effects of NPK and organic fertilizer on vine length (cm) of cucumber.

TREATMENT	WEEKS AFTER PLANTING		
	3	4	5
NPK	20.5b	56.3b	110.3bc
GM	22.2b	63.9ab	121.0abc
PM	28.9a	78.5a	139.7a
GM+NPK	20.0b	52.4b	104.0bc
PM+NPK	24.0ab	66.9ab	125.8ab
CONTROL	20.5b	56.5b	97.3c

Where: GM: Goat manure; PM: Poultry manure; GM+NPK; PM+NPK, WAP: Weeks after planting. Values in a column followed by different letters differed significantly at $P=0.05$ level of probability by Duncan Multiple Range Test (DMRT).

3.1.2 Vine girth

Table 4 showed the effect of different sources of organic manure and NPK fertilizer on stem girth of cucumber at 3, 4 and 5 weeks after sowing. Cucumber stem girth increased significantly with the application of PM at 3, 4 and 5 WAP. At 3 WAP, the plot treated with PM produced the thickest vine girth, and there were no significant differences among some of the plots treated with NPK, GM, GM+NPK,

PM+NPK as well a control plot. At 4 WAP, there were significant differences at ($P < 0.05$) PM and other treatments. PM increased by about 32% over the control plot. There were significant differences among all the treatments at 5 weeks after planting while PM gave the thickest vine girth and control gave the thinnest with no significant difference from the plots treated with NPK.

Table 4: Effects of NPK and organic fertilizer on vine girth (cm) of cucumber.

TREATMENT	SAMPLING PERIOD (WAP)		
	3	4	5
NPK	6.4b	7.7ab	7.9b
GM	7.0b	8.4ab	8.9ab
PM	8.3a	9.3a	10.0a
GM+NPK	6.3b	8.6ab	8.3b
PM+NPK	6.9b	8.2ab	8.5ab
CONTROL	6.1b	7.0b	7.4b

Where: GM: goat manure; PM: poultry manure; GM+NPK; PM+NPK, WAP: Weeks after planting. Values in a column followed by different letters differed significantly at $P=0.05$ level of probability by Duncan Multiple Range Test (DMRT).

3.1.3 Number of leaves

Table 5 shows the effect of different sources of organic manure and NPK fertilizer on the number of leaves of cucumber at 3, 4 and 5 weeks after planting. The mean number of leaves per plant was significantly influenced by poultry manure at the different weeks of sampled and the highest number of leaves/plant was produced by plots treated

with PM, followed by PM + NPK at 3 and 4 weeks after planting, then GM. The least number of leaves/plants was produced by the control plots in all the weeks of sampled (3, 4 & 5 WAP). But no significant difference was observed among plots treated with NPK, GM, PM+NPK, GM+NPK at 3, 4, and 5 weeks after planting.

Table 5: Effects of NPK and organic fertilizer on Number of leaves of cucumber

TREATMENT	SAMPLING PERIOD (WEEKS AFTER PLANTING)		
	3	4	5
NPK	6.7b	10.3b	15.0b
GM	6.7b	12.3b	17.0b
PM	8.3a	17.3a	25.3a
GM+NPK	6.7b	10.0b	13.0b
PM+NPK	7.0b	12.7b	13.7b
CONTROL	6.0b	9.7b	11.3b

Where: GM: goat manure; PM: poultry manure; GM+NPK; PM+NPK. Values in a column followed by different letters differed significantly at $P=0.05$ level of probability by Duncan Multiple Range Test (DMRT).

3.2 Yield and Yield Components

Statistically, there was no significant difference in the number of fruits across all the treatment, although they possess different value which is higher than one another. Poultry manure produced the highest fruit number with an average of 43.3, and goat manure and NPK fertilizer interaction give the lowest number of fruit with an average of 30.0. The fruit length of cucumber was significantly enhanced by the application of poultry manure+ NPK with 23.28% higher than the control plot but there is no sign of poultry manure, goat manure, NPK, goat manure and NPK interaction. The longest fruit of 26.2cm was observed in the combined application of 20t/ha of farmyard

manure and 60kg/ha NPK fertilizer and the shortest fruit of 20.1 cm was observed in the control (Table 6). The fruit diameter of plants that received 40 t/ha of goat manure was higher, followed by the plot treated with poultry manure. The combined application of 20 t/ha poultry manure and 75kg/ha fertilizer gave a diameter of 58.6cm which is 13% higher than control. The fruit weight per plant was significantly influenced by Poultry manure. The highest fruit weight (75.5 kg) per plant was observed in the treatments receiving poultry manure at the rate of 40 t/ha and the least value of 39.0kg was observed in the treatment containing NPK.

Table 6: Effects of NPK and Organic fertilizer on yield and yield components of cucumber.

TREATMENT	Fruit number	Fruit Length (cm)	Fruit diameter (cm)	Fruit weight, (t/ha)
NPK	27.7a	22.4ab	58.0a	39.0b
GM	30.7a	23.5ab	59.7a	57.2ab
PM	43.3a	24.4ab	58.9a	75.5a
GM+NPK	30.0a	22.3ab	57.6a	47.4ab
PM+NPK	30.3a	26.2a	58.6a	48.6ab
CONTROL	33.3a	20.1b	51.5b	40.1b

Where: GM: goat manure; PM: poultry manure; GM+NPK; PM+NPK. Values in a column followed by different letters differed significantly at $P=0.05$ level of probability by Duncan Multiple Range Test (DMRT).

3.3 Proximate Composition

Results of the proximate composition analysis of the cucumber based on the nutrient sources used are presented in table 7. The ash content gave a picture of the mineral concentration or inorganic component of the sample. These minerals served as inorganic co-factors in metabolic processes, it, therefore, implies that, if there is little or inadequate quantity of these inorganic co-factors, there could be metabolic impairment. As observed from this research, the ash content of the cucumber with respect to the nutrient sources (NPK, GM, PM, GM+NPK, PM+NPK) and control ranged between 0.51 and 0.36. This implies that NPK in cucumber contains higher mineral content. The moisture content of cucumber with respect to the nutrient sources ranged from (86.86-97.46), the highest moisture content was recorded from GM, the high moisture content in a fruit or vegetable encourages

the multiplication of microorganism, leading to mould growth, thus reducing in market value. Low moisture helps in the storage of the fruits although for a short period. The protein content of the cucumber with respect to the nutrient sources ranged from 1.26 - 0.32 in which plots treated with NPK gave the highest value and control plots gave the least.

The results for the fat content corroborates the general perception that vegetables are low lipid-containing food as the values ranged from 0.15 to 0.10. The low levels of fat and protein in cucumber are good indicators of nutritive quality as excess fat consumption causes cardiovascular disorders such as atherosclerosis, cancer and ageing. The PM was observed to give the highest Fibre value of 0.45. The average crude fibre contents in this experiment showed the capacity of cucumber to keep up with internal distention for ordinary

peristaltic movement of the digestive system which is one of the major physiological roles that crude fibre plays in the living framework. The results also observed the importance of organic manure as a source of dietary fibre. The carbohydrate content

ranged from 1.47-0.56 in which the highest value was recorded in the PM+NPK plot, with 13.3% higher than the control that has the second higher value. PM treated plot has the highest fibre content which was 2.22% higher than the control plot.

Table 7 PROXIMATE COMPOSITION

Treatments	Fat	Water	Ash	Protein	Carbohydrate	Fiber
NPK	0.15a	96.36f	0.51ab	1.26a	0.86d	0.41ab
GM	0.10ab	97.75a	0.36c	0.87b	0.56e	0.36b
PM	0.10ab	97.19d	0.52a	0.70c	1.04c	0.45a
GM+NPK	0.10ab	97.66b	0.54a	0.45d	0.85d	0.40ab
PM+NPK	0.05b	97.11e	0.46b	0.48d	1.47a	0.43a
CONTROL	0.10ab	97.46c	0.37c	0.32e	1.31b	0.44a
Mean	0.1	95.67	0.46	0.68	0.01	0.42

4. DISCUSSION

The higher values recorded in PM and PM+NPK treated plots in all the parameters measured could be attributed to a higher level of nutrients especially nitrogen and phosphorous in poultry manure available for plant growth as shown in laboratory analysis and their release as well as synchronization of nutrients released within the short period (NPK) of growth of the cucumber plant. There were significant differences among all the different treatments i.e. NPK, GM, PM, GM+NPK, PM+NPK and control at 5weeks intervals after sowing. PM gave the highest vine length at 5weeks after sowing with 43% higher than control, cucumber treated with GM produced the second-longest vine which is 24% higher than the value of the control plot. The cucumber growth parameters were strongly influenced significantly by poultry manure, followed by PM+NPK. The significant difference recorded in terms of the impact of poultry manure is attributed to the composition of the manure which is known to contain higher nitrogen and phosphorus as compared to the other manure used (Goat manure), this is attributed with the findings and reports of

[5], and [13] which attributed increased development of crop plants to the release of more nutrient elements through nutrient that has been made accessible by the manure. In addition, and in concordance with the report of [15] who showed that poultry manure delivered essential elements which advanced high photosynthetic activities that improved the development and yield of watermelon. Cucumber stem girth increased significantly with the use of poultry manure at 3, 4 and 5 weeks after sowing (WAS), this is predictable with the reports of [19], and [11] which showed that poultry manure (the richest known animal manure) is fundamental for laying out and keeping up with the ideal soil state for plant development. It is additional equivalent to the discoveries [6, and 12] who detailed that poultry manure is not just a modest and compelling wellspring of N for sustainable crop production, but improves soil physical properties by reducing the temperature, bulk, density, and increasing total porosity if higher rates are applied. The addition of poultry and goat manure increased the water holding capacity and reduced the incidence of erosion thereby making more nutrients

available to the soil [8]. It is also of concern that the sole application of PM was observed to give higher values in terms of growth and yield, although no significance was observed for yield contrary to the report of [7] who observed that an increased yield in Sorghum when 5 t/ha of goat manure was combined with 20 kg N + 10 kg P ha⁻¹. [18] also reported increased melon growth and optimum yield with organo-mineral fertilizer at 4 t/ha and the application of inorganic fertilizer at 41 kg N+ 20kg P. This increase in yield of cucumber could be related to the fact that nutrients were more readily available when organic and inorganic fertilizers are combined. The experiment conducted was not in support of the above reference because the combination of organic and inorganic manure did not give the highest yield unlike a single application of poultry manure, this observation may be that the amount of the nutrient element content in NPK was not synchronised with the number of major nutrient elements in the manure or could be to the fact that dosage of individual nutrient sources used in the combination was reduced. The low value recorded for fat content in the experiment corroborates the fact that vegetables are food with low lipid values as observed by [25] and thus cucumber add significantly as a source of non-visible oil to the diet in which it may be present. In the same vein the Moisture content values of 86.8-97.75% and ash of 0.36-0.52 recorded fall within the range as given by [2].

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