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Hot pepper (*Capsicum annum* L.) production using different organic manure and inorganic fertilizer in Akure, Nigeria

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Abstract
Experiment on *Capsicum annum* production using different organic manure and inorganic fertilizer was conducted at the Crop Type's Museum of Crop, Soil and Pest Management Department of Federal University of technology, Akure Nigeria. The treatments used were: (T1) Neem seed fertilizer @ 300kg/ha, (T2) sunshine organomineral fertilizer @300kg/ha, (T3) Ahes @5tonn/ha, (T4) cow dung @5tonn/ha, (T5) poultry manure @ 5tonn/ha, (T6) sheep and goat dung @5tonn/ha, (T7) pig dung @ 5tonn/ha, (T8) N.P.K @300kg/ha and (T9) control replicated three time. Plant height (cm), number of leaves, number of branches, stem girth (cm), cumulative number of fruits and weight of fruits (g) were measured. Results from the study showed that, highest yield value was obtained in plots where 300kg/ha of sunshine organomineral fertilizer was applied while lowest yield value was obtained in control. This suggested that for optimum production of pepper, 300kg/ha of sunshine organomineral fertilizer may be applied particularly in the study area and its environment.

Keywords: Pepper, growth, manure, fertilizer

Introduction
The bulk production of *Capsicum annum* (pepper) is found in the savanna zone and derived savanna areas of south western Nigeria. *Capsicum annum* is an important vegetable crop that is grown throughout the world especially in the tropics. Pepper has increased in popularity, valve and importance over a long period, thus making it an indispensable part of the daily diet of millions of Nigerian.

Capsicum annum is a wonderful vegetable crop that may be eaten raw or cooked. It is an important source of vitamin A, vitamin C and vitamin B6. It protects the body against diseases attack and preventing health promoting diseases (Amarzon, 2012- 2017). Previous researcher has reviewed the nutritional requirements of pepper as an antiodants and hypoglycaemic activities (Loizzo *et al.*, 2015; Tundis *et al.*, 2013) [12, 18]. The fruits of capsicum annum played major roles in pain relief and weight reduction (Sharma *et al.*, 2013) [17].

The crop responds to both organic and inorganic fertilizer which has been reported by several researchers (Aliyu, 2002; Khan *et al.*, 2010) [4, 10]. Studies reviewed that various crops response to inorganic fertilizer in difference ways, the use of inorganic fertilizer could maintain or not maintain the higher yield in some crop, for example *Capsicum annum* over the years shown emergence of micronutrients produce by this inorganic fertilizer which result in deteriorations of soil physical properties (Khan *et al.*, 2010) [10]. According to Bokhtiar *et al.*, 2008 [8], organic manures gave better yield when applied with chemical fertilizer.

The role of organic and inorganic fertilizer is to improve the yields, quality and also for quick maturity of pepper. The use of organic manure cannot be over emphasized because of its usefulness in improving the physical conditions of soil and nutrients supplies for soil productivity and crop improvement (Aliyu, 2000) [3].

In view of increased in demand for food due to population, high cost and scarcity of inorganic fertilizers and unavailability of high yielding crop varieties as planting material, total reliance on organic manure and inorganic fertilizer alone as fertilizer may not be realistic. For examples Deore *et al.*, 2010 [8] reported the unfulfillment of organic manure on crop nutrients. Hence complementary use of organic manure with inorganic fertilizer should be employed so as to sustain soil fertility management strategy for pepper production. Thus, this present study

was carried out to assess the response of different types of organic manure and inorganic fertilizer on the growth and the yield of capsicum annum.

Material and Method

Site information

The field experiment was conducted at the Crop Types Museum Farm of the Department of Crop, Soil and Pest Management, Federal University of Technology, Akure (FUTA). FUTA lies within the tropical rain forest belt between latitude 5^0N and 15^0E of the equator with an annual mean temperature of about 27^0c which is adequate for the pepper growth.

Soil properties

Soil properties were determined by taking the soil samples randomly on the site before planting. The soil auger was used to collect sample at a depth of 25cm and was taken to the laboratory in a polythene bag. The soil samples were bulked together and it was sieved with <2mm sieved mesh and prepared for analysis.

Soil analysis

The pre-planting and post planting soil analysis was done. Soil properties were analyzed for pH in 1.1 soil to water using glass calomel system (Crockford and Nowell, 1976) [7]. Available P (phosphorus) was extracted using the Bray p-1 extracted and the amount of plus ascorbic acid solution to develop blue color which was read on spectrometer at 660nm. The exchangeable base (K, Na, Ca and Mg) were extracted with 1m ammonium acetate (NH_4OHAC) pH 7 and the amount were measured on flame photometer.

Collection of organic materials

The organic manure was collected from the livestock section of the Teaching and Research Farm of the Federal University of Technology, Akure. The organic manure was dried to reduce the moisture content.

Sources of pepper seed

The pepper seed used for the research were gotten from NIHORT in Ibadan Nigeria.

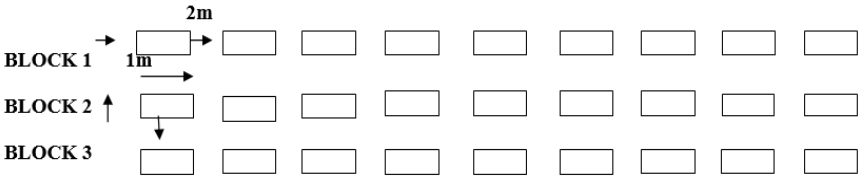
Nursery preparation

The seed was raised in nursery for three weeks at 2m × 1m. Seeds were drilled in rows 15cm apart. These were covered with thin layer of soil and polythene mulch and then watered regularly until the seedlings emerged. The seedlings were transplanted at one seeding per hole at the spacing of 50cm × 60cm.

Land preparation

The site was cleared manually using cutlass and hoe, plant debris was packed without burning, the site was marked out into blocks and plots. Each plots measured 2m× 1m with a walkway of 1m between the blocks and plots.

Experimental plot layout



Experimental design

The experimental design used was randomized complete block design (RCBD). There were nine treatments replicated three time and the treatments levels were presented in Tables 1 below.

Table 1: Treatment levels used for the experiment

S/N	Treatments	Symbols
1	Neem seed fertilizer @ 300kg/ha	T_1
2	Sunshine organomineral @ 300kg/ha	T_2
3	Ashes @ 5tonn/ha	T_3
4	Cow dung @ 5tonn/ha	T_4
5	Poultry manure @ 5tonn/ha	T_5
6	Sheep and goat dung @ 5tonn/ha	T_6
7	Pig dung @ 5tonn/ha	T_7
8	N.P.K 15-15-15 @ 300kg/ha	T_8
9	Control	T_9

Weeding

This was done manually at 5, 10 and 15 weeks after transplanting

Pest control

Termites and other soil microorganism that might hamper the smooth growth of the seedings were controlled immediately after transplanting using carbofuran or worm force to sterilize the soil.

Treatments application

The treatments were applied at four weeks after transplanting as shown in Table 1. The rate of application for Neem seed was 300kg/ha, Sunshine organomineral was 300kg/ha, Ashes was 5tonn/ha, Cow dung was 5tonn/ha, Poultry manure was 5tonn/ha, Sheep and goat dung was 5tonn/ha, Pig dung was 5tonn/ha and N.P.K 15-15-15 was 300kg/ha. The treatments were applied in a ring formed around the plant.

Data collection and sampling techniques

Data collection commenced at one week after treatments application. The following parameters were considered weekly.

- Number of leaves: Direct counting of the leaves number
- Plant height: a measuring tape was used to measure the height of the plant
- Stem girth: the girth was estimated by means of vernier caliper
- Numbers of branches per stem: direct counting of the number of branches
- Number of fruits: direct counting of the number of fruits
- Fresh weight of the harvested produces: weighing balance was used to take the weight of fruits.

Data analysis

The data obtained for the soil analysis and the yield parameters were analyzed statistically using the ANOVA (Analyses of variance). Data was analyzed using SPSS computing software package and the treatments mean comparison was done with Duncan Multiple range Test (DMRT).

Results

The physical and chemical properties of the soil before planting are presented in table 2 below. The soil at the experimental site was sandy loam. The pH of the soil before planting was high (3.23). The phosphorus was low and nitrogen content was moderate, while the percentage of organic matter. Organic carbon, potassium and magnesium were low. The calcium and magnesium were moderate. The textual classification of soil was sandy loam.

The response of different types of manure on chemical properties of the soil after treatments application is presented in table 3. The results shows that the highest value for pH was recorded in treatment where ashes 5tonn/ha was applied, while the lowest value was obtained in the control. The highest value of nitrogen was obtained in the treatment where 300kg/ha of N.P.K 15-15-15 fertilizer was applied, while the lowest value was obtained in the control. The highest organic matter was obtained in the treatment where 300kg/ha of N.P.K 15-15-15 fertilizer was applied, and the lowest value was also obtained in the control. The highest phosphorus was obtained in the treatment where 300kg/ha of N.P.K 15-15-15 fertilizer were applied, while the lowest value was obtained in the control. The highest potassium was obtained in the treatment where Ashes 5tonn/ha was applied, while the lowest value was obtained in the control. The highest sodium value was obtained in the cow dung 5tonn/ha was applied, while the lowest value was obtained in the control. The highest calcium value was obtained in the treatment where 300kg/ha of organomineral fertilizer was applied, while the lowest value was obtained in the control. The highest magnesium value was obtained in the treatment where 300kg/ha of N.P.K 15-15-15 fertilizer was applied, while the lowest value was obtained in the control.

Growth parameters

The data presented in Table 4 shows the effect of different types of manure on the plant height of pepper. Plant height (cm) differed significantly ($p<0.5$) across treatments throughout the experiments. Sunshine organomineral fertilizer gave the highest performance. Similar trends were also observed on the effect of manure types on the number of leaves and branches (Table 5 and 6). Growth parameters measured also differed significantly ($p<0.5$) across treatments. Sunshine organomineral fertilizer gave the highest performance.

The effect of different types of manure on the stem girth of pepper is presented in table 7. Result also showed that the plots applied with 300kg/ha Sunshine organomineral fertilizer gave the highest performance followed by plots treated with 5tonn/ha of Cow dung and the plot treated with 300kg/ha of Neem seed fertilizer.

Number of fruits and fruit weight

The effects of different types of manure on cumulative number of fruits and weight (g) of fruits of pepper presented in table 8 shows that there were significant differences across the treatments. Treatments 2 (300kg/ha of Sunshine organomineral) has the highest fruits number and fruits yield, followed by treatment 4 (5 tonn/ha of Cow dung) and treatment 1 (300kg/ha of Neem seed fertilizer).

Table 2: Pre-cropping soil analysis

Properties	Valves
pH 1.1 (H_2O)	3.23
Nitrogen (N) (%)	0.13
Organic matter (%)	0.86
Organic carbon (%)	0.50
Phosphorus (p)(mg/kg)	2.96
Calcium (Ca) (mmol/kg)	3.70
Magnesium (Mg) (mmol/kg)	2.30
Sodium (Na) (mmol/kg)	0.34
Potassium (K) (mmol/kg)	2.96
Sand (%)	70.04
Clay (%)	16.10
Silt (%)	5.68

Table 3: Chemical properties of the soil after treatments application

Treatments	pH(H_2O) 1.2	O/C (%)	O/M (%)	N (%)	P (mg/kg)	K^+ (mmol/kg)	Na^+ (mmol/kg)	Ca^+ (mmol/kg)	Mg^+ (mmol/kg)
Neem seed	3.05	2.87	4.95	0.43	6.84	0.43	0.77	2.60	2.80
Sunshine organic mineral	2.82	2.53	4.37	0.38	11.74	0.33	0.55	7.00	3.40
Ashes	4.34	2.79	4.82	0.42	6.69	0.58	0.71	3.50	2.50
Cow dung	3.11	2.11	3.65	0.32	4.74	0.54	0.89	3.20	1.70
Poultry manure	2.95	2.29	3.96	0.34	4.36	0.26	0.58	2.90	1.50
Sheep and goat dung	2.72	2.33	4.02	0.35	9.49	0.37	0.84	3.40	1.70
Pig dung	3.68	3.83	3.83	0.33	5.99	0.36	0.66	4.30	3.10
N.P.K	3.29	3.41	5.88	0.51	18.51	0.35	0.55	5.40	4.80
Control	2.70	0.48	0.83	0.10	3.97	0.23	0.44	2.01	1.50

Table 4: Response of different types of manure on the plant height (cm) of *Capsium annum*

Treatments	weeks after treatment application				
	1	2	3	4	5
300kg/ha Neem seed	15.41bc	21.57bc	30.98b	41.43ab	48.31bc
300kg/ha Sunshine organomineral fertilizer	18.19a	25.57a	40.22a	48.56a	58.28a
5tonn/ha Ashes	15.07c	20.32cd	27.95bc	37.24bc	45.73cd
5tonn/ha cow dung	16.97ab	23.18ab	30.94b	44.09ab	53.20ab
5tonn/ha poultry maure	11.81d	16.49e	20.26ef	24.96e	29.67e
5tonn/ha sheep and goat manure	13.91c	16.08e	21.69de	27.46de	30.78e
5tonn/ha pig manure	12.24d	18.27de	20.55def	27.69de	38.65d
300kg/ha N.P.K fertlilzer	14.97c	19.23cd	25.38cd	33.83cd	40.83d
Control	9.04e	11.65f	15.94f	17.92f	22.10f

Means follows by the same letter in the same column are not significantly different from each other by Duncan Multiple Range Test at 5% level of probability

Table 5: Response of different types of manure on the number of leaves of *Capsium annum*

Treatments		weeks after treatment application			
	1	2	3	4	5
300kg/ha Neem seed	4.16bc	8.18bc	8.95bc	9.62ab	10.07ab
300kg/ha Sunshine organomineral fertilizer	4.71a	10.09a	10.23a	11.53a	17.30a
5tonn/ha Ashes	4.05bcd	8.05c	8.35c	8.86ab	9.98bc
5tonn/ha cow dung	4.47ab	9.11ab	9.20ab	10.45ab	11.90ab
5tonn/ha poultry maure	3.62de	7.18cd	7.41cd	6.22b	8.22e
5tonn/ha sheep and goat manure	3.54e	5.36be	6.82d	8.45b	9.63e
5tonn/ha pig manure	3.81cde	4.41e	5.80e	6.71b	7.00cde
300kg/ha N.P.K fertlilzer	3.77cde	5.93c	7.93c	8.42b	8.77bcd
Control	3.01e	3.52ef	4.11f	4.79f	5.45f

Means follows by the same letter in the same column are not significantly different from each other by Duncan Multiple Range Test at 5% level of probability

Table 6: Response of different types of manure on the number of branches of *Capsium annum*

Treatments		weeks after treatment application			
	1	2	3	4	5
300kg/ha Neem seed	2.43b	2.60abc	3.03ab	3.20a	3.46ab
300kg/ha Sunshine organomineral fertilizer	3.16a	3.29a	3.30a	3.45a	3.61a
5tonn/ha Ashes	2.39b	2.56abc	2.96ab	3.08a	3.30abc
5tonn/ha cow dung	2.75ba	2.77ab	3.23ab	3.24a	3.51a
5tonn/ha poultry maure	1.24de	1.34de	1.91e	2.03b	2.45d
5tonn/ha sheep and goat manure	1.52cd	1.68cd	2.19ed	2.40b	2.90c
5tonn/ha pig manure	1.86bcd	2.08bc	2.51cd	2.91a	3.02bc
300kg/ha N.P.K fertlilzer	2.29b	2.47abc	2.80bc	2.98a	3.17acd
Control	0.50e	0.74e	1.07f	1.52c	1.71e

Means follows by the same letter in the same column are not significantly different from each other by Duncan Multiple Range Test at 5% level of probability

Table 7: Response of different types of manure on the stem girth (cm) of *Capsicum annum*

Treatments	weeks after treatment application		
	1	2	3
300kg/ha Neem seed fertilizer	1.14bc	1.19b	1.32b
300kg/ha Sunshine organomineral fertilizer	1.34a	1.43a	1.52a
5tonn/ha Ashes	1.03c	1.14bc	1.26b
5tonn/ha cow dung	1.23ab	1.31a	1.36b
5tonn/ha poultry maure	0.69fg	0.78fg	0.78e
5tonn/ha sheep and goat manure	0.78ef	0.88ef	0.93d
5tonn/ha pig manure	0.85de	0.97de	1.07c
300kg/ha N.P.K fertlilzer	0.92d	1.05cd	1.12c
Control	0.60g	0.70g	0.72e

Means follows by the same letter in the same column are not significantly different from each other by Duncan Multiple Range Test at 5% level of probability

Table 8: Response of different types of manure on the cumulative number of fruits and weight (g) of fruits of *Capsicum annum*

Treatments	Number of fruits	Weight of fruits
300kg/ha Neem seed fertilizer	1524.3c	738.33c
300kg/ha Sunshine organomineral fertilizer	2157.0a	1259.67a
5tonn/ha Ashes	1330.7cd	615.33cd
5tonn/ha cow dung	1859.7b	952.33b
5tonn/ha poultry maure	443.3f	205.33f
5tonn/ha sheep and goat manure	801.3e	392.67e
5tonn/ha pig manure	957.7e	456.00de
300kg/ha N.P.K fertlilzer	1083.7de	558.33d
Control	182.7f	125.00f

Means follows by the same letter in the same column are not significantly different from each other by Duncan Multiple Range Test at 5% level of probability

Discussion

Most of the post planting soil parameter excelled on plots where organic and inorganic fertilizers was applied, this result was in conformity with Makinde *et.al.*, 2009 [13], who reported the positive impact of organic and inorganic manure on soil chemicaI properties. It could be observed from the result obtained that there were increase in plant height, stem girth, number of leaves, number of branches, and fruits yield. The result showed that application of different types of manure significantly influenced the growth and yield of pepper, this was similar to the result obtained by Olowokere (2004) [15] who reported that organic and organomineral fertilizer increase significantly the yield of vegetables such as pepper, tomato and okra.

The positive response and increased in growth parameters and yields of pepper with applied treatments might be due to the

low initial nutrient status in the used soils. Also, the response to different types of manure probably shows that these fertilizers serve as sources of nitrogen, which is more than any other element, appeared to control growth and yield potentialities in south western Nigeria soil; this confirms the finding from earlier studies carried out by (Olaniyi, 2005) [14]

The vigorous increase in height and number of leaves, number of branches of *Capsicum annum* was due to early release of nutrients contained by the applied fertilizers (N.P.K and sunshine organomineral fertilizer) this was also in agreement with the results obtained by Akanbi *et al.*, 2004 and Olaniyi *et al.*, 2005 [14]. There was a boost in the morphological growth of the *Capsicum annum*, the result was in agreement with Law-Ogbomo and Egharevba, (2010) [11] who reviewed the significantly different of soil amendments and control on the number of branches of pepper.

The result of this study also confirms the finding of Gonzalez *et al.*, (2009) [9] who reported that organic manure and inorganic fertilizer supplied most of the essential nutrients at growth stage resulting in increase of growth variables including plant height, numbers of leaves and number of branches of pepper.

On the other hand, the increase in total fruit yield could be due to variation in plant height, as well as formation of primary, secondary and tertiary branches in the plots that were treated with sunshine organomineral fertilizer, this might caused increase potential of fruits bearings buds and also leaf area that maximizes photosynthetic capacity and assimilate partitioning to the fruits. This result is further consolidated by the findings of Sam-Aggrey and Bereke- T sehai (2005) [16] who reported positive impacts of vegetative growth, yield and yield components of pepper. Bosland and Votava (2000) [6] also pointed out that primary and secondary branches were locations of fruit buds and thus foundations of new fruit bud development in peppers. Their report is in conformity with the present result, consolidating the role of branches in determining pepper total fruits yield.

Conclusion and Recommendation

This study confirms the role of organic and inorganic fertilizer in increasing growth and yield of pepper. The highest yield value was obtained in treatment where 300kg/ha of sunshine organomineral was applied, followed by cow dung @ 5tonn/ha and Neem seed @ 300kg/ha while the lowest yield value was obtained in the control. The best performance (growth and yield) of pepper were obtained in plots where 300kg/ha of sunshine organomineral fertilizer was applied, followed by cow dung @ 5tonn/ha and Neem seed @ 300kg/ha, this may be as a result of increase and timely released of nutrient elements by organomineral fertilizer. Hence therefore it can be concluded and recommended that 300kg/ha of sunshine organomineral fertilizer can be used by farmers for pepper production in the study area.

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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