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Effect of Poultry Manure Rates on the Growth and Yield of Pepper (*Capsicum annum*) in Umudike

Emeka Chibaby Chigozie[1, *], Akpan Annah Udo[1], Emeka Chidiebere Prince Osuji[2]

[1]Department of Agronomy, Michael Okpara University of Agriculture, Umudike, Nigeria

[2]Department of Agriculture, Alex Ekwueme Federal University, Ndufu-Alike, Nigeria

Email address:

Chigoziepat212@gmail.com (Emeka Chibaby Chigozie)

[*]Corresponding author

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Abstract: This research was done at Michael Okpara University of Agriculture Umudike Student's Farm, with an objective to evaluate the effects of poultry manure rates on the growth and yield of pepper (Capsicum annum) during the 2015 cropping season. Pepper (Capsicum annum), a vegetable crop which belongs to the Solanaceae family and Capsicum genus, has served many purposes over time. The yield obtained by small-scale farmers in southeastern part of the country is often very low due to various production constraints attributed to poor soil, fertility etc. The treatments used were 10 t/ha, 15 t/ha and 25 t/ha as well as control. The experiment was laid out on a randomized complete block design (RCBD) with three replications. All data obtained were subjected to analysis of variance (ANOVA) using the Genstat package at 0.05 probability level and means compared using least significant difference (LSD). The result from the experiment showed an increase in both growth and yield parameters at different manure rates. Poultry manure rate of 15 t/ha recorded the highest yields for number of leaves per plant, stem girth, plant height while the control recorded the lowest yield. The work showed that an increase in the rate of 25 t/ha did not affect yield rather there was a drop in the yield, hence it is safe to recommend 15 t/ha to farmers in this region. The application of poultry manure to the farm will result in long term nutrient availability for crops as well as increased yield. There is the therefore the need to treat the poultry manure before application to avoid disease development. The findings suggest further studies especially in other localities.

Keywords: *Capsicum*, Poultry Manure, Growth, Yield

1. Introduction

Pepper (*Capsicum annum* L.) is a vegetable crop from the family *Solanaceae* and reported to be indigenous to Central and South America. Some of the five domesticated species include *C. annum* L., *C. baccatum* L., *C. chinensis* L., *C. pubescens* L., and *C. frutescens* L. [6]. Although vast differences in trait exist but most commercially cultivated cultivars of pepper in the world belongs to the species *C. annum* L. In Nigeria, it is one of the most important vegetables grown due to its various functions and uses especially in sub-humid and semi-arid tropics [2]. Bell or sweet pepper is used in flavouring dishes in many parts of the world. It can be cooked or eaten as raw salad. It is rich in nutrient that may be lacking in other food materials thereby making it more palatable and hence improves food intake and digestion. The leaves are also consumed as salad in soup or eaten with rice. It was also discovered to be a good source of medicinal preparation for black vomit, gout and paralysis [13]. Bell pepper has low calorie value but the nutritive value is especially high for vitamins A and C. Peppers are also used in pickles of various kinds consisting of pungent fruits preserved in brine or strong vinegar. Apart from being used for flavouring, sauces and in canned products, pepper is widely used in pharmaceutical industries as a powerful stimulant and carminative, and externally as counter irritant due to the capsaicin in the placenta tissue and septa of the fruit. The crop can be grown on much kind of soils ranging from fine sands through many loams, clay loams and silt loams but sandy loams and loams are preferable [11].

Peppers were classified as day neutral plants. Low to moderate rainfall of 635-1200 mm per annum is adequate for the crop. Also, Jaliya and Sani reported that peppers require more heat and are more sensitive during cool periods when temperatures are between 4.4°C to 15.6°C [11]. *C. annum* L. responds to both organic and inorganic fertilizers and also positively to nitrogen and phosphorus fertilizers [16, 3]. Nigeria is one of the major producers of pepper in the world accounting for 50% of the total African production [10]. World production statistics in 2006 showed that Nigeria's pepper production is about 204,200 metric tons, while the dry fruit production figures for Nigeria in 2007 was 49,500 metric tons out of Africa's total of 457,650 metric tons [17]. The savannah region of Nigeria where most of the pepper production takes place is reported to have poor soil (lacking nitrogen and phosphorus supply). Although the crop is widely cultivated in Nigeria, yield obtained by small-scale farmers in southeastern part of the country are often very low due to various production constraints such as soil degradation, lack of information on weather and climate changes, cost and non-availability of inorganic fertilizers. As a result of the low yield obtained, there tend to be hike in prices per unit weight [15, 14]. In order to increase productivity, farmers in this region are now being encouraged to look for alternative to chemical fertilizers which negatively impacts the environment, crop and man as well. Poultry manure like other organic manures are known to improve the soil by enhancing both its physical and chemical properties. There is a variability in the nutrient composition of manures and this depends on the type of animal, its age, the feed supplied, bedding materials used, storage and handling of manures [8, 3], hence the reason for the differential responses of crops to different manures. It is mostly incorporated during tillage due to its ability to release nutrients gradually and therefore can support crops for a long time. For manure to be effective, large amounts of up to 10 t ha^{-1} is needed for application depending on the nutrient, competition and concentration. Poultry manure contains high amounts of nitrogen, phosphorus, calcium, magnesium and potassium than other forms of organic manures. It also increases water holding capacity and plant nutrient in the soil when properly decomposed [2]. Therefore, the aim of this study is to determine the effects of poultry manure rates on the growth and yield of pepper within the study locality.

2. Materials and Methods

2.1. Experimental Site

The experiment was carried out in the Student's Farm, Michael Okpara University of Agriculture Umudike, Abia State within the rainforest zone of Southeast Nigeria. The area lies on latitude 5° 28'N and 5° 30'N and longitude 7° 31'E and 7° 33'E, also with an elevation range of 60-180 mm above sea level [14].

2.2. Field Size

The research field size was 8 m x 8.7 m. The site was manually cleared and debris packed. A bed size of 1.8 m x 2 m size was made, with 0.5 m in between the beds as inter-row spacing. Poultry manure was incorporated into the soil two weeks before transplanting.

2.3. Soil Sample Collection

Soil samples were randomly collected using an auger from depth of 0-30 cm across the experimental site prior to transplanting and taken to Soil Science Laboratory (SSL), National Root Crops Research Institute (NRCRI) Umudike, to analyze for its physico-chemical properties.

2.4. Treatment Source and Analysis

Manure was sourced from the poultry house at Umudike which operated a deep litter system type. Samples were treated by drying under shade for two weeks before applying to the farm. Some samples of the manure were taken to the Lab to analyze for NPK and other elements like Na, Mg and Ca (Table 1), to determine their percentages. The poultry manure collected was carried to the Crop and Soil Science Laboratory, Michael Okpara University of Agriculture and weighed. They were weighed using a sensitive weighing balance into three different rates that serve as the treatments (0 t/ha, 10 t/ha, 15 t/ha and 25 t/ha) for the experiment. The experiment was laid out on a randomized complete block design (RCBD) with three replications.

Table 1. *Soil physical and chemical properties of the experimental site.*

Parameter	Value
Textural class	Sandy clay loam
Sand%	20
Silt%	8
Clay%	72
pH (H_2O)	7.50
Total P (Mg/Kg)	7.40
Total N (%)	0.04
Organic carbon (%)	0.12
Organic matter (%)	1.14
Exchangeable Ca (Cmol/Kg)	4.20
Exchangeable Mg (Cmol/Kg)	0.63
Exchangeable K (Cmol/Kg)	0.43
Exchangeable Na (Cmol/Kg)	1.34
Exchangeable acidity (Cmol/Kg)	0.10
Effective Cation Exchange Capacity (Cmol/Kg)	6.90
Base saturation	6.30

Source: Field work, 2015.

2.5. Seed Source

The pepper seeds were sourced from National Root Crops Research Institute, NRCRI Umudike as well as from the local market.

2.6. Nursery and Field Layout

The seeds were sown in well prepared nursery pots and germination was noticed 7 days later. Field transplanting was conducted when the seedlings were three weeks old.

2.7. Field Maintenance

Weeds were controlled manually by the use of hoe at 3 and 6 weeks after transplanting (WAT), which kept the plots clean.

2.8. Data Collection

Data was collected on growth and yield parameters through random sampling of three plants from each plot that was later tagged. Measurement of growth characters were done at 3, 6 and 9 WAT. Yield was determined by weighing freshly harvested fruits from the net plots with a balance scale. The fresh fruit weights per net plot were added and taken as yield per plot and the yield per hectare computed thereafter was recorded. The matured fruits were harvested manually by hand picking. Care was taken not to damage or severe the fruiting branches in the course of harvesting. The fruits were also placed directly into well labeled field baskets before counting and weighing. Harvest was done based on fruiting frequency.

3. Data Analysis

All data collected were subjected to analysis of variance (ANOVA) using Genstat package at 0.05 probability level while Fishers least significant difference (LSD) was adopted to separate the means according to Gomez and Gomez (1984).

4. Results and Discussion

4.1. Effect of Poultry Manure Rates on Number of Leaves of Pepper Per Plant

The numbers of leaves increased statistically at 3, 6 and 9 WAT, ranging from 9.30 to 23.00. The highest mean was recorded at 9WAT. Poultry manure rate with 15 t/ha recorded higher number of leaves per plant of 11.53 (3WAT), 19.00 (6WAT) and 37.60 (9WAT) respectively, compared with the control which yielded the lowest (6.80 at 3WAT), (7.70 at 6WAT) and (10.60 at 9WAT) (Table 2). Number of leaves per plant also declined at the highest rate of 25 t/ha. Number of leaves per plant was not significantly different ($p>0.05$) at 3WAT but were significantly different ($p<0.05$) at 6 and 9WAT. This goes in line with the work of Dauda et al. who reported that nutrients in manures most especially nitrogen and other elements are released slowly and become readily available towards the later part of the growing season [7].

Table 2. *Effect of different poultry manure rates on number of leaves per plant at 3, 6 and 9 weeks after transplanting (WAT) during 2015 cropping season.*

Treatment	Weeks after transplanting (WAT)		
	3	6	9
0	6.80	7.70	10.60
10	9.97	12.30	22.50
15	11.53	19.00	37.60
25	8.90	12.30	21.20
Mean	9.30	12.80	23.00
LSD	3.48	7.00	11.40

Source: Field work, 2015.

4.2. Effect of Poultry Manure Rates on Girth Per Plant (cm) of Pepper

Girth per plant increased slightly increased from 1.12 to 2.08 at 3, 6 and 9 WAT. Poultry manure rate of 15 t/ha recorded the highest girth per plant at 1.27 (3 WAT), 2.40 (6 WAT) and 2.83 (9 WAT), as against control which had the lowest of 0.80 (3 WAT), 1.13 (6 WAT) and 1.53 (9 WAT). Girth per plant had slight increase at the rate of 25 t/ha giving 1.13 (3 WAT), 1.47 (6 WAT) and 1.90 (9 WAT). Girth per plant was significantly different ($p<0.05$) at 6 and 9 WAT, respectively (Table 3). There was no significant difference ($p>0.05$) at 3 WAT. This work agrees with Aliyu who reported that treatments that receive high poultry manure increases in vegetative growth. Although, increase in rate manure above the normal rate did not translate to increase in the girth of the plant [3].

Table 3. *Effect of poultry manure rates on girth per plant (cm) at 3, 6 and 9 WAT during 2015 cropping season.*

Treatment	Weeks after transplanting (WAT)		
	3	6	9
0	0.80	1.13	1.53
10	1.27	1.50	2.03
15	1.27	2.40	2.83
25	1.13	1.47	1.90
Mean	1.12	1.62	2.08
LSD	0.49	0.77	0.38

Source: Field work, 2015.

4.3. Effect of Poultry Manure Rates on Height (cm) Per Plant of Pepper

Height per plant increased overtime with mean ranging from 4.23 to 10.99 at 3, 6 and 9 WAT. Poultry manure rate of 15 t/ha recorded the highest height per plant at 5.20 (3 WAT), 9.13 (6 WAT) and 17.30 (9 WAT) against control which yielded the lowest (2.60 at 3 WAT, 5.20 at 6 WAT and 4.97 at 9 WAT. Height per plant increased at the highest rate of 15 t/ha giving 5.20 (3WAT), 9.13 (6 WAT) and 17.30 (9 WAT). Height per plant showed significant difference ($p<0.05$) at 3 WAT and highly significant at 9 WAT, but not significant at 6 WAT (Table 4). Similar results were reported by John et al. who noted that poultry manure contains essential nutrient element associated with high photosynthetic activities and thus promoted root and vegetative growth [12].

Table 4. *Effect of poultry manure rates on plant height (cm) of pepper at 3, 6 and 9 WAT during 2015 cropping season.*

Treatment	Weeks after transplanting (WAT)		
	3	6	9
0	2.60	5.20	4.97
10	4.33	8.40	10.83
15	5.20	9.13	17.30
25	4.80	7.93	10.87
Mean	4.23	7.67	10.99
LSD	1.71	3.22	3.48

Source: Field work, 2015.

4.4. Effect of Poultry Manure Rates on Number of Fresh Fruit Per Plant, Weight of Fresh Pepper Per Plant and Fresh Fruit Yield (kg/ha)

The treatment of 15 t/ha had the highest number of fresh fruits (4.43) and weight per plant (86.7), respectively. Number of fruits per plant and weight were significantly different ($p<0.05$). Fresh fruit yield was statistically affected by different rates of poultry manure. Also, the highest yield (5417 kg/ha) was recorded for treatment of 15 t/ha while control had the lowest yield (1052 kg/ha). The treatment at 25 t/ha however caused a drop in yield (3044 kg/ha) instead of increase (Table 5). Fresh fruit yield was significant ($p<0.05$). This observation agrees with the findings of Alabi who also stated that application of organic waste like poultry droppings increased growth and yield of *Capsicum* significantly more than inorganic fertilizers [1]. The mean number of fresh fruits, weight per plant and fresh fruit yield was 3.07, 44.30 and 2766.25, respectively. Similar result was obtained by Anonymous where poultry manure significantly increased fresh fruit weight of chili pepper, *Capsicum annum* variety Tattase at a rate of 2% by volume in combination with 60 kg N ha [5]. In the same vein, Aliyu and Kuchinda worked with different organic manure at Samaru to determine their effect on yield and composition of pepper, reported that the yield of pepper increased with increase in the rate of manure [4]. However, poultry manure and guano to produce more fruit yield than farm yard manure.

Table 5. *Effect of poultry manure rates on number of fresh fruit per plant, weight of fresh pepper per plant and fresh fruit yield during 2015 cropping season.*

Treatment	Number of fresh fruits/plant	Weight of fresh fruits/plant	Fresh fruit yield (kg/ha)
0	2.23	16.80	1052
10	2.30	24.80	1552
15	4.43	86.70	5417
25	3.33	48.70	3044
Mean	3.07	44.30	2766.25
LSD	1.21	44.23	2764.6

Source: Field work, 2015.

5. Conclusion and Recommendation

For crop production to meet the growing demands of our population, organic matter such as poultry manures are necessary inputs to promote vegetative mass, dry weight, plant height, and rate of dry matter increment per leaf unit area, photosynthetic potential and consequently the yield of *Capsicum,* and also as a known most convenient substitute of chemical fertilizers used by local farmers to supplement yield. The results of the experiment have shown that both growth and yield of parameters increased with the poultry manure rates of 10 t/ha, 15 t/ha, up to 25 t/ha compared with the control, even though this values dropped at 25 t/ha indicating that further increase beyond 15 t/ha remains uneconomical to both pepper farmers and the crop itself. It is therefore safe to say that the poultry manure rate of 15 t/ha is best performing and can be recommended to pepper farmers in this region. In addition, our work showed that continuous application of poultry manure to the soil will result in long term nutrient availability for crop use, especially vegetables like *Capsicum.* Further studies are encouraged in this field in order to determine the impact on poultry manure in disease development of the crop as well as its potency over time in the face of climate changes.

Conflict of Interest

All the authors do not have any possible conflicts of interest.

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