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GROWTH AND YIELD RESPONSES OF PEPPER (*Capsicum frutescens* L.) TO VARIED POULTRY MANURE RATES IN UYO, SOUTHEASTERN NIGERIA

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ABSTRACT

Field trial was carried out during the early cropping seasons of 2007 and 2008 at University of Uyo Teaching and Research Farm, Uyo, Akwa Ibom State, Nigeria to evaluate the effects of poultry manure rates (0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, and 22 t/ha) on growth and yield of pepper (*Capsicum frutescens* L.). A randomized complete block design with three replicates was used. Results showed that increase in poultry manure rate resulted in increase in growth and yield of pepper up to 8 t/ha rate. It also showed decline in yield with application rate above 8t/ha. Application of 8 t/ha produced 22.75 and 23.56 t/ha of fresh pepper in 2007 and 2008, respectively while 10 t/ha produced 22.70 and 23.91 t/ha of fresh pepper in 2007 and 2008, respectively. This implies that application above 8t/ha rate will not be economical and beneficial to the farmer.

Keywords: pepper, poultry manure, growth, yield.

INTRODUCTION

Pepper (*Capsicum frutescens* L.), an annual herb or shrub with many branches, belongs to the *Solanaceae* family. The unripe fruits are green or purple in colour but turn red, orange, yellow or brown when ripe (Udoh *et al*., 2005). Pepper is an important crop species in the world. It is one of the most important vegetables grown in Nigeria and other parts of the humid and semi-arid tropics (Aliyu, 2000). It is commonly used as condiments (Alabi, 2006) and the non-pungent species (*Capsicum annum*) are eaten raw as salad while the stronger flavoured types (chilies) are popular in all kinds of cookery as pungent species. It is also used in seasoning sauces and soup and other dishes. As a medicinal plant, pepper is used in the prevention and treatment of cold and fever (Udoh *et al*., 2005). The very hot varieties of pepper (Chilies) have a high content of the alkaloid capsaicin ($C_{18}H_{27}0_3$) which imparts the pungency or spicy taste. Pepper like other vegetables crops contributes nutritiously with nutrients that may be lacking in other food materials hence improve food intake (Grubben, 1997).

Pepper can be grown up to sea-levels of 3,000 m in the tropics, preferably with a rainfall of 600 -1200 mm. It is sensitive to water logging and excessive rain (Udoh *et al*., 2005) and thrives best in relatively warm climate with a temperature range of 18-27^{0}C. A sandy loam soil which holds moisture fairly well with liberal supply of organic matter is ideal for growth of pepper (Udoh *et al*., 2005).

Presently, pepper is widely cultivated in Southeastern Nigeria but the yield is low and low fertility status of the soils has been advanced as a serious factor. Maintenance of soil fertility has been established as a prerequisite for sustainable crop production and increase yield while organic manuring has been reported to play a vital role in this regard (Jablonska, 1990; Ullah *et al*., 2008).

The use of organic manure has been reported to enhance soil productivity, increase the soil organic carbon content, soil micro-organism, improves soil structure, the nutrient status of the soil and enhance crop yield (Beckman, 1973; Udoh *et al*., 2005; FAO, 2000). The superiority and richness of poultry manure over other manures has been confirmed in some studies (De-lannoy and Romain, 2001; Asiegbu, 1987). Asiegbu (1987) observed that the application of 10t/ha of poultry manure gave significantly greater number of fresh pods and fresh pod weight in okra compared with 50kg N + 22kg P + 6kg K ha^{-1}. Manure application has also been found to encourage early maturity, uniformity in repining, increased fruit size and yield of tomatoes (Husseib, 1997). Maynard (1991) reported that the yield of lettuce fertilized with 5 t/ha poultry manure was equal or greater than those obtained with inorganic fertilizer. Aliyu (2000) reported increase in seed and fruit yield in sweet pepper as a result of poultry manure application. Reduction in soil bulk density and the considerable increase in exchangeable cations has been said to be a justification of the desirability of poultry manure for yield improvement of vegetable soybean (Hsieh and Hsu, 1993; Asiegbu, 1987; Sanchez *et al*., 1992). Hemeng *et al*., (1995) reported that poultry manure was one of the best forms of organic fertilizers for the production of plantain while Uko *et al*., (2009) recommended application of 10t/ha of poultry of manure for okra production in a warm wet climate.

Therefore it was these benefits and, the fact that inorganic fertilizers are expensive and environmentally unfriendly that necessitated this study to determine the optimum rate of poultry manure for chili pepper

production in the humid tropical rainforest belt of Uyo, Nigeria.

MATERIALS AND METHODS

The study was carried out during the early 2007 and 2008 cropping seasons at the University of Uyo Teaching and Research Farm located at Uyo (Latitude $5^0$17' and $5^0$27'N, Longitude $7^0$27' and $7^0$58'E and altitude, 38.1m above sea level). Uyo is a rainforest zone which receives about 2500mm rainfall annually. The rainfall pattern is bimodal, with long (March - July) and short (September - November) rainy seasons separated by a short dry spell of uncertain length, usually during the month of August. The mean relative humidity is 78%, atmospheric temperature is 30^0C and the mean sunshine hours is 12 (Peters *et al*., 1989). The soil belongs to the *ultisol* broad group.

Twelve poultry manure rates (0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20 and 22 ha^{-1}) constituted the treatments. A randomized complete block design with four replicates was used. Each replicate measured 74m x 4m while a plot size was 4m x 4m with 12 plots per replicate, giving total 36 plots. The inter-block and plot spacing was 2m and 1m, respectively. All plots were constructed into seedbeds and the poultry manure incorporated according to treatment.

The pepper (bell variety) seedlings were raised in a nursery for 45 days. At thirty days, the seedlings in the nursery were allowed hardened off for one week before transplanting to the field. Only healthy and uniformly sized seedlings were transplanted in the evening at a spacing of 90cm x 60 cm. Transplanting was done in April in both years. Weeding was done at 3, 6 and 9 weeks after transplanting. Incidence of pests and diseases was minimal hence was controlled manually. Ten plants were randomly tagged per plot for determination of plant height, number of leaves per plant, leaf area, number of branches per plant, number of days to 50% flowering, number of fruits per plant, fruit length, and fruit yield per hectare (t/ha). Data collected were subjected to analysis of variance procedure and treatment means that indicated significant difference were separated using Duncan multiple range test (Duncan, 1955).

RESULTS

Some soil physico-chemical properties of the experimental site showed that it was sandy loamy (Table-1) with low levels of nitrogen, potassium and organic matter, high level of available phosphorus and strongly acidic. Poultry manure analysis indicated high level of nitrogen and organic carbon (Table-2).

The number of leaves per plant as influenced by poultry manure rates differed significantly at 2, 4, 6 ad 8 after transplanting (WAT) in both years (Table-3). It increased with increase in rate of poultry manure. Application of 22 t/ha produced the highest average number of leaves per plant (18.35, 27.33, 39.18 and 54.25 and 20.77, 34.11, 42.15 and 58.71 at 2, 4, 6 and 8 WAT in 2007 and 2008, respectively). The least number of leaves per plant was recorded in control treatment (8.33, 10.40, 15.11 and 21.70 in 2007 and 9.02, 11.04, 16.71 and 24.18 in 2008 at 2, 4, 6 and 8 WAT, respectively). At 8 WAT, application of 22t/ha of poultry manure produced 1 - 6 and 2 - 9% more number of leaves than other treatments in 2007 and 2008, respectively. Plant height as influenced by poultry manure rates significantly differed at 2, 4, 6 and 8 WAT (Table-4). Pepper height increased with increase in poultry manure rates. The application of 22 t/ha produced the tallest plants (11.92, 18.72, 31.00 and 42.44 cm in 2007 and 11.99, 20.71, 39.20 and 51.22cm in 2008, at 2, 4, 6 and 8 WAT, respectively). The shortest plants were recorded in control treatment (6.50, 9.25, 1511 and 20.21cm in 2007 and 6.33, 10.33, 14.75 and 20.75cm in 2008 at 2, 4, 6, and 8 WAT, respectively). At 8 WAT, application of 22 t/ha rate produced plants that were taller than other treatments by 0.4 - 53 and 0.2 - 60%. Poultry manure rates significantly affected leaf area at 2 4, 6, and 8 WAT (Table-5). The application of 22t/ha produced the widest leaf area (4.2, 4.22, 4.66 and 5.19cm^2 and 4.25, 4.33, 4.89 and 5.01 cm^2 at 2, 4, 6, and WAT in 2007 and 2008, respectively). The control treatment produced the smallest leaf size on the average (2.1, 2.43, 2.60 and 2.99cm^2 and 2.01, 2.41, 2.66 and 2.99cm^2 at 2, 4, 6, and 8 WAT in 2007 and 2008, respectively). At 8 WAT, application of 22t/ha of poultry manure produced 2-44 and 9-45% wider leaf on average than other treatments. Number of branches per plant as influenced by poultry manure rates was significant at 2, 4, 6, and 8 WAT in both years (Table-6). Application of 22t/ha produced the highest number of branches on the average (1.33, 4.38, 5.86 and 7.85 in 2007 and 1.30, 4.39, 5.93 and 7.78 in 2008 at 2, 4, 6, and 8 WAT, respectively). The least number of branches per plant on average was recorded in control treatment (1.10, 2.00, 2.33 and 3.51 and 1.23, 2.30 and 3.00 at 2, 4, 6, and 8 WAT, respectively). At 8 WAT, application of 22 t/ha rate produced more number of branches per plant on the average and exceeded other treatments by 4-55 and 5-26% Application of 22 t/ha rate, contributed to early flowering, (23.12 and 23.22 days after transplanting in 2007 and 2008, respectively) whereas flowering was most delayed in the control treatment (35.11 and 34.75 days after transplanting in 2007 and 2008, respectively) The control treatment delayed 50% flowering by 25-34 and 4-33% days compared to other treatments in 2007 and 2008, respectively. The total number of fruits per plant was significantly influenced by poultry manure rates (Table-7). In both years, increase in poultry manure increased the number of fruits per plant, from 8.75 and 9.17 in 2007 and 2008, respectively in the control treatment to 44.41 in 2007 and 44.39 in 2008 when 10t/ha rate was applied. The 10t/ha rate produced 80% more number of fruits than other rates in 2007 and 79% more number of fruits in 2008. Fruits length did not differ significantly in both years. However, the longest fruit was from the 22t/ha rate (8.33 and 8.05cm in 2007 and 2008, respectively) while the shortest fruit was recorded in the control treatment (6.11 and 6.10 cm in 2007 and 2008, respectively). The fruit yield differed significantly in 2007 and 2008 (Table-7) with increase in poultry manure rates

increasing pepper yield up to 8t/ha rate. The application of 8t/ha out-yielded other rates by 64% in 2007 and also economically superseded others by 66% in 2008.

Table-1. Soil Physico-chemical properties of the experiment site.

	Soil depth (cm)			
Soil properties	**0 – 15**		**15 – 30**	
	2007	**2008**	**2007**	**2008**
Total N (%)	0.12	0.12	0.05	0.04
Organic matter (%)	2.53	2.50	2.01	2.01
Available P ($mgkg^{-1}$)	227.11	225.70	183.21	180.15
K	0.11	0.13	0.09	0.08
Ca	2.95	3.02	2.06	2.14
Mg	4.10	4.20	7.10	8.90
Na	0.20	0.22	0.10	0.09
Exchange acidity	4.66	4.43	4.13	4.11
Bulk density (gcm^{-3})	1.30	1.41	1.50	1.54
pH (1:1) H2o	4.75	4.80	4.90	5.20
Sand (%)	90.20	89.10	85.10	88.30
Silt (%)	3.30	4.20	6.90	5.60
Clay (%)	6.50	6.70	8.00	6.10
Electrical conductivity	0.06	0.08	0.06	0.05
ECEC	13.21	12.30	17.03	17.42
Base saturation%	63.20	46.12	78.14	78.21

Table-2. Chemical composition of poultry manure.

Properties (%)	**Values**	
	2007	**2008**
Nitrogen	4.71	4.40
Phosphorous	0.39	0.24
Potassium	0.81	0.77
Calcium	0.05	0.06
Magnesium	0.25	0.30
Sodium	0.37	0.36
Organic Carbon	49.20	48.30

Table-3. Numbers of pepper leaves per plant as influenced by poultry manure rates in 2007 and 2008.

Poultry (tha^{-1})	2007 Weeks after transplanting				2008 Weeks after transplanting			
	2	4	6	8	2	4	6	8
0	8.33b	10.40d	15.11e	21.70e	9.02d	11.04d	16.71c	24.18e
2	10.45b	17.31c	22.45d	30.03d	12.62c	17.45c	24.20d	34.45d
4	13.31ab	19.41c	24.17d	35.61c	13.62c	20.11b	24.17d	42.11c
6	15.21a	19.92b	27.11c	40.18b	16.33b	22.16b	28.16c	45.21c
8	15.33a	21.03b	28.12bc	43.71b	17.13b	26.15b	30.15c	47.61bc
10	15.45a	22.17b	30.18b	45.12ab	17.55b	28.11ab	32.17b	50.25b
12	15.49a	22.36b	31.62b	47.20a	17.55b	28.35ab	33.14b	50.47b
14	16.03a	24.61ab	33.14b	49.28a	17.61b	28.55ab	35.25b	56.18a
16	16.17a	24.75ab	36.17a	52.61a	18.25ab	30.11a	37.25ab	56.18a
18	16.18a	26.20a	38.60a	52.92a	18.25ab	30.25a	39.25a	57.81a
20	16.25a	27.20a	39.16a	54.11a	20.61a	32.00a	42.01a	58.61a
22	18.36a	27.33a	39.18a	54.25a	20.77a	34.11a	42.15a	58.71a

Within each column, means with the same subscript are not significantly different according Duncan (1955)

Table-4. Pepper height (cm) as influenced by poultry manure rates in 2007 and 2008.

Poultry (tha^{-1})	2007 Weeks after transplanting				2008 Weeks after transplanting			
	2	4	6	8	2	4	6	8
0	6.50b	9.25c	15.11b	20.21d	6.33c	10.33c	14.75d	20.75d
2	9.00a	12.83b	18.25b	23.61c	9.809	15.00b	18.45c	23.63d
4	9.21a	14.116	20.10b	25.16b	10.31a	15.10b	21.75c	27.25c
6	9.25a	14.75b	21.25b	28.85ab	10.33a	16.05ab	22.61c	30.11bc
8	10.77a	17.12a	25.129b	29.15ab	10.51a	18.41a	27.06b	31.52b
10	10.77a	17.18a	26.16ab	30.61ab	10.63a	18.71a	27.63b	31.87b
12	10.03a	17,77a	27.12ab	32.15ab	10.73a	18.81a	30.03a	32.46b
14	10.33a	18.21a	27.51ab	39.12a	10.85a	20.11a	35.00a	48.55a
16	11.64a	19.51a	30.11a	42.16a	11.53a	21.18a	36.71a	50.14a
18	11.67a	18.52a	30.42a	42.19a	11.81a	20.22a	38.08a	51.04a
20	11.70a	18.61a	30.42a	42.27a	11.83a	21.63a	38.11a	51.13a
22	11.92a	18.72a	31.00a	42.44a	11.99a	20.71a	39.20a	51.22a

Within each column, means with the same subscript are not significantly different according Duncan (1955)

Table-5. Pepper leaf area (cm^2) as influenced by poultry manure rates.

Poultry (tha^{-1})	2007 Weeks after transplanting				2008 Weeks after transplanting			
	2	4	6	8	2	4	6	8
0	2.10c	2.43b	2.60b	2.99b	2.01c	2.41c	2.66b	2.99b
2	2.32c	3.81a	3.82a	4.00a	2.30b	3.71b	3.90a	4.20a
4	2.49bc	3.87a	4.00a	4.13a	2.35b	3.80b	4.00a	4.30a
6	2.74bc	4.00a	4.21a	4.80a	2.55b	4.01a	4.11a	4.35a
8	2.80b	4.00a	4.23a	5.30a	2.95ab	4.11a	4.20a	4.55a
10	3.11a	4.01a	4.28a	5.32a	3.03ab	4.12a	4.20a	4.75a
12	3.80a	4.11a	4.33a	5.42a	3.40ab	4.83a	4.30a	4.90a
14	3.92a	4.15a	4.33a	5.01a	3.51ab	4.86a	4.51a	4.90a
16	4.12a	4.15a	4.34a	5.10a	3.91ab	4.99a	4.56a	4.91a
18	4.16a	4.17a	4.36a	5.12a	4.21a	4.30a	4.75	4.93a
20	4.18a	4.17a	4.60a	5.18a	4.22a	4.30a	4.79a	5.00a
22	4.20a	4.22a	4.66a	5.29a	4.25a	4.33a	4.89a	5.51a

Within each column, means with the same subscript are not significantly different according Duncan (1955)

Table-6. Number of pepper branches as influenced by poultry manure rates.

Poultry (tha^{-1})	2007 Weeks after transplanting				2008 Weeks after transplanting			
	2	4	6	8	2	4	6	8
0	1.10a	2.00b	2.33b	3.51c	1.23a	2.30c	2.80b	3.02c
2	1.30a	2.50b	4.10a	5.33	1.33a	2.51c	4.60a	5.36b
4	1.30a	2.55b	4.25a	5.75b	1.33a	3.51b	4.83a	5.77b
6	1.33a	3.24a	4.75a	5.81b	1.33a	3.70b	4.51a	5.80b
8	1.33a	3.95a	5.33a	5.93b	1.45a	4.00a	5.35a	5.80b
10	1.20a	4.31a	5.63a	7.25a	1.45a	4.05a	5.63a	6.95a
12	1.30a	4.20a	5.71a	7.33a	1.45a	4.15a	5.63a	7.00a
14	1.33a	4.25a	5.71a	7.45a	1.50a	4.33a	5.77a	7.00a
16	1.33a	4.33a	5.83a	7.51a	1.50a	4.35a	5.80a	7.20a
18	1.31a	4.35a	5.83a	7.51a	1.50a	4.36a	5.83a	7.21a
20	1.33a	4.35a	5.83a	7.53a	1.33a	4.05a	5.85a	7.65a
22	1.33a	4.38a	5.86a	7.85a	1.30a	4.39a	5.93a	7.78a

Within each column, means with the same subscript are not significantly different according Duncan (1955)

Table-7. Yield and yield components of pepper as influenced by poultry manure rates.

	2007				2008			
Poultry manure rates (t/ha)	**Number of days 50 % to flowering**	**Total number of fruits per plant**	**Fruit length** (cm) **plant**	**Fresh fruit yield** (t/ha)	**Number of days 50 % to flowering**	**Total number of fruits per plant**	**Fruit length** (cm) **plant**	**Fresh fruit yield** (t/ha)
0	35.11a	8.75e	6.11a	8.22c	34.75a	9.19f	6.10a	8.25e
2	32.11a	17.65d	6.25a	10.43	33.41a	18.33e	6.30a	11.40d
4	26.32b	25.62c	6.33a	15.21b	26.34a	36.51c	6.38a	18.80c
6	26.10b	32.33b	6.41a	17.03ab	26.34a	40.45b	6.38a	19.11
8	23.33c	42.75a	7.21a	22.75a	24.55a	44.35a	7.14a	23.56a
10	23.75c	44.41a	7.01a	22.70a	24.18a	44.39a	7.24a	23.91a
12	23.73c	42.33a	5.71a	21.61a	24.18a	42.42a	7.28a	23.90a
14	23.73c	42.33a	7.10a	21.60a	24.18a	42.01a	7.35a	23.33a
16	23.33c	42.10a	7.12a	21.82a	231.25a	40.13b	7.75a	22.82ab
18	23.33c	32.13b	7.21a	20.75a	23.25a	40.25b	7.88a	22.04b
20	23.30c	32.33b	7.30a	20.00a	23.25a	39.50b	7.91a	21.90b
22	23.12c	28.75ca	8.33a	19.33a	23.22a	30.51d	8.05a	20.03cb

Within each column, means with the same subscript are not significantly different according Duncan (1955)

DISCUSSIONS

The significant effects of the poultry manure may be attributed to low soil fertility of the experimental site as evidenced by the soil characteristics. Tisdale and Nelson (1975) noted that crop response to manure application is affected by nutrient reserve in the soil and that crops response to fertilizer application in soil with very low nutrient content than soil with high nutrient reserve. Organic fertilizer apart from releasing nutrient elements to the soil has also been shown to improve other soil chemical and physical properties which enhance crop growth and development (Stevenson and Ardakani, 1972; Udoh *et al*., 2005). In addition, poultry manure has also been reported to increase soil pH (Udoh *et al*., 2005), hence the acidic soil of the experimental site which could have caused the unavailability of nutrient element to the crops was checked by the limiting potential of organic manure (Ogbonna, 2008).

Moreover, poultry manure contains essential nutrient elements associated with high photosynthetic activities and thus promoted roots and vegetative growths (John *et al*., 2004). The increase in poultry manure rate increased the number of leaves, plant height, leaf area and number of branches. This could be attributed to improved soil conditions (moisture retention, soil structure and aeration and increase nitrogen availability) following the poultry manure application. Nitrogen is known to enhance physiological activities in crops thereby improving the synthesis of photo-assimilates (Aliyu, 2000). The increase in vegetative growth in treatments that received high poultry manure rate could be due to high nitrogen content (Frank, 1965). Nitrogen is an important constituent in pepper metabolises and chlorophyll necessary for promoting aerial growth, increase tap-root ratio, leaf area, number of branches and height (Olson *et al*., 1971). Number of days to 50% flowering is a function of nitrogen concentration and was well supplied by the poultry manure applied to the soil (Dauda, 2002). This led to rapid crop growth development and consequently early flowering than the control plot where there was nitrogen deficiency (Dauda, 2002; Eguchi *et al*., 1958). Application of poultry manure resulted in increase number of fruits per plant, longer fruits and fresh fruit yield. This could be attributed to the fact that the poultry manure supplied essential nutrients for enhanced productivity (Gupta and Shukla, 1977; Takaichi *et al*., 1979; Dauda, 2008) Nitrogen ability to promote vigorous foliage growth; increased meristematic and physiological activities in the plant resulting in production of more assimilate used in formation of fruits has been established. The result showed that at higher rate of manure, number of fruit and fruit yield tend to decrease with increase in poultry manure rate. This agrees with the report by Aliyu (2003) that excess nitrogen application reduced number of fruits and yield. Also Mitchel *et al.* (1978) reported that application of manure above agronomic rate may result in accumulation of heavy metals in both soils and plant tissue with adverse effect on crop growth and performances. In addition, high rate of poultry manure may release phototoxic quantities of ammonia and nitrate salts which may adversely affect soil micro-organisms responsible for mineralization of plant nutrients (Weil and Kroonje,

1979). This apparently explains the observations made on some agronomic parameters with higher poultry manure rates used in this study.

CONCLUSIONS

The result suggests that application of poultry manure can improve pepper growth and yield. However, application of not more than 8 - 10t/ha of poultry manure rate can enhance pepper production in Uyo and improve farm income.

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