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Evaluation of Growth and Yield of (*Capsicum annum* L.) var 'Nsukka Yellow' under Different Fertilizer Regimes in Ibadan, South-western Nigeria

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ABSTRACT

Capsicum annum (L.) var 'Nsukka Yellow' is a spice crop in high demand and which commands a high price in the South Eastern parts of Nigeria because of its bright yellow colour and aroma which distinguishes it from other pepper varieties. The production of this spice crop should not be restricted to this region alone; it should be extended to other parts of the country with the use of adequate fertilizer. Therefore, a field trial was conducted at the National Horticultural Research Institute, Ibadan, South Western Nigeria to assess the growth and yield of this pepper under different fertilizer regimes. The experiment was laid out in a randomized complete block design with four replications. Treatments used were control (no NPK or poultry manure), 15 t/ha poultry manure, 30 t/ha poultry manure, 45 kg/ha NPK 15: 15: 15, 90 kg/ha NPK 15: 15: 15 and 15 t/ha poultry manure + 45 kg/ha NPK 15: 15: 15. Data were collected at two-week intervals. Results showed that the combination of poultry manure and NPK fertilizers (15 t/ha + 45 kg/ha) was the best in terms of plant height, number of leaves, stem girth, main branch and yield compared to the control. Yield was significantly ($P < 0.05$) influenced by different fertilizer regimes. A yield of 14.2, 11.4, 10.9, 9.1, 7.7 and 3.4 t/ha was obtained in combined fertilizer, 90 kg/ha NPK 15: 15: 15, 45 kg/ha NPK 15: 15: 15, 30 t/ha poultry manure, 15 t/ha poultry manure, and the control respectively.

Keywords: evaluation, fertilizer rates, location, Nsukka yellow pepper
Abbreviations: PM, poultry manure, **WAT**, weeks after transplanting

INTRODUCTION

Pepper (*Capsicum annum* L.) is an important vegetable in the world, both in tropical and temperate regions. In Nigeria, it is regarded as third most important vegetable after onions and tomatoes (Odedina *et al.* 2006). It is an important source of vitamins A and C. Nigeria is the largest producer of pepper in Africa, with production of 452,673 metric tonnes accounting for about 50% of the African production (FAOSTAT 2009). Its consumption accounted for about 20% of the average consumption per person per day in Nigeria (Erinle 1989; Alegbejo 2002). It is characterized by its yellow colour at fruit ripening and a unique aroma, which distinguishes it from other pepper varieties; 1-3 fruits occur in the axil of one leaf. There is also a myth that it loses its aroma if planted in other parts of the country (Amakor 1994). However, most of the research activities have been on other pepper varieties and limited mostly to the Northern part of the country (Olanrewaju and Sowemimo 2003). However, production of a particular variety, 'Nsukka Yellow' is mostly cultivated in the Eastern states of Nigeria, notably in Nsukka and Enugu areas, and is not very common in riverine areas. It is eaten raw in salads and cooked in various ways (Purseglove 1991).

Plants, like other organisms, require nutrients for their growth and reproduction. However, the use of inorganic fertilizers alone cannot guarantee sustainable yield of the crop, hence the need to be complemented with organic fertilizer (Alasiri 2002).

Nutrients are needed for normal plant growth and to maintain healthy life, roots and vegetative growth and the developments of crops (Tittonel *et al.* 2008; Aruna *et al.* 2009). The quantity and quality of applied nutrients taken up by plants are determined to a large extent by the way in which the nutrient carrier is presented to the plant (Awe *et al.* 2009). However, pepper is reported to respond to improved soil fertility (Yahaya 2009).

In order to achieve high yield in pepper, there is a need to augment the nutrient status of the soil to meet the crop's needs and thereby maintaining the fertility of the soil. This is achievable with adequate nutrients in the soil and their proper management (Tittonel *et al.* 2008; Adebayo *et al.* 2009). One way of increasing the nutrient status is by boosting the soil nutrient content either with the use of organic materials such as poultry manure, animal waste and the use of compost or with the use of inorganic fertilizers (Dauda *et al.* 2005). The application of manure fortified with inorganic fertilizer was also advocated to increase soil concentration of nutrients and organic matter (Eghbal 2002). Soliman and Hassan (2004) also observed that the application of organic materials wither alone or in combination with chemical fertilizers increased the soil availability of N, P and K.

Poultry manure is very cheap and effective as a source of N for sustainable crop production, but its availability remains an important issue due to its bulky nature, while inorganic fertilizer is no longer within the reach of farmers with poor resources due to its high cost (Rahman 2004). However, John *et al.* (2004) advocated for the integral use of organic manure and inorganic fertilizers to supply adequate quantities of plant nutrients required to sustain maximum crop productivity and profitability, while minimizing the environmental impact for nutrient use. There is therefore a need to evaluate the effect of integration of both organic and inorganic fertilizer on the performance of pepper var 'Nsukka Yellow' in the South western region of Nigeria.

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MATERIALS AND METHODS

A field experiment was conducted at the National Horticultural Research Institute, Ibadan, Nigeria. The location lies at 03° 35′ E, 07° 24′ N, 168 m above sea level in the rainforest transition zone of South Western Nigeria. Pepper seedlings were raised in a nursery with sterilized top soil and cured poultry manure. The top soil was sterilized by adding the desired amount of soil in an oven roasting bag, add some water to the soil to keep it moist, tie the mouth of the bag and make an opening for thermometer. The soil bag was placed on the pan and heated between 160-170°C for about 30 min (a thermometer was used to check the soil temperature). The sterilized soil was removed, cool thoroughly before planting. Seeds were planted 5 cm apart, then the holes were covered with a thin layer of soil and lightly watered; sowing depth was about 5 mm. Nursery trays were placed under shade to protect the seedlings from direct influence of rain drops.

Watering in the nursery was on every other day. Germination commenced a week after planting in the nursery. Prior to planting, soil samples were taken at a depth of 0 to 15 cm from different parts of the field and thoroughly mixed to form a composite sample. The soil sample was air dried and passed through a 2-mm then a 0.5-mm sieve to assess soil texture and for chemical analyses. The sample was analyzed for pH, organic carbon (C), total nitrogen (N), available P, exchangeable Ca, K, Na and Mg. The pH of the soil sample was determined with glass electrode pH meter using a 1:1 soil-water (solution) ratio in distilled water as reported by Bates (1954), organic C determination was by using the wet oxidation method of Walkley black (1934), total N by the regular macro Kjeldahl method (Bremner 1965), available P determined by the Bray P-1 method (Bray and Kurtz 1945) while exchangeable Ca, K, Na and Mg was analyzed with flame photometry (Pratt 1965). The seedlings were transplanted to the field after 4 weeks. Transplanting was done with a hand fork and with ball of earth around the roots. Each plot measured 2 m × 2 m with an inter-plant spacing of 30 cm × 75 cm with 18 plants per plot. The experimental design used was a randomized complete block, with six treatments (including a control with no fertilizer or poultry manure) and four replications. Treatments used were:

a) Control (no fertilizer or poultry manure);
b) Organic fertilizers (poultry manure) – 15 t/ha and 30 t/ha at 2 split applications;
c) Mineral fertilizers (NPK 15: 15: 15) – 45 and 90 kg/ha at 2 split applications;
d) Combined fertilizers (poultry manure + NPK 15: 15: 15) – 15 + 45 kg/ha at 2 split applications.

Missing stands were supplied five days after transplanting. The treatments were applied on split applications, first 2 weeks after transplanting and then at the flowering stage. Data collected included plant height, number of leaves, stem girth, main branches and yield (t/ha) and were subjected to analysis of variance using a linear model procedure of statistical analysis (SAS Institute 2003). Mean were compared using least significant difference (LSD) at $P = 0.05$.

RESULTS AND DISCUSSION

The chemical composition of the poultry manure used is presented in **Table 1** while the soil physico-chemical properties before the experiment are presented in **Table 2**. The latter showed that the fertility status is average, especially for major elements.

There were significant treatment effects on the vegetative growth of pepper (**Tables 3-6**). Four weeks after transplanting, pepper plants that received a combination of poultry manure and inorganic fertilizer (NPK 15: 15: 15) were significantly taller than plants from other treatments tested. The shortest plants were control plants (i.e., no fertilizer treatments). This same trend occurred throughout the period of data collection until 12 weeks after transplanting (**Table 3**). This same trend occurred for the number of leaves. An increase in the number of leaves was observed with an increase in poultry manure and NPK rates. The most efficient treatment producing significantly higher leaves was with plants that received a combination of poultry manure and inorganic fertilizer (**Table 4**). The response of pepper plants in terms of stem girth, main branches followed the same trend whereby the lowest values were recorded for control plants and higher values for fertilized plants. This result suggests that nutrient availability, especially N, determines plant vegetative development (Adebayo *et al.* 2009). The consistently poor performance of non-fertilized plants and those planted with low N amendment revealed that when nutrients are available in adequate amounts, plants tend to grow at their optimum potential. The best performance of 'Nsukka yellow' pepper was consistently observed under the integration of organic and inorganic fertilizers. This implied that the integration provided more nutrients at the required time. Mineralization of organic matter occur at a

Table 1 Chemical composition of the poultry manure.

Element	Absolute % chemical composition
N	2.95
P	0.34
K	5.35
Ca	5.31
Mg	0.49
Na	0.36
OC	47.40

Table 2 Soil physico-chemical properties before the experiment.

pH	6.5
Organic C (g/kg)	0.88
Total N (mg/kg)	0.94
Available P (mg/kg)	5.82
Exchangeable bases (Cmol/kg)	
Ca	0.09
Mg	0.15
Na	0.04
K	0.09
Exchangeable bases	
CEC	0.45
Mn (mg/kg)	28.58
Fe (mg/kg)	8.87
Cu (mg/kg)	0.60
Zn (mg/kg)	2.63
Particle size analysis	
Sand	810
Silt	120
Clay	70

Table 3 Effect of fertilizers on plant height (cm) of 'Nsukka yellow' pepper.

Treatments	Weeks after transplanting (WAT)				
	4	6	8	10	12
15 t/ha PM + 45 kg/ha NPK 15: 15: 15	12.1	28.1	35.0	46.3	52.2
90 kg/ha NPK 15: 15: 15	10.5	19.8	33.6	43.8	47.8
45 kg/ha NPK 15: 15: 15	9.8	16.9	29.3	41.2	44.1
30 t/ha PM	9.4	16.8	28.2	40.5	42.4
15 t/ha PM	9.2	15.9	27.1	38.9	42.2
Control	7.1	12.8	23.2	33.2	38.3
LSD (0.05)	1.7	28.1	11.5	15.5	15.4

PM: poultry manure

Table 4 Effect of fertilizers on number of leaves of 'Nsukka yellow' pepper.

Treatments	Weeks after transplanting (WAT)				
	4	6	8	10	12
15 t/ha PM + 45 kg/ha NPK 15: 15: 15	27.1	75.8	221.2	252.6	266.2
90 kg/ha NPK 15: 15: 15	22.0	68.7	160.8	225.6	259.7
45 kg/ha NPK 15: 15: 15	20.6	54.4	158.5	213.1	245.6
30 t/ha PM	19.7	50.9	139.5	204.0	239.3
15 t/ha PM	17.4	40.8	125.5	201.8	218.6
Control	14.5	35.1	113.4	195.3	156.9
LSD (0.05)	2.71	2.81	11.8	12.90	16.28

PM: poultry manure

Table 5 Effect of fertilizer on stem girth (cm) of 'Nsukka yellow' pepper.

Treatments	Weeks after transplanting (WAT)				
	4	6	8	10	12
15 t/haPM + 45kg/ha NPK 15: 15: 15	1.12	1.82	2.97	3.63	3.93
90 kg/ha NPK 15: 15: 15	1.00	1.53	2.90	3.48	3.80
45 kg/ha NPK 15: 15: 15	0.98	1.43	2.80	3.30	3.73
30 t/ha PM	0.88	1.40	2.47	3.20	3.53
15 t/ha PM	0.86	1.37	2.27	3.17	3.30
Control	0.60	1.33	1.63	2.10	2.70
LSD (0.05)	0.01	0.14	0.93	0.72	0.33

PM: poultry manure

Table 6 Effect of fertilizer on main branches of ' Nsukka yellow' pepper.

Treatments	Weeks after transplanting (WAT)				
	4	6	8	10	12
15 t/ha PM + 45 kg/ha NPK 15: 15: 15	0	4.8	6.0	6.3	8.0
90 kg/ha NPK 15: 15: 15	0	3.9	5.3	6.0	7.7
45 kg/ha NPK 15: 15: 15	0	3.6	5.1	5.6	7.4
30 t/ha PM	0	3.9	4.6	5.1	6.2
15 t/ha PM	0	2.9	3.9	5.5	6.8
Control	0	1.8	2.5	3.1	4.9
LSD (0.05)	0	1.3	1.5	1.3	1.6

PM: poultry manure

Table 7 Effect of fertilizer on the yield (t/ha) of 'Nsukka yellow' pepper.

Treatments	Yield (t/ha)
15 t/ha PM + 45 kg/ha NPK 15: 15: 15	14.2
90 kg/ha NPK 15: 15: 15	11.4
45 kg/ha NPK 15: 15: 15	10.9
30 t/ha PM	9.1
15 t/ha PM	7.7
Control	3.4
LSD (0.05)	1.11

PM: poultry manure

slow rate while also improving the soil physical, chemical and biological properties while that of inorganic matter is faster. Grichs (1990) observed that, apart from the role of organic manure as a store house for plant nutrients, it is a major contributor to the cation exchange capacity and acts as a buffering agent against pH fluctuation. Organic fertilizer plays a key role in sustaining the desirable soil physical, chemical and biological conditions for satisfactory growth and development of crops. Better performance of pepper plants occurred under integration of both organic and inorganic fertilizers. This can be attributed to increased nutrient use efficiency (Murwira and Kirchman 1993).

Fuchs (1970), as in this study, also reported that nutrients from mineral fertilizers enhanced the establishment of crops, while those from the mineralization of organic manure promoted yield when combined with fertilizer. Titiloye (1982) also reported that the most satisfactory fertilizer treatment for improving crop performance was a judicious fortification of organic fertilizers with inorganic fertilizers. Kang and Balasubramanian (1990) also reported that high and sustained crop yield could be achieved with a judicious and balanced NPK fertilizer combined with organic amendments. Organic and organomineral fertilizers increased the yield of maize significantly (Adeoye *et al*. 2008; Ojeniyi *et al*. 2009) and vegetables such as pepper (Fagbola and Dare 2003) tomato (Olowokere 2004) okra, melon and amaranthus (Makinde 2007; Akanni and Ojeniyi 2008).

Pepper yield differed significantly among treatments (**Table 7**). The highest yield of 14.2 t/ha was obtained with combined fertilizer, while 90 kg/ha NPK 15: 15: 15 resulted in 11.4 t/ha, 45 kg/ha NPK 15: 15: 15 in 0.9 t/ha, 30 t/ha poultry manure in 9.1 t/ha, 15 t/ha poultry manure in 7.7 t/ha and the control in 3.4 t/ha. Damke *et al.* (1988) observed that fresh fruit yield increased as the fertilizer rate increased. Safia *et al*. (2001) also reported that the addition of chemical fertilizer caused higher sweet pepper yield. Prabu *et al*. (2003), while investigating the effect of integrated use of organic fertilizers with reduced levels of inorganic fertilizers, concluded that the yield of okra increased significantly with an increase in fertilizer, farmyard manure and bio-fertilizer application.

Better yield observed for both organic and inorganic sources over the control could be attributed to the higher N availability and beneficial effects of these materials. This is similar to the results obtained by Akanbi *et al.* (2007) and Shokalu *et al.* (2009). Akanbi *et al.* (2007) explored compost technology with *Telfairia occidentalis* using the following treatments: Soil incorporated NPK 60 kg/ha (recommended for leafy vegetables), *Tithonia diversifolia* compost extract in 1:1, 1:2, 1:3 extract to water, cassava compost extract in 1:1, 1:2, 1:3 extract to water and control with no nutrient in any form as foliar spray, liquid fertilizer and nutrient source. Plants that received nutrients in form of foliar spray performed similarly with those that were fertilized with soil applied NPK fertilizers, but *Tithonia diversifolia* (a less lignified and high biodegradable plants) compost extract in the ratio 1:2 dilution performed best compared to other dilution ratios and the control. Shokalu *et al.* (2009) with 10 t/ha poultry manure and 30 kg/ha NPK 15: 15: 15 achieved a seed weight yield of 112.08 kg of sunflower seed compared with 44.98 kg achieved with the control with no fertilizer or poultry manure.

CONCLUSION

The treatments that combined poultry manure and mineral fertilizer (15 t/ha+ 45 kg/ha) gave the best results in terms of all growth parameters measured and the yield, while the control (no NPK or poultry manure) showed the lowest values. This indicates that provided that the problem of affordability and procurement of mineral fertilizer by resource-poor farmers persists, the use of this mineral fertilizer with poultry manure (less expensive and affordable) should be a viable alternative.

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