Comparative effect of conventional fertilizers and organic fertilizers in pepper production (C*apsicum frutescens*)

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ABSTRACT

A study was carried out to evaluate the potential of organic, mineral and organomineral fertilizers on the growth and yield of pepper. The treatments were compost of rice husk and cow dung (1.5 and 2.5 t/ha), Organomineral fertilizer at 1.5 t/ha, NPK (52kgN, 45 kg P_2O_5, 30 kg K_2O /ha) and a control (no fertilizer). The experiment was randomized complete block design with three replications. Growth parameters such as plant height, stem girth, number of leaves, branches as well as yield parameters were taken. The results ($p<0.05$) indicated that NPK fertilizer was significantly better among the treatments for fresh pepper fruit production. However, compost of rice husk and cow dung at 2.5 t/ha gave a better yield in dry pepper production.

Keywords: Organic fertilizer, mineral, organomineral, pepper, Yield

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INTRODUCTION

Pepper (*Capsicum frutescence*) belongs to the family Solanaceae. It is a shrubby perennial with inflorescence of several flowers, which is a major vegetable crop and an important constituent of local dishes in West Africa. Pepper is normally used as a spice in the preparation of soup and stew when cooked with tomatoes and onions. It can also be used as a condiment and extensively in flavouring of processed meat, colouring certain food preparation and also used for medicinal purposes (Olaniyi and Ojetayo, 2010). In pepper production, Nigeria was rated second in the world in 1979 (Yamaguchi, 1983). However, production later declined and since the early 1980's, export has been minimal (Aliyu *et al*., 1996). Nigeria is the fifth in the world pepper production (USDA, 2001) with over 630,000 metric tones (Muhamman and Auwalu, 2009). It is cultivated principally in southwestern and northern Nigeria between latitudes 10°N and 12°3N in the northern guinea savannah and Sudan savannah ecological zones (Adeola *et al*., 2011, Erinle, 1988). It is an excellent source of vitamins. Pepper produces high amounts of Vitamin C, provitamin A, E, P - citrin, B1 - thiamine, B2 - riboflavin and B3 - niacin (Bosland and Votava, 2000). One of the major causes of low yield of pepper obtained by farmers is poor soil nutrients. The fragile nature of the soil, couple with overuse of most arable crop lands as a result of continuous cropping in Nigeria has made it mandatory to apply fertilizer to the crops. Tropical soils are beset with the problems of acidity, low nutrient contents, nutrient imbalance and erosion. Use of fertilizer such as organic and inorganic had been found to solve these problems (Babatola and Olaniyi, 1997, Senjobi *et al*., 2012). Inorganic fertilizer practices to many today is known as conventional farming methods. This entails the use of inorganic amendments on the soil. This method of soil improvement utilizes large amount of petroleum based fertilizer, as in the case of breakdown of the triple bond between nitrogen molecules, as plants cannot utilize nitrogen in the form in which it occurs in the atmosphere. The major limitation to the usage of chemical fertilizer is due to the adverse effect they have on plants which include deterioration of plant quality, diseased susceptibility and environmental pollution (Adeoluwa and Adeogun 2010). Worldwide concerns regarding the safety of the food supply, anthropogenic degradation of the natural environment and ecological systems have led to an increased emphasis on the development of sustainable agriculture (Dodson and Stearman, 2012). Currently, in some countries any food having less than 70% organic production is banned from entering into the market. This is because inorganic fertilizer has toxic or residual effect on soil which upon uptake by plant contaminates the produce as such threatening the safety level if the residual level is above the maximum permissible level by the World Health Organization. One of the ways to maintain or improve soil fertility is by maintaining its organic matter. This is possible through the use of organic materials. Organic materials are available in huge amounts in the form of farm waste, poultry litter and industrial waste. These materials could be utilized more effectively and sustainably through recycling rather than being destroyed through burning (Olowoake, 2010). Organic materials improve soil texture, reduce erosion, disease and weed

germination by enhancing the nutrient and water retention capacity, improve tilth and overall productivity of the soil (Olowoake, 2012). Moreover, since understanding of nutrient supply to the soil is crucial for soil optimum production and maintenance, therefore, the aim of this study is to adequately study the effect of mineral fertilizer, composted rice husk and organomineral fertilizer on the performance of pepper (*Capsicum frutescence*) as well as establishing optimum application rate of organic fertilizer for pepper production.

MATERIALS AND METHODS

The field experiment was conducted at the Department of Agronomy, Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria. It lies on Latitude 7° 34 N and Longitude 3° 48 E, The mean annual rainfall of the site is 1220mm and it is bimodal in distribution. The land used for the experiments had been previously cropped for staple food crops such as maize and yam. The land was left fallowed for 3 years. Prior to land preparation, soil samples (0-15cm) were taken randomly from the experimental site with a soil auger. Samples were bulked, air –dried, and ground to pass through a 2 mm sieve. The soil samples were analyzed for physico-chemical properties as follows: Soil particle size was determined by Bouyoucos method (Bouyoucos, 1962). Soil pH was measured electrometrically in a 1:2.5 soil-water suspension (McLean, 1982). Soil organic carbon was determined by Walkey black modified method (Black, 1965). Available Phosphorus and total nitrogen were determined separately by Technicon All method (Technicon, 1975), while exchangeable Ca, Mg, K, Na and effective CEC in soils by use of atomic absorption spectrophotometer (Tel and Hargerty, 1984).

The seeds of NHVI-F pepper were sown on prepared nursery beds and water regularly using a watering can and checked for seedling emergence which started on the 4^{th} day after sowing. The field was cleared manually with the use of hoe and cutlass .The total area of the land was 19m x8m ($152m^2$) and the size of each sub plot was 2.25m x 1.5m ($3.38m^2$), with an inter-plot space of 0.5 m. Seeds of accession NHVI-F were transplanted to the field plot at a spacing of 75cm x 75cm within and between rows respectively. The experimental design was laid out in a randomized complete block design (RCBD) with three replications. Five treatments was used for the experiment, the treatments are as follows; Control-No fertilizer, Organomineral fertilizer (Grade A) - 1.5 t/ha, compost of rice husk and cow dung 2.5 t/ha and NPK (52kg N/ha, 45kg P_2O_5/ha and 30kg K_2O/ha).

Table 1: Nutrient content of compost of rice dust and cow dung (70:30)

Nutrient Element	Concentration grade A
N (gkg^{-1})	44.2
P (gkg^{-1})	10.8
K (gkg^{-1})	6. 8
Ca (gkg^{-1})	6.8
Na (gkg^{-1})	0.8
Fe ($mg\ kg^{-1}$)	8153.4
Zn ($mg\ kg^{-1}$)	712.7
Mn ($mg\ kg^{-1}$)	558.3
Cu ($mg\ kg^{-1}$)	257.4

Organomineral fertilizer is a commercial product of Pacesetter Fertilizer Plant, Ibadan, Oyo State Nigeria. Compost and Organomineral fertilizer was applied two weeks before transplanting in a ring, 5 cm radius and about 2 cm deep around pepper plant. The results of analyses of the fertilizers are summarized in Table 1. Six pepper plants were randomly sampled from each plot to record observations. The pepper growth and yield parameters collected include, plant height, stem girth, number of leaves per plant, number of branches, number of fruits, fresh weight fruit and dry weight. The data collected were subjected to analysis of variance (ANOVA) and treatment means were separated by Duncan Multiple Range Test (DMRT) of SAS (2012).

Table: 2 Proximate analysis for Organo-mineral fertilizer Grade A

Nutrient Element	Concentration
N (gkg^{-1})	13.9
P (gkg^{-1})	6.0
K (gkg^{-1})	3.9
Ca (gkg^{-1})	0.6
Mg (gkg^{-1})	3.1
Na (gkg^{-1})	6153

Source: Pacesetter Fertilizer Company, Ibadan, Nigeria

RESULTS AND DISCUSSION:

Characteristics of soil used

The results of the physical and chemical analysis of the soil used prior to the commencement of the experiment are shown in Table 3. The soil is sandy and slightly acidic. The total nitrogen, Potassium were very low (Ayodele, 1983), with the exception of phosphorus that is above the critical level (10-16mg/kg). The results shows that the soil is low in fertility and hence, the need for its restoration for optimum production.

Table 3: Physico-chemical properties of experimental soil

Parameters	Soil test value
pH (water) 1:1	6.5
Org. C (gkg^{-1})	1.5
Total N (gkg^{-1})	0.28
P Mehlich ($mgkg^{-1}$)	11.4
Exchangeable bases (c mol kg^{-1})	
K	0.3
Mg	0.7
Ca	3.7
Extractable micronutrients (cmol kg^{-1})	
Fe	53
Zn	100
Mechanical composition (cmol kg^{-1})	
Sand	852
Silt	74
Clay	74
Textural class	Sand

Effects of treatment on agronomic parameters

Application of fertilizer treatments significantly increased the pepper plant height. Organomineral fertilizer had the highest value of plant height at 15 weeks after planting though not significantly different ($p<0.05$) from the value recorded from pepper plant treated with NPK and compost. Mean plant height ranges from 52.8cm and 76.0cm. At 15 weeks after transplanting number of leaves, number of branches and flower number were highest for NPK treatment and lowest for control treatment with a significant difference ($p<0.05$). This is an indication of better nutrient release ability of NPK for pepper growth and development. Application of compost of rice at 1.5 t/ha and NPK exhibited significantly influenced the mean number of flowers over the growing period. This came as a result of improved nutrition of the treated plants, which accelerated the growth and the accumulation of biomass of the photosynthesizing organ. The results are fully agreement with the findings of Małgorzata (Berova *et al.,* 2010).

Table 4: Effects of different -fertilizer on vegetative growth of pepper at 15WAT

Treatment	Plant height (cm)	Stem girth (cm)	No of / branches plant	No of flower /plant
Control	52.7b	2.3b	40.7c	16.7c
Compost rice husk + cow dung- 1.5t /ha	59.3a	2.5ab	43.3c	34.0a
Compost rice husk + cow dung -2.5t /ha	61.7a	2.5ab	72.7b	23.7b
NPK	74.0a	3.3ab	133.0a	32.7a
OMF -1.5 t/ha	76.0a	3.4a	79.0b	19.0bc

Mean with same letter(s) along the column are not significantly different (DMRT= 0.05)

OMF- Organomineral fertilizer

Effect of fertilizer source on fruit and yield parameters

Fruit yield attributes of pepper varied significantly with different rate of fertilizer (Tables 5). Variations exist among and within treatments. NPK produced the highest number of fruit whereas control produced least. NPK fertilizer produced the higher fresh yield of pepper, but was not significantly different from compost of rice husk and cow dung at 2.5 t/ha. However, 2.5 t/ha of compost of rice husk and cow dung was significantly higher than that of fresh yield of pepper produced from 1.5 t/ha of OMF. The performance of the compost may be linked to its N content. This is in line with report from Wolkowski, 2003 and Olowoake and Adeoye, 2010 that better plant vegetative development and yield occurs, most especially when soil is amended with compost made from materials of low C: N ratio. Dry pepper fruit weight values (28.7g) was highest in compost of rice husk and cow dung at application rate 2.5 t/ha (Table 5). The dry pepper fruit weight obtained from compost of rice husk and cow dung at 2.5 t/ha was significantly different from all other treatment including the control. The dry weight values of 14.0g obtained from organomineral fertilizer might be due to low application rate which could not meet the development of pepper production. The highest dry fruit weight obtained from the compost might be related to the positive effect of compost in increasing the root surface per unit of soil volume, water-use efficiency and photosynthetic activity, which directly affects the physiological processes and utilization of carbohydrates. Similar results were obtained by Rahman *et al.* (2012) on chili.

Table 5: Effects of different -fertilizer on fruit yield of pepper at 15WAT

Treatments	Number of fruits	Fresh fruit weight (g) 6fruits/plant	Dry fruit weight (g) 6 fruits /plant
Control	12.0	8.3c	3.0d
Compost rice husk + cow dung- 1.5t /ha	24.3	20.53b	14.3c
Compost rice husk + cow dung -2.5t /ha	38.67	32.6ab	28.7a
NPK	48.3	39.0a	23.3b
OMF -1.5 t/ha	36.0	16.1b	14.0c

Mean with same letter(s) along the column are not significantly different (DMRT= 0.05)

OMF- Organomineral fertilizer

CONCLUSION

From the result of the experiment, it was shown that application of rice husk and cow dung compost at 2.5t /ha produced the best dry pepper fruits which is a more reliable yield factor than fresh fruits weight. Therefore, compost of rice husk and cow dung at 2.5t/ha could replace conventional NPK fertilizers in the cultivation of pepper (*Capsicum frutescens*), and consequently minimize environmental pollution by these inorganic compounds.

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