COMPARATIVE EFFECT OF ORGANIC FERTILIZERS ON GROWTH AND YIELD OF LONG CAYENNE PEPPER IN TWO AGRO-ECOLOGICAL ZONES OF NIGERIA

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Abstract: The objective of this study was to improve the growth and yield of long cayenne pepper using 10 organic fertilizers. Organic fertilizers including tithonia compost (TC), poultry manure from a battery cage (PMB), poultry manure from dip-litter (PMD), pacesetter organic fertilizer (POF), sunshine organic fertilizer (SOF), ayeye organic fertilizer (AOF), brewery waste (BW), cow dung (CD), oil palm bunch ash (OPBA), cocoa pod husk (CPH) were collected at some specific locations in Oyo, Osun and Ondo States of Nigeria. The experiment was a 2×11 factorial experiment fitted into a randomized complete block design consisting of 10 organic fertilizers and the control at two locations (Ibadan and Ogbomoso) in 2008. The dosage of 130 kg N ha⁻¹ of each of organic fertilizer was applied one week before transplanting. Six-week-old pepper seedlings were transplanted into a plot of 3m×2m (6m²) with one seedling per hill. Growth and yield data collected were subjected to analysis of variance (ANOVA) and the least significant difference (LSD) at p<0.05 was used to compare the means. The results of the experiment reveal that the overall macronutrient content of the ten evaluated organic fertilizer sources was presented in the following order: SOF>OPBA=CPH>AOF>TC>POF>PMB=CD>BW>PMD. All the organic fertilizers more significantly enhanced the growth and yield of pepper than the control. The best three organic fertilizers at both locations in terms of fruit length were TC=SOF=PMB. Fruit size at Ogbomoso was relatively bigger than that of Ibadan. The total fruit yield was highest under TC, SOF, PM and PMD at both locations. In conclusion, variations existed in the nutrient composition of the organic fertilizer. Meanwhile, TC, PM, PMD and SOF were significantly similar in their ability to improve pepper yield. Moreover, PMB, TC and SOF significantly enhanced the vegetative growth of pepper.

Key words: organic fertilizer, pepper, seedlings, yield and growth.

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Introduction

Pepper (*Capsicum frutescens*) is an important fruit vegetable crop commercially grown in the tropics. The crop originated in Central and South America and was first domesticated in Mexico, but later taken to Europe by the Spanish explorers and Portuguese traders. The genus *Capsicum* consists of 22 wild species and five domesticated species. Its production and consumption have steadily increased worldwide in the 20th century due to its roles as both vegetable and spice (Salter, 1985; Wien, 1997). The five domesticated capsicum species are *C. annuum*, *C. frutescens*, *C. Chinense*, *C. baccatum*, and *C. pubescens* (Bosland and Votava, 2000). Also, the species can be divided into several groups based on the number of fruits per plant, pungency, fruit color, fruit shape, intended use, flavor and plant size. Most cultivars of pepper commercially cultivated in the world belong to the *C. annuum* L. species (Smith et al., 1987; Bosland, 1992).

Pepper is produced throughout Nigeria. It is an integral part of diet and a main constituent of soups and stews consumed by the people. Its fruits are consumed fresh, dried or processed (Alegbejo et al., 1999; Gruben and Tahir, 2004). The average daily consumption of pepper by a Nigerian adult is estimated at 15g, which is higher than those of tomatoes and most other vegetables (Gruben and Tahir, 2004). Pepper requires a high level of mineral nutrients in the growing medium for effective performance. The nutrients essential for pepper include nitrogen, phosphorus and potassium which have been put at 130 kg, 160 kg and 140 kg per hectare, respectively (Gruben and Tahir, 2004). These nutrients are inherently low in the tropical soils, especially in Nigeria, but they can be improved either through bush fallow, shifting cultivation, crop rotation or by the application of organic or inorganic fertilizers.

However, the use of mineral fertilizer is costly and also has negative environmental effects. In addition, inorganic fertilizers may not replace trace mineral elements in the soil which often becomes rapidly depleted by crops. However, the nutrients in organic fertilizers are by nature released much more slowly than mineral fertilizers, hence the use of organic fertilizers makes nutrients readily available to crops at all the growth stages. Organic fertilizers from composts and other sources can be quite variable from one batch to another (Moyin-Jesu, 2008). These forms of fertilizers have been reported to improve soil structure and its long-term productivity as well as plant biodiversity and provide essential nutrients to the plant, and enhance the quality of the plant and the fruit, especially of *Capsicum annum* (Enwall et al., 2005; Alabi, 2006).

Worldwide, there is an increasing interest to use organic manures as a trail to compensate the decrease in soil fertility. The need to reduce costs of fertilizing crops has revived the use of organic fertilizers (Delate and Camberdella, 2004; Farhad et al., 2009). Organic fertilizers of various sources such as compost, animal
wastes, city wastes, domestic wastes, industrial wastes, and the like, release their nutrients for a long period of time, so they are sustainable and last longer in the soil. They are also capable of supplying nutrients through the growth periods of pepper. Therefore, it is necessary to look for alternatives, locally sourced organic materials that are inexpensive, sustainable, and that release their nutrient contents slowly and are environmentally compatible to enhance the yield and nutritional qualities of pepper.

The objective of this study was therefore to screen 10 organic fertilizer sources for nutrient contents and their effects on the growth and fruit yield of long cayenne pepper.

Materials and Methods

This study was conducted at the National Horticultural Research Institute (NIHORT) Idi-Ishin, Ibadan (7° 33´ N and 3° 56´ E; 168 m above sea level) and the Ladoke Akintola University of Technology, Ogbomoso Teaching and Research Farm, Ogbomoso (8° 10´ N and 4° 10´ E; 275 m above sea level), in 2008. Physical and chemical characteristics of the locations are described in Table 1.

Table 1. Chemical and physical characteristics of the soils of the experimental fields in Ibadan and Ogbomoso.

|                      | Ibadan | Ogbomoso |
|----------------------|--------|----------|
| pH (H2O)             | 5.9    | 5.5      |
| Organic carbon (g kg⁻¹) | 4.4    | 3.8      |
| Total N (g kg⁻¹)    | 0.3    | 0.3      |
| Available P (mg kg⁻¹) | 7.9    | 4.2      |
| Fe (mg kg⁻¹)        | 10.6   | 11.8     |
| Cu (mg kg⁻¹)        | 2.6    | 2.0      |
| Zn (mg kg⁻¹)        | 2.8    | 2.2      |
| Ex. K (cmol kg⁻¹)    | 0.2    | 0.3      |
| Ex. Na (cmol kg⁻¹)   | 0.3    | 0.3      |
| Ex. Ca (cmol kg⁻¹)   | 2.8    | 3.2      |
| Ex. Mg (cmol kg⁻¹)   | 0.6    | 0.6      |
| Ex. acidity (cmol kg⁻¹) | 0.3  | 0.4      |
| ECEC (cmol kg⁻¹)    | 4.7    | 5.0      |
| Base saturation (g kg⁻¹) | 930 | 924      |
| Sand (g kg⁻¹)       | 878    | 864      |
| Silt (g kg⁻¹)       | 110    | 122      |
| Clay (g kg⁻¹)       | 12     | 14       |

The accession of pepper (*Capsicum frutescence*) (NHV-1A) used in the study is a high yielding and early maturing type developed in NIHORT. It is adapted to different agro-ecologies in Nigeria and it is relatively tolerant to viral, bacterial,
fungal and nematode diseases. Nursery trays were filled with a sterilized sieved mixture of top soil, sand and cured poultry manure in a ratio of 2:1:1 and seeds of the pepper accession were sown in the trays and watered daily for the first 14 days, and once in two days thereafter until the time of transplanting at six weeks after sowing (WAS).

The experiment was a 2×11 factorial experiment fitted into a randomized complete block design consisting of 10 organic fertilizer sources and the control at two locations (Ibadan and Ogbomoso). The dosage of 130 kg N ha⁻¹ of each of organic fertilizer was applied one week before transplanting. Six-week-old pepper seedlings were transplanted at a spacing of 50cm × 50cm into a plot of 3m × 2m (6m²) with one seedling per hill corresponding to 40,000 plants ha⁻¹. The nutrient composition of the ten organic fertilizers collected at specified locations in Oyo, Osun and Ondo States is described in Table 2, while the description of the 10 organic fertilizers is as follows:

Table 2. Nutrient constituents of organic fertilizers.

| Organic fertilizer | N   | P   | K   | Ca  | Mg  | Na  | Fe  | Zn  | Cu  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| TC                 | 16.1| 10.4| 29.3| 21.5| 6.0 | 8.6 | 6.7 | 129.0| 29.5|
| PMB                | 15.3| 37.6| 10.6| 20.9| 2.9 | 6.1 | 14.6| 180.5| 38.5|
| PMD                | 14.1| 22.9| 20.9| 9.5 | 4.1 |    | 10.5| 120.5| 36.5|
| POF                | 12.0| 45.0| 38.0| 25.8| 5.2 | 4.6 | 6.2 | 118.0| 34.0|
| SOF                | 36.0| 50.0| 30.3| 45.6| 3.0 | 2.1 | 11.4| -   | -   |
| AOF                | 3.5 | 37.8| 26.1| 22.0| 8.0 | 5.6 | 8.5 | 110.0| -   |
| BW                 | 7.8 | 76.0| 7.9 | 1.3 | 3.1 | 5.7 | 7.8 | 140.0| 22.5|
| CD                 | 5.0 | 28.0| 24.0| 18.5| 6.4 | 8.4 | -   | -   | -   |
| OPBA               | 7.6 | 110.2| 15.3| 24.1| 9.1 | 4.8 | 12.4| 110.0| 16.8|
| CPH                | 7.8 | 95.1| 11.1| 21.7| 8.4 | 5.4 | 8.6 | 134.2| 42.4|

Note: TC = Tithonia compost, PMB = Poultry manure from a battery cage, PMD = Poultry manure from dip-litter, POF = Pacsetsker organic fertilizer, SOF = Sunshine organic fertilizer, AOF = Ayeye organic fertilizer, BW = Brewery waste, CD = Cow dung, OPBA = Oil palm bunch ash, CPH = Cocoa pod husk.

Tithonia compost (TC) was prepared in NIHORT with Tithonia as the major component mixed with poultry manure at the ratio of 3:1 (Tithonia: poultry manure) on a dry weight basis (Akanbi, 2002; Adediran et al., 2003).

Poultry manure from a battery cage (PMB) was poultry layers’ droppings collected from a battery cage at the Institute of Agricultural Research and Training (IAR&T), Research Farm, Moor Plantation, Ibadan in Ido Local Government Area of Oyo State.

Poultry manure from dip-litter (PMD) was poultry manure droppings collected from the poultry unit of ZARTECH farms at Gbekuba Area, Apata, Ibadan in Ido Local Government Area of Oyo State.
Comparative effect of organic fertilizers on growth and yield of long cayenne pepper

Pacesetter organic fertilizer (POF) is a product of the Oyo State organic fertilizer plant located at the Bodija cow market, Ibadan, Ibadan North Local Government Area of Oyo State. Market wastes (remnants of vegetables and food stuffs) and animal dung were the major components of this organic material.

Sunshine organic fertilizer (SOF) was collected from the Ondo State organic fertilizer factory at Igbatoro Estate, Akure in Akure South Local Government Area of Ondo State. It was produced from the combination of industrial, city and market wastes.

Ayeye organic fertilizer (AOF) was obtained from the Ayeye fertilizer factory located at Ayeye area, Ibadan, Ibadan North East Local Government Area of Oyo state. The major raw material was urban wastes.

Brewery waste (BW) was collected from the Nigerian Breweries factory, Alakia, Ibadan, Ibadan North West Local Government Area of Oyo State.

Cow dung (CD) was collected from the Akinyele cow market situated at Akinyele Local Government Area, Oyo State.

Oil palm bunch ash (OPBA) was collected at Ajagba village in Iwo Local Government Area of Osun state.

Cocoa pod husk (CPH). Dried cocoa pods were collected from the Cocoa Research Institute of Nigeria (CRIN), Idi-Ayunre, Oluyole Local Government Area of Oyo state.

Data on plant height, number of branches, number of leaves and leaf area (Salau et al., 2008), fruit length, fruit diameter, plant dry weight and fruit yield were taken from five randomly selected plants per plot. Fruit yield was determined by harvesting and weighing fruits from the five randomly sampled plants twice a week for five weeks, then total fruit weight was determined and average weight per plant was calculated and multiplied by plant population per hectare to get fruit yield in tons per hectare. The data collected were subjected to analysis of variance (ANOVA) and the least significant difference (LSD) at p<0.05 was used to compare the means.

Results and Discussion

Organic fertilizers from different sources significantly affected pepper height. Plants grown with TC, SOF, PMD, PMB and CPH were significantly taller than plants grown with other organic fertilizers. All the organic fertilizers produced plants that were significantly better than the NOF (control). Pepper responded positively to the applied organic fertilizers at both locations in a similar way. Meanwhile, pepper was significantly taller at Ogbomoso than at Ibadan. Significant variation also existed in the number of branches produced by the pepper plant in response to the applied organic fertilizer within and across locations. Pepper produced more branches at Ogbomoso than at Ibadan. All the organic fertilizer
sources at both locations were significantly better than the control. The top five fertilizers at Ibadan in terms of the number of branches included PMB (14.43), TC (13.25), BW (12.00), CD (15.17) and SOF (13.90). In addition, a similar result was obtained at Ogbomoso with PMB (17.84), TC (16.69), BW (15.59), CD (15.17) and SOF (13.90), being the best five fertilizers. Significant differences existed in the response of pepper to organic fertilizers at locations in terms of the number of leaves, and all the organic fertilizers produced plants that were significantly better than the control. The top five sources at Ibadan were TC (226.28), BW (215.06), SOF (214.91), PMB (207.11) and CD (182.04), whereas at Ogbomoso the best five were TC (237.88), SOF (226.51), BW (226.49) and PMB (218.60). At both locations, the leaf area of pepper in response to organic fertilizer was similar. Plants treated with organic fertilizers had significantly higher leaf area than the control (Table 3).

Table 3. Effects of organic fertilizers on the vegetative growth of long cayenne pepper in Ibadan and Ogbomoso.

| Organic fertilizer | Plant height (cm) | Number of branches | Number of leaves | Leaf area (cm²) |
|--------------------|-------------------|--------------------|-----------------|----------------|
|                    | Ibadan            | Ogbomoso           | Ibadan          | Ogbomoso       |
| TC                 | 80.89             | 87.01              | 13.25           | 16.69          | 226.28          | 237.88          | 1587.44        | 1610.96        |
| SOF                | 81.39             | 87.54              | 10.49           | 12.97          | 214.91          | 226.51          | 1645.13        | 1670.26        |
| PMD                | 79.25             | 85.52              | 9.53            | 12.97          | 170.04          | 181.34          | 901.06         | 925.83         |
| PMB                | 79.50             | 85.89              | 9.53            | 12.97          | 174.11          | 185.22          | 1223.30        | 1247.71        |
| CPH                | 72.55             | 78.70              | 11.58           | 15.17          | 182.04          | 193.64          | 1265.83        | 1290.81        |
| CD                 | 70.74             | 76.80              | 12.00           | 15.59          | 215.06          | 226.49          | 1279.32        | 1310.90        |
| POF                | 67.40             | 69.28              | 9.44            | 12.97          | 174.11          | 184.69          | 1169.28        | 1194.59        |
| BW                 | 63.31             | 69.28              | 10.00           | 13.71          | 174.11          | 184.69          | 1169.28        | 1194.59        |
| NOF                | 53.04             | 59.13              | 5.77            | 9.24           | 132.00          | 143.78          | 1169.28        | 1194.59        |
| L.S.D₀.₀₅         | 5.05              | 5.09               | 1.57            | 1.66           | 6.37            | 6.44            | 14.9           | 20.89          |

Note: TC = Tithonia compost, PMB = Poultry manure from a battery cage, PMD = Poultry manure from dip-litter, POF = Pacesetter organic fertilizer, SOF = Sunshine organic fertilizer, AOF = Ayeye organic fertilizer, BW = Brewery waste, CD = Cow dung, OPBA = Oil palm bunch ash, CPH = Cocoa pod husk, NOF = No organic fertilizer.

Organic fertilizer sources significantly influenced the fruit length of pepper at both locations. Plants treated with organic fertilizers produced significantly longer fruits than the control. This may be due to the fact that they act as a substrate for soil microorganisms, which leads to increased microbial activity, thereby increasing the rate of organic material decomposition and release of nutrients for plant uptake (Nasef et al., 2004; Palada et al., 2004; Khalid and Shafei, 2005).
best three organic fertilizer sources at both locations in terms of fruit length were TC, SOF and PMB (Table 4). At both locations, fruits of plants treated with organic fertilizer were significantly bigger than the control. The best three organic fertilizer sources in terms of fruit size include SOF (3.53cm) = TC (3.07cm) > BW (3.77 cm) (Table 4).

Table 4. Effects of organic fertilizers on yield components of long cayenne pepper in Ibadan and Ogbomoso.

| Organic fertilizer source | Fruit length (cm) | Fruit diameter (cm) | Plant dry matter (g/plant) |
|---------------------------|-------------------|---------------------|----------------------------|
|                           | Ibadan | Ogbomoso | Ibadan | Ogbomoso | Ibadan | Ogbomoso |
| TC                        | 13.07 | 16.55 | 3.07 | 4.29 | 1.58 | 2.17 |
| SOF                       | 12.26 | 15.71 | 3.53 | 4.69 | 2.15 | 2.76 |
| PMB                       | 8.29 | 11.74 | 2.09 | 3.31 | 1.20 | 1.87 |
| PMD                       | 12.24 | 15.45 | 2.31 | 3.50 | 1.58 | 2.22 |
| CPH                       | 8.11 | 11.50 | 2.53 | 3.66 | 2.18 | 2.73 |
| CD                        | 8.26 | 11.74 | 2.00 | 3.28 | 1.39 | 1.91 |
| POF                       | 8.06 | 11.42 | 1.80 | 3.13 | 1.22 | 1.83 |
| BW                        | 7.28 | 10.79 | 2.25 | 3.77 | 1.37 | 1.83 |
| AOF                       | 9.06 | 12.42 | 2.17 | 3.39 | 1.60 | 2.21 |
| OPBA                      | 7.11 | 10.59 | 2.33 | 3.67 | 1.20 | 1.75 |
| NOF                       | 6.22 | 9.73 | 2.50 | 3.72 | 1.28 | 1.80 |
| L.S.D0.05                 | 1.74 | 1.77 | 0.56 | 0.57 | 0.24 | 0.26 |

Note: TC = Tithonia compost, PMB = Poultry manure from a battery cage, PMD = Poultry manure from dip-litter, POF = Pacesetter organic fertilizer, SOF = Sunshine organic fertilizer, AOF = Ayeye organic fertilizer, BW = Brewery waste, CD = Cow dung, OPBA = Oil palm bunch ash, CPH = Cocoa pod husk, NOF = No organic fertilizer.

The total fruit yield/ha was highest under TC, SOF, PMB and PMD at both locations (Figure 1). The composition of any organic fertilizer is a function of the source, location and the materials from which they are made. Variations existed in nutrient compositions of organic fertilizers used because they were made from various materials. TC, PMB, PMD and SOF were significantly similar in their ability to improve pepper fruit production basically due to their composition. Pepper planted performed differently in response to the applied organic manure because the nutrient content of different organic fertilizer types differed. The level of the content may vary in the same quantity of different fertilizer types. Adetiloye et al. (1985) and Titiloye et al. (1985) have also reported that organic fertilizers vary with materials from which they are composted. The PMD, though was significantly similar in enhancing pepper growth and yield, did not have as many N constituents as TC, PMB and SOF.
Figure 1. Effects of ten organic fertilizers on fruit yield of long cayenne pepper.

TC = Tithonia compost, PM = Poultry manure from a battery cage, DPM = Poultry manure from dip-litter, POF = Pacesetter organic fertilizer, SOF = Sunshine organic fertilizer, AOF = Ayeye organic fertilizer, BW = Brewery waste, CD = Cow dung, OPBA = Oil palm bunch ash, CPH = Cocoa pod husk, NOF = No organic fertilizer.

Conclusion

From this study, it could be concluded that different organic fertilizer sources were found to vary in macro and micro nutrients. TC, PMB, PMD and SOF were significantly similar in their ability to improve pepper yield, but TC, PMB and SOF could be selected based on their relatively higher N content.

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UTICAJ ORGANSKIH ĐUBRIVA NA RAST I PRINOS DUGAČKE KAJENSKE PAPRIKE U DVEMA AGROEKOLOŠKIM ZONAMA NIGERIJE

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R e z i m e

Cilj ovog istraživanja bio je da se poboljša rast i prinos dugačke kajenske paprike upotrebom deset organskih đubriva. Organska đubriva uključujući “titonski kompost” (TC), živinski stajnjak iz kaveznog uzgoja (PMB), živinski stajnjak sa prostirkom (PMD), ostaci povrća i hrane + živinski stajnjak (POF), komercijalno organsko đubrivo nastalo kombinacijom industrijskog, gradskog i pijačnog organskog otpada, (SOF), komercijalno đubrivo od gradskog otpada (AOF), otpad iz pivara (BW), kravlju balegu (CD), pepeo od ostataka isceđenih plodova uljane palme (OPBA), ljsku od plodova kakaoa (CPH) sakupljena su na određenim lokalitetima u državama Ojo, Osun i Ondo u Nigeriji. Ogled je postavljen 2008. godine po potpuno slučajnom blok sistemu, kao dvofaktorijalni, gde je uključeno deset organskih đubriva i kontrola i koja su ispitivana na dva lokaliteta (2x11) Ibadan i Ógbomoso. Doza od 130 kg N ha-1 svakog organskog đubriva primjenjena je jednu nedelju pre rasadivanja. Šestonedelni rasad paprike rasaden je na parcelu dimenzije 3×2 m (6 m2) sa po jednom biljkom po kući. Prikupljeni podaci o rastu i prinosu obrađeni su analizom varijanse (ANOVA), a najmanja značajna razlika (LSD) pri nivou p<0,05 korištena je kako bi se uporedile srednje vrednosti. Rezultati ogleda pokazuju da je ukupan sadržaj osnovnih hranljivih elemenata deset ispitivanih organskih đubriva imao sledeći raspored: SOF > OPBA = CPH > AOF > TC > PMF > PMB = CD > BW > PMD. Sva organska đubriva značajno su povećala rast i prinos paprike u odnosu na kontrolni tretman. Tri najbolja organska đubriva na dva lokaliteta u pogledu dužine ploda bila su TC = SOF = PM. Veličina ploda na lokalitetu Ógbomoso bila je relativno veća nego na lokalitetu Ibadanu. Ukupan prinos ploda bio je najviši u tretmanima sa TC, SOF, PM i PMD na obe lokalitete. Na kraju, varijacije su postojele u sastavu hranljivih elemenata organskog đubriva. U isto vreme đubriva TC, PMB, PMD i SOF su bila značajno slična po svojoj sposobnosti da poboljšaju prinos paprike. Pored toga đubriva PMB, TC i SOF značajno su uticala na vegetativni porast paprike.

Ključne reči: organsko đubrivo, paprika, rasad, prinos i rast.

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