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Full Length Research Paper

Growth and yield responses of ginger (*Zingiber officinale*) to three sources of organic manures in a typical rainforest zone, Nigeria

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A field study was carried out in the 2011/2012 cropping seasons at the Teaching and Research, Farms of the Delta State University, Asaba Campus, Asaba, a typical rainforest zone in Nigeria. The aim was to evaluate the responses of ginger to three sources of organic manures namely; cow-dung manure, poultry manure and pig manure at the rate of 20 t/ha. The experiment was a randomized complete block design with three replicates. Growth and yield parameters of ginger were taken at the 4, 6, 8, 10, 12 and 14 weeks after planting (WAP), while fresh weight was taken at 16th week after planting (WAP). The growth parameters observed were plant height, number of leaves, leaf area and number of tillers. Data collected were subjected to analysis of variance (ANOVA) and significantly different means in the F-test were separated using the Least Significant Difference (LSD) at 5% level of probability. Results showed significant increase in plant height, number of leaves and leaf area at the 6th to 12th WAP compared to the control. Growth parameters were not significantly different (P > 0.05) at the 4th WAP. Plots treated with poultry manure produced the highest plant height of 12.67 cm, highest number of leaves of 14.87 and leaf area of 231.8. This was followed by pig manure with values of 12.12, 14.25 and 222.5 cm. The least mean values of 7.14, 12.58 and 210.5 cm were obtained from the control. The general results indicated that organic manures in the forms of cow dung, poultry and pig manures have great tendency to increase growth characters and yield of ginger in a rainforest zone, Nigeria.

Key words: Growth and yield responses, ginger, organic manures rainforest zone, Nigeria.

INTRODUCTION

Ginger is the rhizome of the plant *Zingiber officinale* that is well consumed as a delicacy, medicine and spices. It is a perennial reed-like plant with annual leafy stems that is about a meter (3 to 4 feet) tall. The plant is usually propagated vegetatively by planting rhizome pieces which produce clusters of white and pink flower buds that bloom into yellow flowers. The mature roots of ginger are fibrous and the juice from old ginger roots is extremely potent and often used as spices and a quintessential ingredient of Chinese, Korea, Japanese and many South Asian cuisines for flavouring dishes (Jakes, 2007). It is also used largely as recipes such as ginger bread, cookies, crackers, cakes, ginger-ale and ginger beer (Asumugha et al., 2006; Jakes, 2007). The medicinal values of these great ancient spices are widely recognized across the continents to contain a number of unique organic phytochemical ingredients that can take care of some human ailments. Recent studies on health

related effects of ginger which have also stimulated farmers concern on the growth of the plant have shown the efficacy of the plant in some life challenging ailments such as entero toxin induced diarrhea, diabetic nephropathy, nausea, plasma antioxidant, vomiting, high cholesterol, high blood pressure and inflammation (Chen et al., 2007; Ernest and Pittler, 2008; Kim et al., 2008).

Like any other plant, ginger requires the right kind of nutrients to sustain its growth and maximum yield especially in the humid environment where rainfall is high and nutrient reserves are low due to leaching, and erosion effects. Plant nutrients usually supplied by the soil in most Sub-Saharan environment are often inadequate and sometimes in plant unavailable form hence, they need to be augmented with other sources that are cheap and environmentally friendly. The use of organic manures is one technology that have been exploited overtime and across ages because of its ability to restore soil fertility, supply major plant nutrients, such as N. P. K., Ca, Mg and also stabilizer soil pH (Sanchez and Miller, 1986). Increase in soil chemical properties which are quite essential in crop growth and yield have also been associated with organic manures (Adetunji, 1990). Organic manures however are without their limitations. These include inadequate availability, transportation an handling problems, slow nutrient release, high C:N ratio and sometimes heavy metal pollution (Ayeni et al., 2010). Now that emphasizes are gradually shifting to organic agriculture to maintain soil productivity and limit the use of synthetic fertilizers some of which have contributed to the changing climate, the objective of this study therefore was to evaluate the responses of three sources of organic manures to the growth and yield of ginger in a typical rain forest zone where the crop is aptly grown.

MATERIALS AND METHODS

Description of the study area

The study was conducted at the Teaching and Research Farms of the Faculty of Agriculture, Delta State University, Asaba during the 2011/12 cropping seasons. The experimental area is located within latitude 06° 14'N and longitude 06° 49'E of the equator, and lies significantly in the tropical rainforest zone with over 1,650 mm of rainfall per annum. The rainfall is bimodal in character with peaks in July and September. The mean temperature is about 37.3°C**;** and a relative humidity of a bout 73.2%. The land area is relatively flat and influenced seriously by seasonal flooding due to 'its proximity to River Niger that naturally demarcated Delta and Anambra States by the Eastern axis. By nature of its geomorphological settings, the study area overlies the ancient metamorphic crystalline basement complex formation which are considerably more acid than base. They are generally gneisses and pegmatites that gave rise to coarse-textured soils that are deficient in dark ferro-magnesian minerals (Egbuchua, 2012). Land use in the study area is virtually based on rain-fed agriculture and the natural vegetation is typically of rainforest but have been reduced to derived savanna due to repeated clearing and cultivation over the years.

Field work

An experimental plot measuring 13 × 6 m was selected for the study. The plot was manually cleared, ploughed and made into 16 beds of 2 × 2 m dimensions. From each bed, composite soil samples were collected for pre-planting soil analysis. The treatments which consisted of cow dung manure, poultry manure and pig manure were applied two weeks before planting using incorporation method. The rate of application across board was 20 t/ha $^{-1}$ Seed pieces of ginger rhizomes were cut to contain at least two buds and weighing about 10 g. Each was planted on the beds at a spacing of 20 × 20 cm at a depth of 5 cm. The planted rhizomes were carefully covered with sand and stubble mulch materials. Watering and weeding were done at intervals. Three weeks after planting, KARATE 2.5 EC was sprayed at the rate of 500 ml/ha to control insect pests. The experimental layout was a randomized complete block design (RCBD) with 3 replicates.

Pre-planting soil analysis

The pre-planting soil analysis was carried out in the Faculty of Agriculture Standard Laboratory Anwai Campus. The most important physico-chemical properties of the soil samples evaluated were: The particle size distribution using hydrometer method as described by Gee and Bauder (1986). The pH was determined in a 1:1 soil/water suspension using digital pH metre. Organic carbon was determined by Walkley-Black dichromate wet-oxidation method (Nelson and Sommers, 1982). Total nitrogen was by micro-kjeldahl distillation technique as described by Bremmer and Mulvaney (1982). Available phosphorus was determined by Bray No 1 method as described by IITA (1982). Cation Exchange Capacity (CEC) was determined by I N NH_4AC method (Rhoades, 1982). The chemical contents of the organic manures used in the study were also routinely analysed using appropriate methods.

Data collection

The growth parameters were determined at 4, 6, 8, 10 12 and 14 weeks after planting (WAP). The parameters essentially determined were; plant height which was measured from the base of the plant to the apex using measuring tape. Number of leaves per 10 randomly selected beds was measured by counting manually. Leaf area was determined by taking the leaf area per plant, and substituting the number of leaves of each plant by the length and width of the middle leaf. Number of tillers was taken from four plants tagged at the middle of each bed by counting at 14 weeks after planting (WAP). Fresh weight of harvested ginger was done at 16 weeks after planting (WAP) using sensitive balance.

Data analysis

Data collected were subjected to analysis of variance (ANOVA). The significantly different means in the F-test were separated using the Least Significant difference at 5% level of probability.

RESULTS

Initial pre-planting soil analysis

The results of the initial soil analysis is shown in Table 1. The textural class of the soil showed that it was

Table 1. Pre planting soil analysis of the study area.

Soil properties	Values
Particle size distribution (%)	-
Sand	83.70
Silt	12.00
Clay	4.30
pH (H_20)	5.5
Organic carbon (gkg^{-1})	15.6
Total nitrogen (gkg^{-1})	1.16
Available phosphorus ($mgkg^{-1}$)	4.35
Cation exchange capacity ($cmolkg^{-1}$)	6.75
Textural class	Loamy sand

Table 2. Chemical properties of the organic manures used for the study.

Characteristics	Organic sources/values obtained		
	CDM	PM	PgM
N (%)	1.06	2.57	1.67
P (%)	0.52	3.08	2.36
K (%)	0.97	2.47	0.75
Ca (%)	1.07	12.68	3.83
Mg (%)	0.88	0.93	0.54
Fe ($mgkg^{-1}$)	572	1756	1691
Mn ($mgkg^{-1}$)	344	573	505
Zn ($mgkg^{-1}$)	123	722	623
Cu ($mgkg^{-1}$)	22	82	510

CDM = Cowdung manure; PM = poultry manure; PgM = pig manure.

sandyloam in texture. The soil pH was strongly acidic with a pH of 5.5. The organic carbon (15.6 gkg^{-1}), total nitrogen (1.16 gkg^{-1}); available phosphorus (4.35 $mgkg^{-1}$) and cation exchange capacity (6.75 $cmolkg^{-1}$) were all seemingly low depicting the low fertility status of the study area.

Chemical content of the organic manures

The analytical values of the chemical content of the organic sources used as treatments are shown in Table 2. The results showed that the three organic sources were high in major macro and micronutrients that can support growth and increase yield of crops.

Morphological growth characters

Plant height

There was a significant effect in the shoot height of ginger as affected by different sources of organic manures. Plant height was found to be progressively increased with the treatment compared to the control (Table 3). The increase in plant heights were most obvious from the 8^{th} week after plant where a significant effect was observed. Plant height got to its highest peak of 12.67 cm with poultry manure treatment. The least value of 7.14 was obtained with the control.

Number of leaves

The effects of treatments on the number of leaves (Table 4) showed that treatment also produced significant highest number of leaves than the control at 14 weeks after planting (WAP). The highest number leaves (14.87) were obtained with the application of poultry manures. This was followed by pig manure (14.25) and cow dung manure (13.22). The control experiment recorded the least value of 12.58.

Leaf area

Leaf area of plants treated with organic manures was not

Table 3. Effects of three sources of organic manures on plant height of ginger (cm).

Treatment (20 t/ha^{-1})	Weeks after planting (WAP)					
	4	6	8	10	12	14
Control (O)	4.55	5.12	6.03	6.32	7.05	7.14
Cow dung manure	4.58	6.65	8.20	9.74	10.23	11.75
Poultry manure	4.59	6.93	8.75	10.78	11.13	12.67
Pig manure	4.59	6.73	8.55	10.17	10.87	12.12
F - LSD (0.05)	NS	NS	0.75	0.91	1.08	0.58

Table 4. Effects of three sources of organic manures on number of leaves of ginger.

Treatment (20 t/ha^{-1})	Weeks after planting (WAP)					
	4	6	8	10	12	14
Control (O)	3.0	4.41	6.02	8.21	10.34	12.58
Cow dung manure	3.0	4.45	6.04	9.33	11.23	13.22
Poultry manure	3.0	4.48	7.13	10.13	13.76	14.87
Pig manure	3.0	4.47	6.82	9.85	12.38	14.25
F - LSD (0.05)	NS	NS	6.02	0.27	0.01	0.05

Table 5. Effects of three sources of organic manures on leaf area of ginger.

Treatment (20 t/ha^{-1})	Weeks after planting (WAP)					
	4	6	8	10	12	14
Control (O)	153.2	155.2	197.5	202.7	210.3	210.5
Cow dung manure	153.4	155.3	210.3	215.8	218.4	218.7
Poultry manure	153.7	155.7	215.8	222.7	231.7	231.8
Pig manure	153.5	155.5	214.4	219.5	222.4	222.5
F - LSD (0.05)	NS	NS	32.75	29.48	32.72	32.74

statistically different ($P < 0.05$) at the 4^{h} and 6 WAP (Table 5). However, progressive increase in total leaf area was observed as from the 8 week up to the 14th week after planting. The highest value of 231.8 was obtained with the application of poultry manure, followed by pig manure (222.5) and the least of value 210.5 was in the control experiment.

Number of tillers

Irrespective of treatment applied, the number of tillers were not significantly different ($P < 0.05$) at 14^{t}, WAP (Table 6). The best tillers of 2.8 was obtained with the application of poultry manure while the least (1.3) was in the control experiment.

Fresh weight

The fresh weight of harvested ginger (Table 7) at 16 WAP produced significantly highest yield of 114.7 kg/ha with the application of poultry manure. The control treatment had the least yield of 10.7 kg/ha.

DISCUSSION

The efficacy of organic manures in promoting crop growth and yield components have been variously studied and reported. Hsieh and Hsieh (1990) has reported high nutrient contents of cowdung, pig and poultry manures which are capable of improving soil quality and increase yield of cultivated crops. Adetunji (2004) has reported reasonable high content of nitrogen, potassium and organic carbon in cow dung manure; high content of copper micro nutrient and lower content of fibrous material in pig manure, and very high content of N.P.K, Ca and micro nutrients in poultry-based manure. The high contents of these macro and micro nutrients have the capacity to improve morphological characters and yield of cultivated crops. Organic

Table 6. Effects of three sources of organic manures on the number of tillers at 14 WAP.

Treatment (20 t/ha^{-1})	Weeks after planting (WAP)
Control (O)	1.3
Cow dung manure	2.3
Poultry manure	2.8
Pig manure	2.5
F - LSD (0.05)	0.06

Table 7. Effects of three sources of organic manures on fresh weight of ginger at 16 WAP.

Treatment (20 t/ha^{-1})	Weeks after planting (WAP)
Control (O)	10.7
Cow dung manure	11.2
Poultry manure	14.7
Pig manure	12.3
F - LSD (0.05)	0.6

manures also have strong tendency to neutralize soil acidity, raise soil buffering capacity and provide micro nutrients such as Zn, B, Cu and Fe that can influence crop production positively.

In this study, most ginger morphological characters such as plant heights, number of leaves, leaf area were significantly ($P \leq 0.05$) increased with the application of the treatments compared to the control experiment where no treatment was applied. The delay in observing significant effects especially at the 4th week after planting (WAP) could be attributed to low rate of initial decay which is controlled by the C: N ratio and lignin contents of the organic sources. The improvement of ginger growth over the control experiment could be vividly explained by the various nutrient contents of the organic manures. For instance, the chemical quality of poultry manure used as treatment showed high contents of organic carbon (176%), total nitrogen (19.2%), phosphorus (28.7%), potassium (2.46%) calcium (21.0%) and magnesium 3.52% coupled with adequate levels of micro nutrients. Hence, poultry manure gave the best performance in terms of growth parameters and yield indices. Similar studies by Hsieh and Hsieh (1990) and Ojeniyi (2011) showed the potency of poultry manure in improving crop quality, quantity and yield when incorporated into cultivated soil. Ayeni et al. (2010) have equally reported that organic manures when properly used have proven to be very efficient in increasing soil nutrient contents, ensuring positive residual effects and enhancing soil's physico-chemical properties.

Although, the quality of any organic manure is very difficult to quantify due to differences in the quality of the sources. The results of the study showed that poultry manure was the most impressive on the growth and yield parameters evaluated. This was followed by pig manure and cow dung manure. All the organic manure sources proved better than the control experiment in all the parameters evaluated . This could be attributed to the various nutrient contents of the organic manures.

Conclusion

The cultivation of ginger in recent years especially in the rainforest zone of Nigeria is at the increase. This is because of high demand of the rhizomes not only as dietary spices but in tackling some ailments of great worries to humanity. These include high blood pressure, high cholesterol level, insomania and various nausea conditions. The general belief in this part of the World is that ginger has the potency of either reducing or eliminating these ailments and as such its consumption is on the increase. Results of the study showed the efficiency of organic manures in ginger production in all aspects of growth and yield parameters evaluated. Although, the use of organic manures is associated with such problems as slow in nutrient release, high C:N ratio and pollution problem. However, its uses will somehow minimize total reliance on mineral fertilizers which are not only too costly for poor resource farmers to acquire, but are associated with problems relating to soil acidity, nutrient inbalance, inadequate supply of macro and micro nutrients and ineffectiveness due to the blanket method of application.

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