International Journal of Forestry and Horticulture (IJFH)
Volume 4, Issue 2, 2018, PP 7-13
ISSN No. (Online) 2454–9487
DOI: http://dx.doi.org/10.20431/2454-9487.0402002
www.arcjournals.org

Effect of Potting Mixtures on Germination, Growth and Yield of Ginger (*Zingiber Officinale*) in Anyigba

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Abstract: *A pot experiment was conducted at the nursery section of the Department of Crop Production, Faculty of Agriculture, Kogi State University, Anyigba to evaluate the effect of potting mixture on germination, growth and yield of Ginger (Zingiber officinale) in Anyigba. The experimental design used was Completely Randomized Design (CRD) with four treatments that is cow dung (CD), poultry manure (PM), sawdust (SD) and the control (CT). Each treatment was replicated six times. The parameters measured were the days of sprouting, number of leaves, leaf area, stem girth, plant height, rhizome size and fresh yield weight. The result shows that the pots treated with poultry manure gave the best performance in all the parameters except the days to sprouting where the pots treated with sawdust sprouted 13 days after planting, followed by control (20 days), poultry manure (22 days), and cow dung (24 days) respectively.*

1. Introduction

Ginger (*Zingiber officinale*) is an herbaceous perennial plant belonging to the order *Scitamineae* and the family *Zingiberaceae*. It is a root crop and a typical herb extensively grown across the world for its pungent aromatic under-ground stem or rhizome which makes it an important export commodity in world trade (NEPC, 1999; Erinle, 1989; Ajibade and Dauda, 2005). Ginger's origin is not well established, though it is generally thought to be a native of Asia, where it was first cultivated. It was also cultivated in the tropical regions of America. Ginger was introduced to Europe by Arab traders from Indian the first century AD. The Arabs also took the plant from India to East Africa in the thirteenth century while the Portuguese took it to West Africa and other part of the tropics in the sixteen century. Ginger was introduced to Nigeria in 1927, Ginger cultivation commenced in Nigeria in 1927 and the locations include southern Zaria, Jamma, Federation district and neighboring parts of plateau. Today ginger is cultivated nationwide, (Okwuow-ulu, 1997). The spice was known in Germany and France in the ninth century and had become common in trade as pepper by the thirteenth century. The plant is now cultivated in different parts of Nigeria, though the major producing areas include Kaduna, Nassarawa, Sokoto, Zamfara, AkwaIbom, Oyo, Abia and Lagos states although southern Kaduna still remain the largest producers of fresh ginger in Nigeria particularly in Kachia, Jabba, Jama'a and Kagarko Local Government Areas (KADP, 2000, KADP, 2004; Bernard, 2008). The varieties produced in Nigeria are 'Taffin Giwa' and 'Yatsun Biri' which is higher in monoterpene and oil, giving a more pungent aroma and pungency. Therefore it is usually preferred for the production of oils and oleoresins (KADP, 2000; ITC, 2007, Chukwu and Emehuite, 2003). Nigeria ranked first in terms of the percentage of total hectares of ginger under cultivation but her contribution to total world output is too low compared to other countries. This can be attributed to the fact that most of production is undertaken by smallholder and traditional farmers with rudimentary production techniques and low yields. In addition, the smallholder farmers are constrained by many problems like the farmers do not see it as a business enterprise, therefore are not adequately focused on profit maximizing motive (FMA, 1993). Therefore, Emmanuel (2008) opined that Nigeria has the potential to expand production in a medium to long-term investment strategy that can develop into self-sufficient industry (FAO, 2010). Efficiency measurement is useful in determining the magnitude of the gains that could be achieved by adopting improved production technology. Efficiency in resource allocation has a far-reaching impact on the observed farm output level. The presence of shortfall in efficiency means that output can be increased without using additional conventional inputs and new technology. (Zhu, 2000; Tauer, 2001; Rahman *et al.*, 2002). Farmers possess the potential to achieve both technical and allocative efficiency in farm enterprises but inefficiency may arise due to a variety of factors some of which are beyond the control of the farmers (Ogunniyi, 2008; Rahman *et al.*, 2002). In addition, inefficiency in production on the part of the farmers has variously been implicated as forces militating against ginger production. Factors such as technical knowledge constrained increased food supply, export and poverty reduction. This may be attributed to high inefficiencies because farmers lack access to information on efficiency, and low literacy levels limiting interpretation of such information to guide them in commercial production. Several efforts have been made to improve ginger production in Nigeria since 1988; however there has been high fluctuation of output. The increase experienced since then is too low to make a meaningful change in the income and standard of living of the farmers (FAO, 2010). While several researches have been concentrating on some of the immediate causes of low output, it seems that deeper issues and causes have not been discussed. It is therefore important to examine the profitability of ginger production and the various production techniques in other to proffer solution on how it could be improved through efficient use of available resources (FAO, 2010). Ginger of commerce is the dried rhizome and it is marketed in different forms such as raw ginger, dry ginger, bleached dry ginger, ginger powder, ginger oil, ginger oleoresin, ginger candy, ginger beer, brined ginger, ginger wine, ginger squash, ginger flakes etc.

Ginger is an herb that, once planted, grows year after year. Each year, it bears parts called hands in the soil. Hands put out branches (fingers) which sprout shoots as they grow out. Leaves make food and store it in hands. As days get shorter, leaves dry down naturally and hands reach mature size. The next year, these new hands sprout (rationing) and the plant spread further.

2. MATERIALS AND METHOD

2.1. Experimental Location

The experiment was carried out at the nursery section of the Department of Crop Production, Faculty of Agriculture, and Kogi State University Anyigba. It is located on latitude 7^0 8^IN and longitude 6^0 43^IN which is situated on the southern guinea savannah on the Agricultural zone of Nigeria. Kogi has a bimodal rainfall with the peak pattern occurring in July and September the mean annual rainfall ranges from 1,560 mm at Kabba in the west to 1,808 mm at Anyigba in the east (Sale *et al.,* 2015). The temperature varies throughout the year with average monthly temperature from 17^0c to 36.2^0c with moderately high humidity varying from an average of 65-85% throughout the year (Sale *et al.*, 2015).

2.2. Treatment and Experimental Design

This experiment was carried out using a Completely Randomized Design (CRD) involving four (4) treatment and six (6) replications, i.e. cow dung, sawdust, poultry manure and control. The experiment was conducted using 24 pots (plastic buckets).

2.3. Soil and Manure Analysis

Soil samples were collected randomly from depth of 0-30 cm across the experimental site. The soil sample were thoroughly mixed, air dried and sieved then later analyzed for physiochemical properties, soil particle size analysis was determined by a hydrometer method, and the textural class determined using textural triangle. Total nitrogen was determined by kjeldahl digestion.

Organic carbon was analyzed, Available phosphorus was extracted by Bray no. 1 method.

Exchangeable bases were also determined in neutral NH_4OAC extract by atomic adsorption for calcium, potassium and cation exchangeable capacity was estimated by summation.

2.4. Organic Manure Analysis

Manure samples were also taken and weighed before applying to the soil. Organic manure was analyzed for Nitrogen using micro Kjeldahl digestion method. Ground samples were digested using nitric-perchloric acid mixture for determination of phosphorus and potassium. The phosphorus content was determined using molybdenum blue colorimetric, while potassium content was determined by flame photometer. Brady (1990) establishes the relationship of the soil aggregate stability to its organic manure.

Table1. *Various Kinds of Organic Manure and their Nutrient Component (%)*

Sample Code	N%	P%	K%
Cow Dung	1.55	1.92	1.06
Poultry Manure	3.13	2.71	1.86
Saw Dust	1.40	1.18	1.03

2.5. Nursery Practices

The seeds (rhizomes) were sown directly inside the perforated pots containing soil and the various weighed organic manures (CD, SD, PM), the pots were perforated at the base to allow excess water to drain. The 12 liters pots were filled with 7.5 kg of soil and 1.5 kg of cow dung, sawdust, poultry manure. Then the control pots were filled with 9 kg of soil. After planting, water was applied on a daily basis to the various pots at a known quantity.

2.6. Parameters Measured

The growth parameters measured were:

Days of sprouting, Number of leaves per stand, Plant height (cm), Stem girth and Leaf area.

2.7. The yield parameters measured are

Rhizome size, Fresh yield weight

2.8. Data Analysis

Data collected were subjected to Analysis of Variance (ANOVA) and LSD test was used to estimate the differences among treatment means.

3. Results and Discussion

3.1. Results

3.1.1. Days of Sprouting

The days at which the plants sprouted vary, the pots with the highest sprouting rate was the saw dust (SD) which sprouted 13 days after planting followed by control (CT) then cow dung (CD) and poultry manure (PM), respectively. The research shows that the comp activeness or looseness of the soil affects the germination of the plant, SD shows the highest and fastest germination rate due to its looseness and PM exhibits the lowest germination rate due to its comp activeness. I.e. if the soil is loose the plant can easily shoot out but when compacted, it will take the plant more time than normal to germinate (Table 2). Brady (1990) establishes the relationship of the soil aggregate stability to its organic manure. In crop production, soils must be loose enough to allow root penetration and seed emergence.

3.1.2. Number of Leaves

There was significant difference among all treated pots at 4 WAP, which SD gave the highest number of leaves (2.67) and cow dung gave the least (0.83). At 8 WAP there was also significant difference, both saw dust and poultry manure gave the highest number of leaves (10.83, and 9.67) as shown in (Table 3).

At 12 WAP the pots with poultry manure gave the number of leaves that is significantly higher (21.17) than the others, i.e. the pot with cow dung, saw dust and control (Table 3). Also at 16 WAP PM Shows significant difference giving the highest number of leaves.

At 20 WAP the pot treated with PM gave the highest number of leaves that is significantly different and higher (25.50) than the other pots (Table 3).

3.1.3. Plant Height

The height of the plant recorded at 4 WAP shows that there was no significant difference between the pots treated and control. At 8 WAP there was a significant difference between the treated pots and the control pots. Also at 12 WAP there was significant difference between the pots treated and the control pot. There was no significant difference at 16 WAP (Table 4).

At 20 WAP also there was a significant difference between treated pots and the control pots. The pot treated with poultry manure gave the plant with the highest height (51.75) while the control pots gave plant with the shortest plant height (25.92) on average (Table 4).

3.1.4. Stem Girth

At 4 WAP there was no significant difference among treated pots and control. At 8 WAP there was a significant difference between pots. There was a significant difference between treated pots and control at 12 WAP. Also at 16 WAP there was a significant difference between pots.

The stem girth diameter measured at 20 WAP shows that there was a significant difference between treated pots with poultry manure showed or gave the thickest stem girth (1.35) and the control gave the thinnest stem girth (1.10) on average calculated (Table 5).

3.1.5. Leaf Area

The leaf area recorded at 4 WAP show that there was a significant difference between the pots treated and the control with saw dust giving the highest leaf area (17.35) and the cow dung gave the lowest (2.34) (Table 6). At 8 WAP there was no significant different between treated pots and the control pots. But at 12 WAP there was a significant difference between pots. At 16 WAP there was a significant difference. There was a significant difference on the leaf area recorded at 20 WAP with both poultry manure and cow dung giving the highest (74.24 and 62.92) leaf area and sawdust and control respectively gave the smallest (43.81 and 35.26) leaf area (Table 6).

3.1.6. Rhizome Size

The rhizome sizes measured after harvest shows that poultry manure (13.17) and cow dung (11.50) has higher influence on the size of Ginger rhizome than saw dust (7.17) and control (7.22). The sizes of the rhizomes were significantly different, with the pots treated with poultry manure giving the highest rhizome size recorded (Table 7).

3.1.7. *Rhizome Weight*

There was a significant different among the treated pots which PM gave the highest weight recorded (128.66) (Table 8).

The results obtained from the weight of the rhizomes per pot at harvest shows that the pot treated with cow dung gave the highest weight (115.83) next to poultry manure respectively (Table 8). While the pots treated with saw dust gave the least weight (33.21) (Table 8).

Table2. *Effect of Potting Mixture on the Sprouting Day of Ginger*

Treatment	Days to Sprouting
Cow Dung	24
Sawdust	13
Poultry Manure	22
Control	20
Significance	*
LSD	6.69
CV (%)	27.90

** — Significant, ** — highly significant, NS — Not significant*

Table3. *Effect of Potting Mixture on the Number of Leaves*

Treatment	Weeks After Planting (WAP)				
	4 WAP	8 WAP	12 WAP	16 WAP	20 WAP
CD	0.83	7.17	18.83	19.83	21.17
SD	2.67	10.83	16.00	16.00	17.17
PM	1.17	9.67	21.17	23.17	25.5
CT	1.67	8.67	16.17	16.5	17.00
Significance	*	*	*	*	**
LSD	0.90	2.68	3.86	3.63	2.34
CV (%)	46.08	22.03	17.40	15.48	10.70

** — Significant, **— highly significant, NS — Not significant*

Table4. *Effect of Potting Mixture on Plant Height*

Treatment	Weeks After Planting (WAP)				
	4 WAP	8 WAP	12 WAP	16 WAP	20 WAP
CD	2.82	18.50	41.33	41.83	42.67
PM	3.17	28.33	50.08	50.50	51.75
CT	4.42	14.95	25.50	25.83	25.92
Significance	NS	*	*	**	**
LSD	-	6.46	9.34	9.10	9.09
CV (%)	-	25.06	25.96	19.84	19.48

** — Significant, **— highly significant, NS — Not significant*

Table5. *Effect of Potting Mixtures on the Stem Girth Diameter*

Treatment	Weeks After Planting (WAP)				
	4 WAP	8 WAP	12 WAP	16 WAP	20 WAP
CD	0.60	1.13	1.15	1.21	1.23
SD	0.83	1.20	1.07	1.19	1.17
PM	0.62	1.30	1.39	1.33	1.35
CT	0.65	0.90	0.93	0.94	1.10
Significance	NS	*	**	*	*
LSD	-	0.26	0.14	0.16	0.17
CV (%)	77.82	18.35	10.27	10.99	11.68

** — Significant, **— highly significant, NS — Not significant*

Table6. *Effect of Potting Mixture on Leaf Area*

Treatment	Weeks After Planting (WAP)				
	4 WAP	8 WAP	12 WAP	16 WAP	20 WAP
CD	2.34	38.20	52.2	59.97	62.92
SD	17.35	39.78	42.93	43.19	43.81
PM	5.57	49.79	69.22	69.99	72.24
CT	5.93	29.07	32.78	33.04	35.26
Significance	*	NS	**	**	**
LSD	6.67	-	12.92	11.04	11.58
CV (%)	69.47	-	21.31	17.40	17.41

** — Significant, **— highly significant, NS — Not significant*

Table7. *Effect of Potting Mixture on the Rhizome Size*

Treatment	Rhizome Sizes
Cow dung	11.50
Saw dust	7.17
Poultry manure	13.17
Control	7.22
Significance	29.62
LSD	3.56
CV (%)	-

** — Significant, **— highly significant, NS — Not significant*

Table8. *Effect of Potting Mixture on the Fresh Weight*

Treatment	Average Weight Rhizome
Cow dung	115.3
Saw dust	33.21
Poultry manure	128.66
Control	29.27
Significance	**
LSD	51.88
CV (%)	55.00

** — Significant, **— highly significant, NS — Not significant*

4. Discussion

4.1. Effect of Potting Mixtures on Germination, Growth and Yield of Ginger

4.1.1. Germination and Growth of Gingers.

From the result obtained from this study, it was observed that ginger was influenced by poultry manure and cow dung. Application of poultry manure at the rate of one kg gave the highest yield for all the growth and yield characters such as; number of leaves, stem girth, plant height, rhizome weight and rhizome size, except the day of sprouting that saw dust gave the highest sprouting rate. This result may be attributed to various factors such as improper decomposition of poultry manure into the soil, poor mineralization, reduction of pest and diseases. Poultry manure has been found to increase soil fertility status.

Soil P^H tend to reduce with a rise in the amount of PM suggesting that poultry manure leads to increase acidity in the soil. Excess N in the soil and soil acidity could cause nutrient imbalance and a reduction in the uptake of the nutrient (Ewulo *et al.,* 2008). The finding shows that all levels of PM performed than CD, SD, and CT which was due to the fact that poultry manure supplies more nutrients than saw dust, cow dung and the control. The PM could have supplied micronutrients which are essential for ginger growth and yield, Stephenson *et al.* (1990) and Oladotun (2002) reported that PM contains macro and micro nutrients such as N, P, K, S, Ca, Mg, Cu, Mn, Bn, and Fe.

In this study ginger performed best in terms of growth and yield under poultry manure and cow dung compare to sawdust treatment and the control. This could be attributed to increase in nutrient efficiency. As recorded for the treatments, the highest ginger rhizome yield was recorded for the pot treated with poultry manure and cow dung.

5. Conclusion and Recommendation

The main reason for applying poultry manure, cow dung and saw dust to the soil is to improve the organic matter amendment of the soil and provision of nutrient to crops. The present study was therefore designed to evaluate the effect of potting mixtures on the germination, growth and yield of ginger.

The analysis shows that poultry manure gave the highest yield that is significantly higher than the sawdust, cow dung and control. It could be concluded that poultry manure significantly produced the highest value in all the characters recorded during the research except the days to germination.

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Citation: *Sale F.A, et al., "Effect of Potting Mixtures on Germination, Growth and Yield of Ginger (Zingiber Officinale) in Anyigba", International Journal of Forestry and Horticulture, vol. 4, no. 2, p. 7-13, 2018. http://dx.doi.org/ 10.20431/2454-9487.0402002*