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Growth and Yield of Radish (*Raphanus sativus L.*) as Influenced by Different Levels of Kalli Organic Fertilizer on the Jos Plateau

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Authors' contributions

This work was carried out in collaboration among all authors. Author UMU designed the study and wrote the protocol. Author III wrote the first draft of the manuscript, performed the statistical analysis and managed the analyses of the study. Author SMO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To determine the effect of Kalli organic fertilizer on the growth and yield of radish.
Study Design: The experimental design used for this study was a Randomized Complete Block Design (RCBD) consisting of four (4) treatments (0, 400, 500 and 600 kgha^{-1}) which were replicated four (4) times.
Place and Duration of the Study: The experiment was conducted at Federal College of Forestry Jos, Plateau State located in the North Central part of Nigeria between September – October, 2018.
Methods: Soil samples were collected and analysed. Agronomic practices such as land preparation, planting, fertilizer application, weeding and harvesting were also carried out. The data was collected on plant height, number of leaves, leaf area, number of roots, length of roots, diameter of roots, root weight and root yield. Data collected was analysed using Analysis of Variance (ANOVA) with Minitab 23 statistical package at 5% level of probability and where

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significance was determined Duncan Multiple Range Test (DMRT) was used to separate the means.

Results: The findings from this research work revealed that there was no significant effect of Kalli organic fertilizer on the plant height, number of leaves. But the leaf area was found to be significant (p=0.05) at 8WAP with the application of 600 kgha^{-1} recording the largest (143.30 cm^2) leaf. The number of roots, length of roots, weight of root and total yield was found to be significant (*P*=0.05) on the application of different levels of Kalli organic fertilizer. The application of 600 kgha^{-1} produced the highest number (35.50) of radish roots, length (24.83 cm) of radish roots, weight (7.20 kg) of radish and total yield (18000 kgha^{-1}) of Radish.

Conclusion: Based on this research study it could be concluded that the application of Kalli (600 kgha^{-1}) organic fertilizer significantly increased the yield of Radish. It is therefore recommended that organic fertilizer can be applied for optimum production of Radish.

Keywords: Radish; kalli; organic fertilizer; sweet potato.

1. INTRODUCTION

Radish (*Raphanus sativus L.*) belongs to the family Brassicaceae, genus *Raphanus* and species *sativus*. It is one of the most important and popular root vegetable grown in tropical, sub-tropical and temperate regions of the world. It is grown both as an annual and a biennial vegetable crop depending upon the purpose of which it is grown. Radish is predominantly a cool season vegetable crop. But, Asiatic types can tolerate higher temperature than European varieties. In the mild climate, radish can be grown almost all year round except for few months in summer [1].

Radish is grown and consumed all over the world and is considered part of the human diet, even though it is not common among some populations. Its young tuberous roots can be eaten raw in salad or cooked as a vegetable. It has a pungent flavour and considered as an appetizer. The young leaves can also cooked and eaten as vegetables. The preparations of radish are useful for liver and gall bladder troubles. The roots, leaves, flowers and pods are active against gram-positive bacteria, urinary complaints, piles and gastrodynia. Also, salt extracted from the root can be dried and burnt to white ash and can be used to mitigate stomach troubles [2].

Most of the nutrients absorbed by plants come from organic matter. Therefore, the unique formulation of Kalli 100% organic fertilizer, which consists of animal and chicken wastes and earth based mineral resources like rock phosphate, lime, gypsum bentonite etc. makes it very rich in nutrients content. They provide rich sources of organic matter to be added to the soil for the growth of variety of crops. Thus, Kalli fertilizer aims to serve society by increasing income to famers through organic fertilization which revitalizes the soil and increase farm yields [3].

Global awareness for the hazard of long-term use of chemical fertilizer is growing and because of this, more farmers are shifting to organic fertilizer. Among the benefits of using fertilizers include as follows; produce non-toxic food, cost effective, increased fertility and of course a safer environment (Xicberg and Offcrmanna, 2002). The positive effects of organic fertilizers on growth and productivity of plants could be attributed to different organic fertilizers groups which increase the levels of extractable N, P, K, Fe, Zn and Mn [4]. This effect will reduce the amounts of chemical fertilizers used for farming and subsequently lessen environmental pollution [5]. Low soil fertility among others is one of the major challenges in crop production. The high cost of these (inorganic) fertilizers has necessitated the need to search for less expensive and environmentally friendly fertilizer [6]. Though, information is available on the combined use of organic manures and inorganic fertilizers for improving soil fertility and crop yields [7]. Singh and Kushwah [8] reported that the effect of organic manures (farmyard manure and compost) in combination with inorganic fertilizers was more pronounced in potato compared with that of organic manures alone. Farmyard manure was found more effective than compost in producing higher tuber yield in potato. This research study therefore was aimed at determining the effect of Kalli organic fertilizer on the growth and yield of radish.

2. MATERIALS AND METHODS

2.1 Study Area

The experiment was conducted at Federal College of Forestry Jos, Plateau State located in

the North Central part of Nigeria which lies at a Latitude of 9.94 and Longitude 8.89 within the Guinea Savannah region with a mean annual rainfall of 1460 mm and temperature range between 19°C and 32°C [9].

2.2 Materials

The materials used for this experimental study include certified Daikon variety radish (White Radish) seeds obtained from Plateau Agricultural Development Programme (PADP), Kalli organic Fertilizer purchased from the company dealers. The measuring tape, meter rule, rope, cutlass, Auger bit, shovel, rake, wheelbarrow, watering can, and hoe were gotten from Crop Production Technology Department, Federal College of Forestry, Jos departmental store.

2.3 Soil Analysis

Soil Samples were collected at random from the field at two different depths (0-30 cm) with the aid of Augar bit, hand trowel. A polythene bag was used to store the sample. The sample was later dried under room temperature and taken to Agricultural Service and Training Centre (ASTC) for analysis to determine the physical and chemical characteristics of the soil in the study area. Soil pH was determined in 1.0:2.5 soil-water suspensions, while exchangeable cations (Na, K, Ca and Mg) and ammonium acetate and organic matter were determined using Walkley-Black method. The hydrometer method was used to determine the soil texture.

2.4 Experimental Design

The experimental design used for this study was a Randomized Complete Block Design (RCBD) consisting of four (4) treatments (0, 400, 500 and 600 $kgha^{-1}$) which were replicated four (4) times.

2.5 Agronomic Practices

a. **Land Preparation:** Land Preparation was done on the 10th of October, 2018. The land was cleared manually using a cutlass and hoe. The soil was thoroughly dogged and the clumps were broken into fine soil particles for ease of sowing [9].
b. **Planting:** Radish seeds were planted at 2 – 5 cm depth and at a spacing of 20 cm x 30 cm. Kalli Organic fertilizer was applied immediately after planting using the side placement method of 5 cm away from the planting spot.
c. **Weeding:** Weeding was carried out twice manually at two (2) weeks interval.
d. **Harvesting:** This was done when the radish root protrudes onto the soil surface.

2.6 Data Collection

Radish plants were randomly selected and tagged. Data from the tagged plants was collected at 2 weeks interval on;

a. **Plant height:** The plant height was measured from the base to tip of the plant with the aid of meter rule in centimeter (cm).
b. **Leaf count:** Number of leaves was counted per plant.
c. **Leaf Area:** The leaf length and breadth were measured and leaf area calculated using
   Leaf Area (LA) = Length x Breadth in centimeter squared (cm^2)
d. **Number of Roots:** This was done by counting the number of roots each plant produces
e. **Length of Root:** This was done using a meter rule in centimeter (cm)
f. **Diameter of Root:** This was measured using a vernier caliper in centimeter (cm)
g. **Root Weight:** This was done by using a weighting balance to determine the weight of the radish root in kilogram (kg)

Data collected was subjected to analysis of variance (ANOVA) at 5% level of significance using Minitab 23. Duncan Multiple Range Test (DMRT) was used to separate the means.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Physical and chemical analysis of soil in the study area

The physical and chemical property of the soil in the study area is presented in Table 1. The result showed that the soil pH was 5.9 which is slightly acidic. It is the preferred soil pH range for good growth and development of most crops. Organic matter had an average value of 11.5%, while the respective nutrient constituents of nitrogen, phosphorus, potassium, calcium and magnesium were in average quantities 0.036%, 6.2, 95.9, 5.3 and 3.6 ppm respectively for optimum production of most crops. The soil could be classified as sandy loam. The percentage composition of

sand, silt and clay (10.88% clay, 12% silt, and 77.12% sand) confirms that the presences of organic matter, which make the soil good for crop production.

3.1.2 Composition of kalli organic fertilizer

Most of the nutrients absorbed by plants come from organic matter. Therefore, the unique formulation of Kalli 100% organic fertilizer consists of animal and chicken wastes and earth based mineral resources like rock phosphate, lime, gypsum bentonite and more. They provide rich sources of organic matter to be added to the soil for the growth of variety of crops.

The composition of Kalli organic fertilizer is presented in Table 2. The result reveals that Kalli organic fertilizer comprised of 7.55 g/kg of N, 2.86 g/kg of P, 1.80 g/kg of K, 0.95 g/kg of Ca, 0.356 g/kg of MgO, 0.795 g/kg of Fe, organic Carbon had 17.80 g/kg while 35.54 g/kg was made of organic matter. This implies that Kalli organic fertilizer has a minimum of 4% N and about 45% organic matter. Kalli fertilizer aims to serve society by increasing income to fanners through organic ferlilizer which revitalizes the soil and increase farm yields.

3.1.3 Plant height

The result from Table 3 shows that there were no significant differences at P ≤0.05 level of probability between the treatments. The application of 600 $kgha^{-1}$ of Kalli fertilizer produced the highest plant height of 24.65 cm, followed by 500 $kgha^{-1}$ with 23.55 cm, then 400$kgha^{-1}$ with 22.98 cm and the control which gave the least plant height 21.48 cm. This shows that the application of 600 kg of Kalli gave the highest plant height at 4WAP. At 8WAP no significant difference was observed at P ≤ 0.05 between the treatments. The application of 600 $kgha^{-1}$ of Kalli gave the highest plant height with 25.93 cm followed by 400 kg ha^{-1} with 25.55 cm, then 500 $kgha^{-1}$ with 25.25 cm and the control which has the least plant height with 24.40 cm. This shows that the application of 600 $kgha^{-1}$ of Kalli fertilizer gave the highest plant height at 8WAP.

3.1.4 Number of leaves

The result (Table 3) shows that there was no significant difference statistically at P ≤ 0.05 between the treatments. The application of 600 $kgha^{-1}$ of Kalli fertilizer gave the highest mean number of leaves of 13.90 followed by 500 $kgha^{-1}$ with 13.05, and then 400 $kgha^{-1}$ with 12.85 and the control which gave the least mean number of leaves with 12.30. This shows that the application of 600 $kgha^{-1}$ of Kalli has the highest mean number of leaves at 4WAP. At 8WAP no significant difference was observed at P ≤ 0.05 between the treatments. The application of 600$kgha^{-1}$ of Kalli fertilizer has the highest mean number of leaves of 15.85, followed by 400$kgha^{-1}$ with 15.45, then 500$kgha^{-1}$ with 14.70 and the control which gave the least mean number of leaves with 14.20. This shows that the application of 600 $kgha^{-1}$ of Kalli has the highest mean number of leaves.

3.1.5 Leaf area

No significant (P ≤ 0.05) effect of Kalli organic fertilizer was observed at 4WAP on leaf area of Radish. However, at 8WAP the result (Table 3) reveals that significant (P ≤ 0.05) effect of Kalli organic fertilizer on leaf area. The application of 600 $kgha^{-1}$recorded the largest leaf (143.30 cm^2) as against the application of 500 (126.07 cm^2), 400 (117.75 cm^2) and 0 (87.94 cm2) $kgha^{-1}$Kalli organic fertilizer.

3.1.6 Number of root

The number of roots was found (Table 4) to be significant (P ≤ 0.05) with the application of different levels of Kalli organic fertilizer. The highest (35.50) number of radish roots was obtained with the application of 600$kgha^{-1}$ followed by the application of 500, 400 and 0 $kgha^{-1}$ with 29.75, 28.25 and 22.00 radish roots respectively.

Table 1. Physical and chemical properties of soil in the study area

Sample	pH	N (%)	P PPM	K PPM	Ca PM	MgPPM	O.M (%)	H+ mMol/ 100 g	Clay (%)	Silt (%)	Sand (%)	Textural Class
0-30 cm	5.9	0.036	6.2	95.9	5.3	3.6	11.5	1.57	10.88	12	77.12	Sandy loam

Source: - Agricultural Services and Training Center KASSA/VOM, 2018

Table 2. Composition of kalli organic fertilizer

Variable	Composition (gkg^{-1})
N	7.55
P	2.86
K	1.80
Ca	0.95
MgO	0.356
Fe	0.795
Organic Carbon	17.80
Organic Matter	35.54

Source: Kalli Organic Fertilizer Company

3.1.7 Length of root

The length of roots was found (Table 4) to be highly significant (P ≤ 0.01) with the application of different levels of Kalli organic fertilizer. The longest (24.83 cm) length of radish roots was obtained at the application of 600 $kgha^{-1}$ followed by the application of 500, 400 and 0 $kgha^{-1}$ with 21.33, 19.43 and 15.51 cm radish roots length respectively.

3.1.8 Diameter of root

No significant effect of Kalli organic fertilizer was observed on root diameter of Radish. However, the application of 600 $kgha^{-1}$ gave the highest (4.28 cm) root diameter of Radish.

3.1.9 Weight of root

The result of the effect of Kalli organic fertilizer on weight of root is presented in Table 4. The result indicates that there was significant (P ≤ 0.01) effect of Kalli organic fertilizer on weight of root. The application of 600 $kgha^{-1}$ measured the highest (7.20 kg) weight of radish while the application of 500 $kgha^{-1}$ was at par with 400 and 0 $kgha^{-1}$ the least weight.

3.1.10 Total yield

The result from Fig. 1 reveals that the highest (18000 $kgha^{-1}$) total yield of Radish was measured with the application of 600 $kgha^{-1}$ followed by the application of 500, 400 and 0 $kgha^{-1}$ with 13575, 12875 and 12125 $kgha^{-1}$ respectively.

Table 3. Growth characteristics of radish as influenced by different levels of Kalli organic fertilizer in the Jos Plateau

Treatment ($kgha^{-1}$)a	Plant height (cm)		Number of leaves		Leaf area (cm^2)	
	4WAP	8WAP	4WAP	8WAP	4WAP	8WAP
0	21.48[a]	24.40[a]	12.30[a]	14.20[a]	94.71[a]	87.94[a]
400	22.98[a]	25.55[a]	12.85[a]	15.45[a]	112.11[a]	117.75[ab]
500	23.55[a]	25.25[a]	13.05[a]	14.70[a]	116.83[a]	126.07[ab]
600	24.65[a]	25.93[a]	13.90[a]	15.85[a]	129.22[a]	143.30[b]
SE±	1.23	0.70	0.71	0.56	17.11	13.56
CV(%)	10.75	5.48	10.74	7.94	29.30	26.85
LS	NS	NS	NS	NS	NS	*

*Means that do not share the same letter are significantly different, WAP = Weeks after Planting, SE = Standard Error, LS = Level of Significance, ns = Not Significant, * = Significant at P ≤ 0.05 level of significance*

Table 4. Yield characteristics of radish as influenced by different levels of kalli organic fertilizer on the jos plateau

Treatment (kg/ha)	Number of root	Length of root (cm)	Diameter of root (cm)	Weight of root (kg)
0	22.00a	15.51[a]	3.39a	4.85a
400	28.25ab	19.43[b]	3.71a	5.15a
500	29.75ab	21.33[b]	3.81a	5.43a
600	35.50b	24.83[c]	4.28a	7.20b
SE±	2.05	0.62	0.31	0.42
CV(%)	21.38	17.99	17.60	21.39
LS	*	**	NS	**

*Means that do not share the same letter are significantly different, SE = Standard Error, CV = Coefficient of Variation, LS = Level of Significance, * = Significant at 0.05, ** = Significant at 0.01*

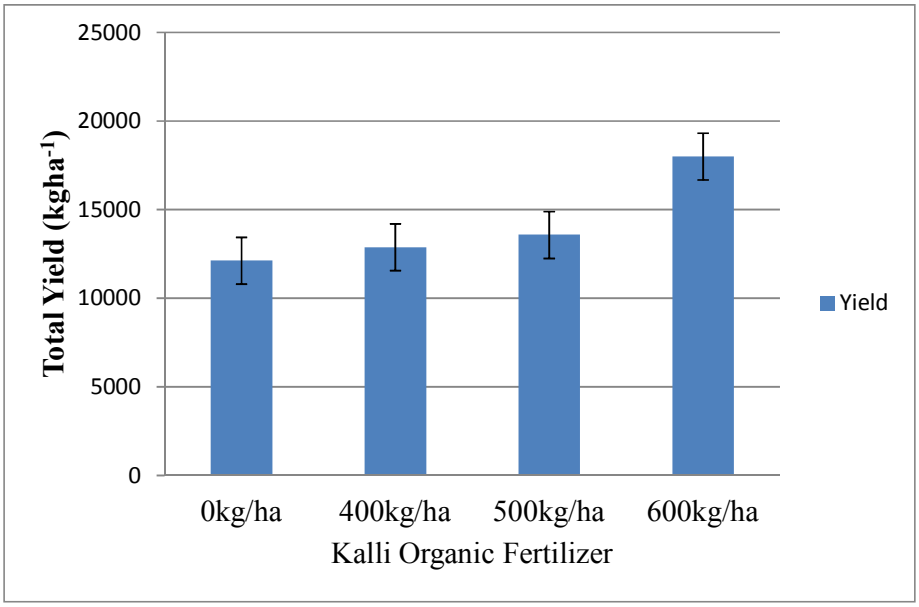

Fig. 1. Effect of kalli organic fertilizer on total yield of radish

3.2 Discussion

3.2.1 Effect of kalli organic fertilizer on the growth of Radish

The findings from this research work revealed that there was no significant effect of Kalli organic fertilizer on the plant height, number of leaves. But the leaf area was found to be significant at 8WAP. This shows that the growth characteristics of Radish are not affected by the application of Kalli organic fertilizer. This result is contrary to Satish [2] who observed that the plant height and number of leaves of Radish was significantly increased by various treatments of organic manure at all the growth stages. Result from Eric and Politud [10] revealed that plant height, number of leaves, tuber length, tuber diameter and pest resistance were not significantly affected by the applications of varying levels of vermicast. According to Sisay et al. [11] deficit and excess amount of nutrients in the soil that could be caused by mineral fertilization can be compensated for by the application of organic fertilizers, which is in line with the results obtained in the current study. Different organic fertilizers and application rates significantly influenced the number of leaves during the first 8 weeks after thinning in 2005 and 2006 except at 8 weeks after thinning for the organic fertilizer in 2006 [12]. The use of both organic materials i.e. chicken manure and inorganic fertilizers (at 50% of the recommended doses) gained the highest values of most plant growth characteristics of radish plants [5]. According to Subedi et al. [13] significantly higher plant height (37.5 cm), number of leaves per plant (24.77), root diameter (39.01 mm), average leaf length (35.03 cm), average leaf width (12.86 cm) was observed in treatment consisting PM (50%). The application of 1 tonne of poultry manure recorded the highest leaf area as against other treatments [2].

3.2.2 Effect of kalli organic fertilizer on the yield of radish

The number of roots, length of roots, weight of root and total yield was found to be significant ($P \leq 0.05$) at the application of different levels of Kalli organic fertilizer. The application of 600 $kgha^{-1}$ gave the highest (35.50) number of radish roots, highest (24.83 cm) length of radish roots, highest (7.20 kg) weight of radish and highest (18000 $kgha^{-1}$) total yield of Radish. This might be due to the availability of the nutrients in readily available form. Radish total root yield was significantly affected due to effect of organic manure [2]. These yield components were significantly affected by the varying levels of vermicast [10]. Yield components of carrot were also increased in response to the increased rate of combined “orga” and urea fertilizer application [11]. Alice [12] stated that the yield (fresh and dry mass) was not significantly influenced during the first year. In the second year, the fresh mass

was only significantly influenced by the rate of organic fertiliser and not the type. Dry mass of carrots in the same year was positively influenced by organic fertiliser. The maximum and lowest root weights were recorded in carrot crops treated with 309 kg ha-1 “orga” + 274 kg ha-1 urea and the control treatment, respectively [11]. Considering the response of carrots in terms of growth, yield and quality to different organic fertilisers and application rates showed that 12.5–25 kg 10 m-2 chicken manure, 25–50 kg 10 m-2 kraal manure or 50 kg 10 m-2 compost showed to be the optimum [12]. According to Khairul Mazed [14] the maximum fresh weight of root (146.50 g) was recorded from O_1 (cow dung) and the lowest fresh weight of root (123.96 g) was recorded from O_0 (control treatment). The fruit yield of tomato differed significantly with the application of liquid organic manures [15].

4. CONCLUSION

Based on this research study it could be concluded that the application of Kalli (600 $kgha^{-1}$) organic fertilizer significantly increased the yield of Radish. Kalli organic fertilizer contains all the macro, secondary and micro nutrients, which are essential to plant growth and development. Thus it is recommended that 600$kgha^{-1}$ of Kalli organic fertilizer should be applied for optimum production of Radish.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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