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Evaluation of animal manure sources and rates of application on the growth characteristics of Citrus rootstock variety in Southeastern Nigeria

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Abstract

Field trials were conducted at the citrus nursery of National Horticultural Research Institute, Mbato Out-Station Okigwe, Imo State during the late seasons of 2014 and 2015 respectively to evaluate the effect of different sources of animal manure and rates on growth characteristics of citrus rootstock variety, rough lemon (***Citrus jambhiri* Lush**). Factor A comprises of poultry manure, cattle dung and piggery waste, while factor B were the rates of application at 0, 10, 15, and 20 t/ha. The rootstock material was sourced from the institute's collection block, processed and laid-out in prepared plots of size 5.5 m x 9.0 m with plant spacing of 0.75 m x 0.25 m between and within the row. The trials were in each case a 3 x 4 factorial experiment fitted into randomized complete block design (RCBD) with four replications. Soil samples were collected and processed for routine analysis at the on-set of the experiment. Data were collected on plant height (cm), number of leaves, plant girth (cm) and number of branches. All data collected were subjected to analysis of variance (ANOVA) using JMB statistical software while means were separated using Fischer's least significant difference (FLSD) at 5% probability level. Results obtained showed that the manure sources significantly ($P<0.05$) increased the measured growth parameters relative to the control. Cattle dung gave highest mean number of leaves (68.1 and 43.8) in 2014 and 2015 respectively and number of branches (3.48 and 4.22) at 8 weeks after treatment application (WATA). However, poultry manure showed best performance in terms of plant height in 2014 at 4 WATA (36.1 cm) and 8 WATA (49.8 cm) and in 2015 at both 4 WATA (47.5 cm) sand 8 WATA (60.0 cm). Application rate of 20 t/ha recorded highest mean value on number of leaves, plant height, number of branches as well as stem girth and is therefore, recommended to citrus nursery farmers in Okigwe zone.

Key words: Animal manures, Citrus rootstock, Rates

Introduction

Citrus (*Citrus spp*) is one of the most important fruit tress grown in Nigeria for fresh consumption and raw materials in the tropics (Adewale *et al.*, 1996). Citrus cultivation is on the increase in Nigeria because of awareness of its nutritional value as a cheap source of vitamin C and as one of the most important raw materials in fruit industry (Aubert and Vullin, 1998). There is high demand for budded citrus seedlings for planting. Citrus seedlings provide the foundation for citrus industry and the farmers who specialize in growing citrus are concerned with the time required for the seedlings to reach buddable stage, which in turn is affected by nutrient element availability in the soil.

The high cost and scarcity of inorganic fertilizers in developing countries such as Nigeria reduced their use by most peasant farmers, thereby generating renewed interest in the use of organic materials as nutrient sources. The Ultisols of South Eastern Nigeria is characterized by low reserves of essential plant nutrients and high soil acidity (Mbagwu, 1992). Use of organic manures is

recommended for managing such soils to improve the nutrient content and sustain yield (Omotayo and Chukwuka, 2009). Organic manures supply organic matter to the soil that modifies soil physical and chemical properties (Onwuka *et al.*, 2008). They are slow release nutrient sources that make nutrients available for longer period of time (Omotayo and Chukwuka, 2009). The use of organic manures enhances soil productivity, increases the soil organic carbon content, enhances the activities of soil micro-organisms, improves the soil crumb structure as well as crop yield (Akani and Ojeniyi, 2007). Addition of different sources of organic manures increase the plant growth characteristics namely plant height, number of leaves and shoots per plant, fresh and dry weight of shoots of plants (Nandekar and Swarkar, 1990; Said; 1997; Zhang *et al.*, 1998) Use of organic manure has been found to improve citrus seedling growth and production through improvement of soil physical properties and supply of nutrient elements and serves as cheap fertilizer source (Lawal *et al.*, 2009).

The production of citrus rootstock in Okigwe Southeastern Nigeria has been with the use of inorganic fertilizers such as NPK and Urea, there is need therefore, to intensify effort in the use of organic manures which are more readily available, cheap and within the reach of poor resource farmers in the zone. It is against this backdrop that this trial was established with the objective to investigate the manure sources and rates that will support effective citrus rootstock production in Mbato Okigwe as well to make recommendations based on the result to citrus rootstock growers in the zone.

Materials and Methods

The experiment was conducted during the late seasons of 2014 and 2015 respectively at the citrus nursery of National Horticultural Research Institute (NIHORT) Mbato out-station Okigwe, Imo state. The station lies between Latitude $05^{0}33^{1}$ N and Longitude 07^{0} and 23^{1} E and 130 meters above sea level. The area enjoys over 2,200 mm of mean annual rainfall with temperature range of between 21^{0} C and 32^{0} C. The site was well drained, non-gravely soil. The soil texture was sandy loam (743 g/kg sand, 155g/kg silt, 122g/kg clay) characterized by low N value (0.90 $gkg^{-1)}$, low P value (6.80 $mgkg^{-1}$) with soil pH of 4.38. The experiment was a 3 x 4 factorial fitted in randomized complete block design (RCBD). Factor A was the manure sources (poultry manure, cattle dung and piggery waste) while factor B was the rates of application (0, 10, 15 and 20 t/ha). The rootstock material was sourced from the Institute's collection block, processed and laid-out in prepared plots of size 5.5 m x 9.0 m each with plant spacing of 0.75 m x 0.25 m between and within the row. Soil samples were collected and analyzed at the on-set of the experiments. Also, samples of the manure was chemically characterized (Table 2). The plots were maintained weed free throughout the duration of the trials. Data were collected on plant height (cm), number of leaves, plant girth (cm) and number of branches. Plant height was measured with a meter rule from the surface of the soil to tip of the tallest leaf. Plant girth was measured using a venier caliper. Number of branches and number of leaves were taken by counting. Ten (10) candidate plants were used to obtain information from each plot. All data collected were subjected to analysis of variance (ANOVA) using JMB (2010) statistical software while means were separated using Fischer's least significant difference (FLSD) at 5% probability level.

Results and Discussion

Properties of soil and manure used for the trial

Some properties of the soil used for the experiment are shown in Table 1. The soil was acidic with a pH value of 4.38. The soil organic carbon and total nitrogen were low with values of 1.60 g/kg and 0.90 g/kg respectively. The low values of soil organic carbon, nitrogen and phosphorus could be

attributed to inherent characteristics of the soil and climatic conditions which resulted in high rate of organic matter decomposition associated with tropical soils. Arable soils of Southeastern Nigeria are mostly sandy, acidic with low organic matter and nutrient status (Nottidge *et al.*, 2005, 2007). The chemical properties of the organic materials used for the study are shown in Table 2. Nitrogen, calcium, potassium and phosphorus contents of the organic manures are high and are expected to improve soil properties and nutrient contents of the soil. The poor fertility status and sandy nature of the soil point to the need for improvement by using organic amendments which are slow-release and can improve soil organic matter base and crop productivity (Omotayo and Chukwuka, 2009).

Table 1: Some physical and chemical properties of the soil used for the experiment.

Soil Properties	**Values**
pH(H_2O)	4.38
Organic carbon (gkg^{-1})	1.60
Total N (gkg^{-1})	0.90
Available P ($mgkg^{-1}$)	6.80
Ca ($cmolkg^{-1}$)	3.20
Mg ($cmolkg^{-1}$)	1.60
K ($cmolkg^{-1}$)	0.19
Na ($cmolkg^{-1}$)	0.06
ECEC ($cmolkg^{-1}$)	5.75
Base saturation (%)	58.2
C/N ratio	11:54
Sand (g/kg)	743
Silt (g/kg)	155
Clay (g/kg)	102
Exchangeable Mn (cmol/kg)	1.08
Exchangeable Zn (cmol/kg)	1.70
Exchangeable Fe (cmol/kg)	6.23
Exchangeable Cu (cmol/kg)	18.75

Table 2: Some properties of the organic manures used for the experiment.

Properties	Poultrv manure	Cattle dung	Piggery waste
pH(H_2O)	8.1	9.8	6.1
Organic carbon (%)	14.9	7.8	7.3
Total N (%)	1.4	1.2	1.0
Available P ($mgkg^{-1}$)	34.6	15.8	6.0
Ca ($cmolkg^{-1}$)	30.5	16.0	28.0
Mg ($cmolkg^{-1}$)	7.6	9.4	6.0
K ($cmolkg^{-1}$)	29.2	23.0	25.0
Na ($cmolkg^{-1}$)	4.2	4.9	4.4
C/N ratio	4:1	5:4	3:4
Exchangeable Mn (cmol/kg)	66.3	76.0	59.0
Exchangeable Zn (cmol/kg)	5.4	5.9	3.9
Exchangeable Fe (cmol/kg)	7.6	3.2	6.0
Exchangeable Cu (cmol/kg)	1.7	0.8	1.3

Effect of organic manure sources on growth parameters

The effect of different organic manure sources and rates on number of leaves at 4 and 8 weeks after treatment application (WATA) in 2014 and 2015 is shown on Table 3. The manure sources increased the number of leaves of rough lemon relative to the control. In 2014 trial, poultry manure gave the highest mean number of leaves at 4 WATA (56.8) while in 2015; at the same 4 WATA cattle dung application gave the highest mean number of leaves (43.8). The application rate of 20 t/ha gave the highest mean number of leaves at 4 WATA in 2014 with values of 59.8.

Table 3; Effect of different manure sources and rates on number of leaves of rough lemon at 4 and 8 weeks after treatment application (WATA) in 2014 and 2015

Rates of organic manure application (t/ha)

4 Weeks after treatment application

	2014					2015				
Manure sources	0	10	15	20	**Mean**	0	10	15	20	**Mean**
Cattle dung	39.1	43.7	45.6	56.1	**46.1**	35.5	40.8	40.9	48.9	**43.8**
Piggery waste	39.0	43.4	46.8	48.9	**44.6**	37.6	44.2	48.4	41.9	**43.0**
Poultry	41.3	53.1	62.6	74.7	**56.8**	42.4	46.9	36.2	33.5	**39.7**
Mean	**39.8**	**46.8**	**51.7**	**59.8**		**40.7**	**41.7**	**44.9**	**44.4**	

LSD (0.05) manure sources = 3.45 10.11
LSD (0.05) manure rates = 3.98 11.69
LSD (0.05) manure sources x rates = 6.90 20.21

8 Weeks after treatment application

	2014					2015				
Manure sources	0	10	15	20	**Mean**	0	10	15	20	**Mean**
Cattle dung	58.6	66.9	71.1	75.9	**68.1**	35.6	43.6	38.3	33.1	**37.6**
Piggery waste	50.2	60.2	69.4	74.3	**63.5**	32.1	33.2	37.1	37.7	**34.7**
Poultry	53.6	63.1	68.2	68.2	**63.3**	37.3	44.5	28.9	31.4	**35.5**
Mean	**54.1**	**63.4**	**69.6**	**72.5**		**35.4**	**40.1**	**35.0**	**33.4**	

LSD (0.05) manure sources = 3.06 7.97
LSD (0.05) manure rates = 3.53 9.20
LSD (0.05) manure sources x rates = 6.12 15.94

Table 4; Effect of different manure sources and rates on plant height (cm) of rough lemon at 4 and 8 weeks after treatment application (WATA) in 2014 and 2015

Rates of organic manure application (t/ha)

4 Weeks after treatment application

	2014					2015				
Manure sources	0	10	15	20	**Mean**	0	10	15	20	**Mean**
Cattle dung	23.8	29.3	34.9	38.5	**31.6**	42.0	49.5	48.2	49.8	**44.9**
Piggery waste	26.7	31.0	38.0	39.6	**33.8**	42.4	43.4	49.6	44.6	**45.0**
Poultry	25.2	36.1	38.5	44.3	**36.1**	47.1	55.4	40.7	46.7	**47.5**
Mean	**25.2**	**32.2**	**37.1**	**40.8**		**43.8**	**49.4**	**46.2**	**43.7**	

LSD (0.05) manure sources =2.17 8.14
LSD (0.05) manure rates = 2.5 9.4
LSD (0.05) manure sources x rates = 4.33 16.28

8 Weeks after treatment application

	2014					2015				
Manure sources	0	10	15	20	**Mean**	0	10	15	20	**Mean**
Cattle dung	38.1	42.9	44.5	53.6	**44.8**	53.4	60.2	60.6	57.8	**58.0**
Piggery waste	39.4	46.0	49.2	53.3	**46.9**	52.3	48.9	63.5	55.4	**55.0**
Poultry	39.2	47.8	54.5	57.9	**49.8**	60.3	58.1	58.3	63.2	**60.0**
Mean	**38.9**	**45.6**	**49.7**	**54.9**		**55.3**	**55.7**	**60.8**	**58.8**	

LSD (0.05) manure sources = 3.68 8.36
LSD (0.05) manure rates = 4.25 9.69
LSD (0.05) manure sources x rates = 7.36 16.79

Poultry manure application however, gave the highest mean plant height values of 36.1 cm and 47.5 cm in 2014 and 2015 trials at 4 WATA (Table 4). Also, in 2014 trial, application of 20 t/ha rate recorded highest mean values at 4 (40.8 cm) and 8 (54.9 cm) WATA respectively while in 2015 trial, poultry manure showed best performance and 15 t/ha rate gave highest mean value (60.8 cm) at 8WATA although this value is not significantly different ($p > 0.05$) with the mean value obtained at 20 t/ha. The interaction of the organic manure sources and rates of application on plant height was significant.

Cattle dung application increased number of branches in 2014 and 2015 trials at 4 and 8 WATA respectively giving highest mean values. However, 20 t/ha rate of application showed the best mean number of branches in 2014 and 2015 trials (Table 5).

Table 5; Effect of different manure sources and rates on number of branches of rough lemon at 4 and 8 weeks after treatment application (WATA) in 2014 and 2015

Rates of organic manure application (t/ha)

4 Weeks after treatment application

	2014					2015				
Manure sources	0	10	15	20	**Mean**	0	10	15	20	**Mean**
Cattle dung	2.58	2.78	3.27	2.80	**3.11**	4.70	5.13	3.63	4.47	**4.48**
Piggery waste	2.37	2.72	2.93	3.29	**2.83**	3.87	3.50	4.77	4.33	**4.12**
Poultry	2.26	2.92	2.97	3.22	**2.84**	4.67	4.90	3.87	3.53	**4.24**
Mean	**2.40**	**2.81**	**3.06**	**3.44**		**4.41**	**4.51**	**4.10**	**4.11**	

LSD (0.05) manure sources = 0.27 0.75
LSD (0.05) manure rates = 0.31 0.87
LSD (0.05) manure sources x rates = 0.53 1.50

8 Weeks after treatment application

	2014					2015				
Manure sources	0	10	15	20	Mean	0	10	15	20	**Mean**
Cattle dung	3.18	3.60	3.53	3.63	**3.48**	4.27	4.17	4.07	4.27	**4.22**
Piggery waste	2.70	3.20	3.27	3.70	**3.01**	4.05	4.16	4.01	4.68	**4.19**
Poultry	3.77	3.20	3.07	3.17	**3.05**	3.82	4.00	3.37	4.59	**3.95**
Mean	**2.88**	**3.33**	**3.29**	**3.32**		**4.05**	**4.11**	**3.82**	**4.52**	

LSD (0.05) manure sources = 0.31 0.56
LSD (0.05) manure rates = 0.36 0.65
LSD (0.05) manure sources x rates = 0.62 1.12

Poultry manure recorded the highest mean value in plant girth in 2015 trial with values of 0.51 cm and 1.02 cm at 4 and 8 WATA respectively (Table 6). Application of 20 t/ha rate recorded highest mean plant girth of 0.51 cm at 4 WATA in the same year.

Table 6; Effect of different manure sources and rates on plant girth (cm) of rough lemon at 4 and 8 weeks after treatment application (WATA) in 2014 and 2015

Rates of organic manure application (t/ha)

4 Weeks after treatment application

	2014					2015				
Manure sources	0	10	15	20	**Mean**	0	10	15	20	**Mean**
Cattle dung	0.39	0.45	0.47	0.48	**0.45**	0.46	0.49	0.52	0.40	**0.47**
Piggery waste	0.35	0.46	0.56	0.59	**0.50**	0.49	0.42	0.45	0.60	**0.49**
Poultry	0.40	0.48	0.50	0.45	**0.46**	0.48	0.59	0.44	0.52	**0.51**
Mean	**0.30**	**0.46**	**0.51**	**0.51**		**0.47**	**0.50**	**0.47**	**0.51**	
LSD (0.05) manure sources = 0.08							**0.09**			
LSD (0.05) manure rates = 0.09							**0.10**			
LSD (0.05) manure sources x rates = 0.15							**0.18**			

8 weeks after treatment application

	2014					2015				
Manure sources	0	10	15	20	mean	0	10	15	20	Mean
Cattle dung	0.67	0.72	0.70	0.74	**0.76**	0.92	1.33	1.30	0.68	**1.06**
Piggery waste	0.64	0.85	0.78	0.75	**0.71**	0.95	1.04	0.96	0.99	**0.98**
Poultry	0.67	0.71	0.80	0.73	**0.73**	0.76	1.02	1.02	1.29	**1.02**
Mean	**0.66**	**0.76**	**0.77**	**0.74**		**0.87**	**1.13**	**1.09**	**0.98**	
LSD (0.05) manure sources = 0.08							**0.40**			
LSD (0.05) manure rates = 0.09							**0.47**			
LSD (0.05) manure sources x rates = 0.15							**0.81**			

The plant height shows rate of assimilation of soil nutrients. It is important in crop development because it has relationship with the number of leaves which plays significant role in photosynthesis (Olaniyan *et al*., 2009). The manures were able to increase the plant growth. One of the reasons behind citrus nursery production is to quicken the time required for the seedlings to reach buddable stage. The required stem girth for budding is 0.65 cm (Olaniyan *et al.*, 2009). The manure sources applied at 15 t/ha and 20 t/ha increased stem girth as mean stem girth of 0.7cm and above was attained at 8 WATA which was significantly different relative to the control (Table 6). This confirms the earlier findings of Lawal *et al* (2009) that application of 20 t/ha poultry manure improved citrus rootstock performance. The increased growth performance might be attributed to the ability of the organic manures to improve soil properties and release of essential nutrient elements (Onwuka *et al*. 2008), which in turn favoured the growth parameters measured.

Conclusion

The different manure sources and rates were able to improve the growth rate of the citrus rootstock relative to the control. Cattle dung increased number of leaves and number of branches while, poultry manure showed best performance in terms of plant height and stem girth. Application rate of 20 t/ha recorded highest mean value in number of leaves, plant height, number of branches as well as stem girth and is therefore recommended.

References

Adewale, J.A., Oladosu, L.D and Laogun, E.A (1996). Factors limiting fruit tree production in south western Nigeria. Implication for extension strategy. Proceeding of 14th annual conf. of Horticultural Soc. of Nigeria. 1st-4th April. 200-204pp

Akani, D.I and Ojeniyi ,S. O (2007). Effect of different levels of poultry manure on soil physical properties , nutrient status , growth and yield of maize .Nig. Journ. Of soil science vol. 20 (2) 47-53.

Aubert,B and Vullin,G (1998). Citrus nurseries and planting techniques. Centre for International Cooperation in Agronomical Research for Development, France, ISBN 2-87614-328-3.

Lawal I. O., Okafor B. N., Olaniyan, J. O. and Adeyemo P. O. (2009). Response of citrus Rootstock varieties to different sources of fertilizers. Proceeding of the 27th Annual Conference of Horticultural Society of Nigeria. Pp37-40

Mbagwu, J. S. C, (1992). Improving the productivity of a degraded ultisol in Nigeria using organic and inorganic amendments, chemical properties and maize yield. Bioresources tech. no.42:149- 154.

Nandekar, D.N. and Swarkar,S.D (1990) . Orissa J. Hort. (18 (1) (c.,f.hort.asbst.62(11).

Nottidge, D.O, Ojeniyi S.O. and Asawalam, D.O. (2005). Comparative effect of plant residues and NPK fertilizer on soil properties in a humid Utisol. *Nigeria Journal of Soil Science.* Pp. 15, 19-13.

Nottidge, D.O., Ojeniyi S.O. and Asawalam, D.O. (2007). Effect of different levels of wood ash nutrient content of maize (Zea may L) and grain yield in an ultisol of south-easthern Nigeria. *Journal of Soil Science* 17: 98 – 103.

Olaniyan, A.A, Okafor,B.N, Lawal ,O.I, Amih,C.A and Ojo, A.T (2009). Effect of nitrogen

fertilizer application on rough lemon citrus rootstock seedlings in the nursery. Proceedings of 27th Horticultural Society of Nigeria conf. Oct.11 – 16, 2009. Pp 44-48

Omotayo, O.E and Chukwuka, K.S (2009). Soil fertility restoration techniques in Sub-Saharan Africa using organic resources. African journal of Agric Research. Vol 4(3) pp 144 – 150.

Onwuka, M. I., Osodeke, V. E and Ano, A. O, (2008). Assessment of the effects of some liming materials on some soil chemical properties in a degraded ultisol of Southeastern Nigeria. Nig. Journ. of soil science. Vol 20(2), pp54-66.

Said A.H. 1997. Influence of Some Organic fertilizers on the growth and Yield of Pepper Plants (Capsicum annum L.) cultivated under plastic houses. M.Sc. Thesis, Fac. Agric. Ain Shams Univ., Egypt

Zhang, C.L, Zhang, Y.D, Gao, Z.M, Xu, G.H, Wang, L.Y and Zhou, Q.S (1998). Journal of Soil Science and Chemistry. 19 (6). 276 - 278