Journal of Engineering and Applied Sciences 14 (24): 9613-9618, 2019
ISSN: 1816-949X

Promoting Soil Productive Capacity using Manure Sources for Enhanced Tomato Growth and Fruit Yield

[1]S.A. Abolusoro, [2]P.F. Abolusoro, [1]C.O. Aremu, [1]S.A. Ige and [3]N.B. Izuogu
[1]Department of Crop Science. Landmark University Omu Aran Kwara State, Nigeria
[2]Department of Agriculture Education, Kogi State College of Education Technical Kabba
[3]Crop Production Department, University of Ilorin, Kwara state, Nigeria, ige.sunday@lmu.edu.ng

Abstract: Field experiment was conducted in Guinea savannah ecological zone of South Western Nigeria in the year 2016 and 2017, respectively to evaluate the effects of different manures (phyto feed, poultry, pig and NPK fertilizer) on the performance of tomato Var Lindo F1. The organic manures were applied at the rate of 0, 5, 10, 15 and 20 ton/ha while NPK fertilizer was applied at the rate of 0, 150, 200, 250 and 300 kg/ha. The experimental design was factorial fitted into randomized complete block. The result from the experiment showed that all the manures had positive correlation on the growth and yield of tomato. Plant height, number of leaves, stem girth and fruit yield were significantly improved in all the manure treatments compared with the untreated control. Higher dosage of manures 20 and 15 ton/ha of organic manures and 300 and 250 kg/ha of NPK in most cases recorded improved growth and yield compared with lower dosages. It is therefore recommended that organic manure at 20 and15 ton/ha or NPK fertilizer at 250 and 300 kg/ha should be applied if tomato is to be produced in the ecological zone for optimum yield.

Key words: Manure, tomato, growth, yield, performance, NPK fertilizer

INTRODUCTION

Tomato, *Solanum lycopersicum* L. is a very important vegetable crop worldwide. It originated from South America Andes (Heuvelink, 2005) and spread around the world following the Spanish colonization of the Americans. World production of this important fruit vegetable is put at 130 million metric tonnes annually (Ahmad *et al*., 2009). Tomato production level in Nigeria is 6 million metric tons on 126,000 ha of land (Idah and Aderibigbe, 2007). This is rather low for a country with an annual population growth rate that exceeds its food production being 2.7 and 2.9, respectively between 1990 and 1997 which narrowed down to 2.6 and 2.7 between 1998 and 2003. Apart from the scarcity of land for arable farming and desertification which has resulted into continuous use of the available land for cropping without a period of fallow. Other factors that contributed to low tomato yield in Nigeria are low soil fertility and unfavorable soil physical properties such as bulk density (Adekiya and Ojeniyi, 2002). Obi and Akinsola (2005) also reported that among the factors contributing to low fruit yield of tomato are depletion of soil fertility, soil acidity and nutrient in balance arising from continuous use of fertilizer. The increase in population put at 2.6 and 2.7 between 1998 and 2003 at the expense of food production is a clear indication that urgent action must be taken to prevent starvation. This can be done by exploiting every available opportunity to increase the fertility of agricultural land. Hence, research attention recently shifted to use of animal wastes which are abundantly produced (Nwajiuba and Chimezie, 2000). The benefits of using organic materials have not been fully reached in the humid tropics because of the huge quantities required to satisfy the nutritional needs of crops. There is also the need to obtain maximum economic value of plant nutrients and protect the water supplies from excessive run off or leaching. There is need to study and determine the appropriate quantity of synthetic fertilizer where available and organic manure for increasing the growth and yield of tomato to be able to meet its demand for the increasing population and also reduce excessive application. This research work aims to compare the performance of the different manure sources on the growth and yield of tomato and determine the appropriate level of different manures that will optimize the fruit yield of tomato.

Corresponding Author: S.A. Ige, Department of Crop Science. Landmark University Omu Aran Kwara State, Nigeria
ige.sunday@lmu.edu.ng

MATERIALS AND METHODS

Descriptions of the research site: The experiment was carried out at the Department of Crop Science Research Farm, University of Nigeria, Nsukka located in the derived savannah ecology (latitude 06' 52 N, longitude 07' 24 E 447.26 m above sea level.

Sources of materials used: Phyto feed (compost) was prepared at Faculty of Agriculture, Department of Crop Science University of Nigeria, Nsukka, poultry manure was obtained from a poultry farm at Nru-Nsukka. Pig manure was collected from villagers that rear pigs. The lindo F1 (determinate) tomato seed was obtained from NIHORT Ibadan. NPK fertilizer was purchased from agrochemical shop at Nsukka.

Nursery preparation: Topsoil, well-cured poultry manure and river sand were mixed at a ratio of 3:2:1, respectively and put into nursery baskets of average size. The baskets were watered for 5 days before sowing. The seedlings were transplanted to the field 3 weeks after emergence.

Planting time: The experiment was conducted between the month of April and August in 2013 and was repeated about the same time in the year, 2014.

Experimental design: The experiment is a 4×5 factorial fitted into a Randomized Complete Block Design (RCBD) with three replications. Each block contained 20 plots and each plot twelve plants. The treatment comprised of three organic manures namely, poultry manure, pig manure, phytofeed these organic manure were applied as soil amendment and were applied at the rates of 0, 5, 10, 15, 20 ton/ha 2 weeks before transplant. Chemical fertilizer NPK at 0, 150, 200, 250, 300 kg/ha 5 weeks after planting. Each plot had a dimension of 2 by 3 m. The plots were separated by a pathway of 0.5 m. The following data were collected from the tomato plant in each of the experiment:

- Stem elongation
- Number of leaves
- Stem girth
- Average fruit weight

Statistical analysis: The mean of the data for the 2 years were pooled together and subjected to Analysis of Variance (ANOVA) and treatment means were compared using the Fisher Least Significant Difference (F-LSD) at 5% probability level as stipulated by Obi and Akinsola (1995). Statistical analysis was done using Discovery Edition 3.

RESULTS AND DISCUSSION

Weather record of the location of the experiment is presented in Table 1. The maximum and minimum temperatures were 30.67 and 21.17°C in 2013 and 31.3 and 20.17°C in 2014. The humidity was high (76.16 and 72.26%) in 2013 and 2014, respectively. Plants on the field received water only from rain. The highest amount of rainfall recorded was 283.96 mm 2013 July and 271.79 mm in June, 2014.

The pre-planting soil analysis showed that soil textural class was clay loam (Table 2). The pH showed that the soil was acidic with a pH value of 4.8. The organic content 1.43% and nitrogen content of 0.29%, available phosphorus 2 ppm were low.

The chemical constituents of the three organic manures are shown in Table 3, the samples of poultry

Table 1: Weather record of the location of the experiment

	2016					2017				
Month	RF (mm)	T (min.) (0°C)	T (max.) (0°C)	RHm (%)	RHe (%)	RF (mm)	T (min.) (0°C)	T (max.) (0°C)	RHm (%)	RHe (%)
Jan.	21.84	20.55	31.23	75	75	0	19.29	31.74	62.06	61.35
Feb.	0	22.18	32.86	75	75	0	22	33.32	67.89	54.11
Mar.	38.1	22.58	32.81	72.74	62.94	14.23	22.52	31.71	72.77	65.55
Apr.	183.81	22.30	30.67	74	68.9	105.16	22.3	31.3	69.93	70.53
May.	198.63	21.61	29.52	74.77	69.87	241.14	21.06	28.29	72.26	72
Jun.	168.6	21.17	28.67	75.67	72.7	271.79	20.87	29.13	72	72
Jul.	283.96	20.71	27.35	74.9	73.61	195.81	20.9	27.74	72.19	72.19
Aug.	219.18	20.26	26.61	76.13	76.16	92.36	20.71	27.29	72	72
Sept.	197.6	20.50	27.43	77	77	401.99	20.33	27.9	73	73
Oct.	167.9	20.74	28.55	77	77	211.08	20.84	28.9	73	72.77
Total	1479.62	212.60	295.7	752.21	728.18	1533.56	210.82	297.32	707.1	685.5
Mean	147.96	21.26	29.57	75.22	72.82	153.36	21.08	29.73	70.71	68.55

University of Nigeria, Nsukka; RF = Amount of Rainfall; T (min.) = Minimum Temperature; T (max.) = Maximum Temperature; RHm = Relative Humidity in the morning, RHe = Relative Humidity in the evening

Table 2: The physical and chemical properties of the soil before the application of manure

Parameters	Values
Particle size distribution (%)	
Sand	22
Silt	35
Clay	43
Textural class	Clay loam
Soil pH (H_20)	4.8
Total nitrogen (%)	0.29
Organic carbon (%)	0.83
Organic matter content (%)	1.43
Exchangeable cations (meq/100 g)	5.0 mg/100 g
Cation exchange capacity	5.00
Available phosphorus (ppm)	2.00

Table 3: The physical and chemical constituents of the organic manure

Manure types	Phyto feed	Pig	Poultry	Soil
pH (H_2O)	6.82	5.13	6.90	4.8
Organic carbon (%)	3.99	3.87	3.87	0.83
Organic matter (%)	6.78	6.74	6.74	1.43
Available P (ppm)	6.00	7.00	12.00	2.00
Total nitrogen (%)	1.12	1.21	2.21	0.29
Calcium (%)	1.18	1.10	1.40	Negligible
Magnesium (%)	0.46	0.42	0.55	Negligible
Potassium (%)	2.22	2.12	2.36	Negligible

manure has pH (6.90), phyto feed pH levels is 6.82 while pig manure had pH (5.13). The nitrogen levels were also quite high with the following values 2.21, 1.12 and 1.21% for poultry, phyto feed and pig manure, respectively. Organic matter was highest in phyto feed manure (6.78%), available P was highest in poultry manure 12 ppm.

Table 4 revealed that organic treatments (poultry, phyto and pig) manure significantly improved the height of the tomato plant better than the NPK fertilizer at all the dosage level tested. The plants treated with the higher dosage of poultry manure (15 and 20 ton/ha) improved the plant height better than other organic and inorganic manure (NPK fertilizers) tested. The highest height (86.23 cm) was recorded from plots treated with 20 ton/ha of poultry manure in the 2 years of the experiment.

Table 5 showed that all the treatment significantly improved the number of leaves per plant compared with the control. All the tested manures at the two higher levels (15 and 20 ton/ha for organic manures and NPK at 250 and 300 kg/ha) significantly improved the number of

Table 4: Analysis of variance on the height of tomato due to treatments application

Manure/Levels	APH 6WAP	APH 8WAP	APH 10WAP	APH 12WAP
Phyto				
0.00	12.75	19.42	23.08	23.92
5.00	20.00	37.08	42.80	43.61
10.00	22.17	49.50	61.00	61.50
15.00	27.42	58.17	67.33	67.70
20.00	28.89	58.85	69.50	70.00
Pig				
0.00	12.17	17.67	20.92	21.33
5.00	20.72	38.17	55.75	57.00
10.00	26.83	43.67	62.83	64.50
15.00	26.92	49.42	66.83	68.14
20.00	27.58	40.33	70.83	71.84
Poultry				
0.00	14.08	18.75	22.42	23.87
5.00	23.90	56.08	62.25	63.33
10.00	26.42	62.42	69.33	69.90
15.00	31.83	62.42	73.00	74.00
20.00	33.42	68.00	84.33	86.23
NPK				
0.00	11.83	16.97	21.83	22.47
150.00	19.50	28.98	34.42	35.22
200.00	23.62	35.58	42.43	43.00
250.00	23.67	31.32	40.83	41.76
300.00	25.75	32.35	42.17	44.90
Mean	22.97	41.26	51.69	52.71
	F-LSD (0.05) 7.92	NS	9.63	7.33

APH = Average Plant Height; WAP = Weeks After Planting

Table 5: Analysis of variance on the number of leaves of tomato due to treatments application

Manure/Levels	ANL 6WAP	ANL 8WAP	ANL 10WAP	ANL 12WAP
Phyto				
0.00	4.25	8.00	10.00	10.02
5.00	5.42	11.83	14.50	14.57
10.00	5.92	12.50	15.95	16.03
15.00	6.92	13.08	16.40	16.48
20.00	7.75	14.58	18.50	18.60
Pig				
0.00	3.83	7.75	9.92	9.94
5.00	6.69	12.33	15.25	15.37
10.00	7.25	13.42	16.75	16.84
15.00	8.58	13.83	17.27	17.48
20.00	7.58	13.54	19.00	19.14

Table 5: Continue

Manure/Levels	ANL 6WAP	ANL 8WAP	ANL 10WAP	ANL 12WAP
Poultry				
0.00	5.42	7.35	9.83	9.95
5.00	6.25	12.83	14.75	14.88
10.00	7.92	14.67	17.25	17.38
15.00	8.90	15.92	19.83	19.98
20.00	10.42	18.92	23.25	23.51
NPK				
0.00	3.67	7.08	9.42	9.99
150.00	4.83	8.58	11.67	14.57
200.00	5.33	9.95	13.50	16.07
250.00	5.37	10.58	14.42	16.57
300.00	4.78	12.53	15.92	18.33
Mean	6.37	11.95	15.17	10.21
F-LSD (0.05)	NS	1.93	1.62	1.23

ANL = Average Number of Leaves, WAP = Weeks After Planting

Table 6: Analysis of variance on the stem girth of tomato due to treatments application

Manure/Levels	ASG 6WAP	ASG 8WAP	ASG 10WAP	ASG 12WAP
Phyto				
0.00	1.88	2.61	2.95	2.98
5.00	3.04	3.77	4.04	4.11
10.00	3.31	3.99	4.47	4.56
15.00	3.81	4.57	4.98	5.20
20.00	4.05	5.00	5.43	5.46
Pig				
0.00	1.81	2.55	2.91	2.94
5.00	2.81	3.66	4.24	4.36
10.00	3.21	4.03	4.54	4.63
15.00	3.54	4.57	5.19	5.25
20.00	3.10	4.52	5.10	5.18
Poultry				
0.00	1.73	2.60	2.90	2.93
5.00	3.51	4.87	5.48	5.56
10.00	3.85	5.27	5.79	5.93
15.00	3.87	5.78	6.24	6.38
20.00	4.09	6.44	6.93	7.07
NPK				
0.00	1.85	2.53	2.74	2.82
150.00	2.27	3.00	3.33	3.43
200.00	3.13	3.81	3.89	3.98
250.00	3.36	3.84	4.19	4.33
300.00	3.57	4.09	4.48	4.55
Mean	3.09	4.08	4.49	4.57
F-LSD (0.05)	0.48	0.50	0.36	0.35

ASG = Average Stem Girth; WAP = Weeks After Planting

leaves. The organic manure treatments improved the number of leaves compared with the control. Better performance in terms of leaves production was observed in all the manure treatments and inorganic manure (NPK). The improvement is proportional to the level of application.

Table 6 showed that the highest levels of organic manure treatments (15 and 20 ton/ha) recorded significantly higher stem girth than the inorganic manure (NPK) treatments. Poultry at 20 ton/ha recorded the highest average mean of 7.07. Table 7 showed that all the treatment levels resulted in significantly greater fruits weight per plant than the untreated control. The weight of plant treated with 15 and 20 ton/ha organic manure were better than inorganic manure treatment at its two highest levels (250 and 300 kg/ha). The yield output valued vary in direct proportion to the levels of treatment applied in all the manures.

According to Oladokun *et al.* (1987), growth can be evaluated by measuring certain vegetative character of the plant. These include plant height, number of leaves, days to flower initiation, days to 50 and 100% flowering number of fruit, etc. The results from the experiment showed that plant height, number of leaves and yield were increased in all the tomato plants treated with various manure. It was observed that, tomato plants that were treated with 20 and 15 ton/ha of organic manure and 300 and 250 kg/ha of NPK in most case, recorded higher number of leaves and yield compared with the tomato plants treated with lower levels of manure 10 and 5 ton/ha of manure and 200 and 150 kg/ha NPK fertilizer in the two years of the experiment. These observation agreed with Akanni and Ojeniyi (2007), Adediran *et al.* (2003), Adekiya and Agbede (2009), Awosika *et al.* (2014). Stephenson *et al.* (1990) who reported similar observation in their various experiments.

Table 7: Analysis of variance on the fruit weight of tomato due to treatments application

Manure/Levels	AFRW	AFRWPP	AFRWL	Y (ton/ha)	AFRC	AFRL
Phyto						
0.00	9.17	27.19	112	1.00	8.37	3.50
5.00	38.19	266.00	1131	9.85	12.77	7.19
10.00	40.44	434.50	1853	16.09	14.10	6.88
15.00	43.58	498.90	2020	18.48	14.30	7.29
20.00	44.87	527.00	2206	19.52	14.00	7.75
Pig						
0.00	9.00	27.00	108	1.00	8.23	3.58
5.00	38.97	277.60	1112	10.28	12.13	5.55
10.00	43.04	438.70	1738	16.25	13.00	6.55
15.00	43.31	505.10	1996	18.70	14.53	7.33
20.00	44.13	551.50	2108	20.40	15.07	7.79
Poultry						
0.00	9.10	32.60	131	1.21	8.23	3.60
5.00	43.02	353.80	1415	13.10	14.26	6.66
10.00	47.80	522.50	2088	19.35	15.27	7.42
15.00	52.54	631.40	2529	23.39	15.40	7.75
20.00	53..63	805.90	3223	29.84	17.07	8.51
NPK						
0.00	9.60	26.00	124.	0.96	8.17	3.47
150.00	24.14	173.00	672	6.40	9.00	3.57
200.00	26.11	208.30	836	7.71	10.00	4.20
250.00	29.55	256.60	1026	9.50	10.57	5.43
300.00	30.04	346.70	1398	10.00	10.76	6.09
F-LSD	(0.05)	152.00	85.77	327.2		1.19
	0.33					

AFRW = Average Fruit Weight; AFRWPP = Average Fruit Weight Per Plant; AFRWPL = Average Fruit Weight; ANFL = Average Number of Flower per plant; ANFR = Average Number of Fruit per plant

Agele (2001) also found that poultry manure litters resulted in better growth and yield of tomato than NPK fertilizer alone. Bertand and Cleyetmarel stated that the positive effect of organic fertilizers added to soil may be attributed to stimulating the activity of bacteria which promote the released availability of N, P and the other nutrients in the soil and enhances nutrients absorption by tomato roots, Kandil and Gad (2009) pointed that organic manure enhances nutrients absorption root and translocation to upper parts of broccoli plants. Gianquinto and Borin (1990) who found that the contribution of manure is very favorable to the high yield of industrial tomato. The number of flowers, number of fruits and yield per plant and total fruit yield per hectare were significantly improved by the sole applications of poultry manure and mineral N fertilizer (Olaniyi and Ajibola, 2008).

CONCLUSION

The best plant development, higher yield and higher fruit yield was achieved from the composted poultry and cattle manures application as compared to other organic fertilizers and control treatments (Durdane *et al*., 2011. Giardini *et al*. reported an increased yield of onion bulbs due to poultry manure which produced yields of more than 35 ton/ha, they have also reported that the highest yield of tomato and marketable yield of tomato due to combined application of poultry manure and mineral fertilizers. In ferralitic soils of Nigeria, Oikeh and Asiegbu (1993) obtained highest tomato yields (10 ton/ha 1) out of poultry and swine manures. The observation from this research showed that application of manure enhance growth and yield of tomato crop, it is therefore recommended that manure should be applied judiciously in line with the recommended doses for enhanced tomato growth and yield in confirmation of the findings of earlier researchers.

REFERENCES

Adediran, J.A., L.B. Taiwo and R.A. Sobulo, 2003. Comparative nutrient values of some solid organic wastes and their effect on tomato (*Lycopersicon esculentum*) yield. Afr. Soils, 33: 99-113.

Adekiya, A.O. and S.O. Ojeniyi, 2002. Evaluation of tomato growth and soil properties under methods of seedling bed preparation in an Alfisol in the rainforest zone of southwest Nigeria. Soil Tillage Res., 64: 275-279.

Adekiya, A.O. and T.M. Agbede, 2009. Growth and yield of tomato (*Lycopersicon esculentum* Mill) as influenced by poultry manure and NPK fertilizer Emir. J. Food Agric., 21: 10-20.

Agele, S.O., 2001. Growth and yield of tomato grown on degraded soil amended with organic wastes. Proceedings of the 35th International Conference on Agricultural Society of Progress Vol. 20, September 16-21, 2001, University in Abeokuta, Nigeria, pp: 151-154.

Ahmad, S., A.K.M. Quamruzzaman and M. Nazim Uddin, 2009. Combining ability estimates of tomato (*Solanum lycopersicum*) in late summer. SAARC. J. Agri., 7: 43-56.

Akanni, D.I. and S.O. Ojeniyi, 2007. Effect of different levels of poultry manure on soil physical properties, nutrients status, growth and yield of tomato (*Lycopersicon esculentum*) Res. J. Agron., 1: 1-4.

Awosika, O.E., M.A. Awodun and S.O. Ojeniyi, 2014. Comparative effect of pig manure and NPK fertilizer on agronomic performance of tomato (*Lycopersicon esculentum* Mill.). Am. J. Exp. Agric., 4: 1330-1338.

Durdane, Y., G. Naif, Y. Yusuf, A. Mine and C. Perihan, 2011. Effect of different organic fertilizers on yield and fruit quality of indeterminate tomato (*Lycopersicon esculentum*). Sci. Res. Essays, 6: 3623-3628.

Gianquinto, G. and M. Borin, 1990. Effect of organic and mineral fertilizer application and soil type on the growth and yield of processing tomatoes (*Lycopersicon esculentum* Mill). Agron. Mag., 24: 339-348.

Heuvelink, E., 2005. Tomatoes: Crop Production Scicence in Horticulture 13. CABI Publishing, Wallingford, Oxfordshire, UK., ISBN:9781845931490, Pages: 339.

Idah, A.P. and B.A. Aderibigbe, 2007. Quality changes in dried tomatoes stored in sealed polythene and open storage systems. Leonardo Electron. J. Pract. Technol., 10: 123-136.

Kandil, H. and N. Gad, 2009. Effect of inorganic and organic fertilizers on growth and production of broccoli (*Brassica oleracea* L.). J. Agric. Sci. Mansoura Univ., 34: 10771-10779.

Nwajiuba, C. and P. Chimezie, 2000. The use of livestock wastes in soil fertility regeneration in Imo state of Nigeria. Proceedings of the 1st Annual International Conference on College of Agriculture and Veterinary Medicine, September 10-13, 2000, Abia State University, Uturu, Nigeria, pp: 137-140.

Obi, A.O. and A.O. Akinsola, 1995. The effect of lime application on the yield of tomato and chemical properties of an Iwo soil in Southwestern Nigeria. Nig. J. Soil Sci., 11: 77-87.

Oikeh, S.O. and J.E. Asiegbu, 1993. Growth and yield responses of tomatoes to sources and rates of organic manures in ferralitic soils. Bioresour. Technol., 45: 21-25.

Oladokun, M.A., M.A.O. Okanla and E.B Esan, 1987. Effects of plant population density on growth and yield of four tea (*Camellia sinesis* L.) clones Mambilla Plateau. N. J. Agron., 2: 1-4.

Olaniyi, J.O. and A.T. Ajibola, 2008. Effects of inorganic and organic fertilizers application on the growth, fruit yield and quality of tomato (*Lycopersicon lycopersicum*). J. Applied Biosci., 8: 236-242.

Stephenson, A.H., T.A. McCaskey and B.G. Ruffin, 1990. A survey of broiler litter composition and potential value as a nutrient resource. Biol. Wastes, 34: 1-9.