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COMPLEMENTARY USE OF POULTRY MANURE AND INORGANIC FERTILIZER IN GINGER PRODUCTION ON AN ULTISOL OF SOUTH EASTERN NIGERIA.

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ABSTRACT

A trial was conducted at Umudike, Nigeria in 1998/1999 and 1999/2000 cropping seasons to determine the effect of complementary use of inorganic fertilizer and organic manure (poultry manure) on the yields of two varieties of ginger (UGI and Maran) compared with the recommended rate of inorganic fertilizer alone. Complementary use of inorganic fertilizer and poultry manure gave consistently higher ginger yields over both the recommended dose of inorganic fertilizer alone and the control (no fertilizer). No significant (P=0.05) soil amendment x ginger variety interaction was observed. Highest ginger yield of 22.52 t ha^{-1} was obtained with 4 t ha^{-1} PM mixed with 45 kg ha^{-1} NPK 15: 15:15, which was significantly different from both 17.16 t ha^{-1} and 17.81 t ha^{-1} obtained with full dose of inorganic fertilizer and no fertilizer application (control) respectively. Complementary use of inorganic fertilizer and poultry manure also resulted in higher plant height over both the control and inorganic fertilizer alone in Maran variety but the effect on UGI was not consistent. Number of tillers per ginger plant was not affected by soil amendment. Higher benefit cost ratios were obtained with complementary use of inorganic fertilizer and poultry manure over inorganic fertilizer alone. The highest benefit cost ratio was obtained with 4 t ha^{-1} poultry manure mixed with 45 kg ha^{-1} NPK 15:15:15.

INTRODUCTION

One of the major constraints to ginger and indeed crop production generally in Nigeria is declining soil fertility (Unamma et al., 1985). In the past soil fertility has been maintained through long fallowing (Agboola and Unamma 1994). Presently due to population pressure, fallow periods have reduced from 10 years to between 1 and 2 years resulting to declining crop yield. The use of inorganic fertilizer alone to achieve high crop yield in the Nigeria farming systems has been found to be unsustainable (Obigbesan and Amalu, 1985). Inorganic fertilizer is scarce and the cost has risen beyond the reach of resource poor farmers. In addition, soils of southeastern Nigeria and most parts of the humid tropics have low activity clays which are characterized by low cation exchange capacity (CEC). Most of the fertilizers applied to these soils are lost to leaching and the expected yield increases is most often not achieved. Soil scientists are now shifting emphasis from the use of inorganic fertilizer alone to the use of mixtures of organic manures and inorganic fertilizer termed complementary use of organic manure and inorganic fertilizer. In India, Yadav et al, (2000) obtained consistently higher crop yields with NPK fertilizer mixed with organic manure (farm yard manure) over NPK inorganic fertilizer alone in a long term experiment. Farmers prefer substituting a proportion of the inorganic fertilizer requirement of their crops with organic manures especially poultry manure because these farmers

generate the organic manures in their farming system (Ano and Ikwelle, 2000). Complementary use of organic manure and inorganic fertilizer is therefore expected to reduce crop production cost for the farmer. The objective of this study was to determine the effect of complementary use of inorganic fertilizer and poultry manure on the yield of two ginger varieties (UGI and Maran).

MATERIALS AND METHOD

The trial was conducted at the research farm of the National Root Crops Research Institute, Umudike, Nigeria (05° 29' N, 07° 33' E) during 1998/1999 and 1999/2000 cropping seasons. The soil was an Ultisol and had a pH in water of 5.2, 2.86% organic matter, 0.18% total nitrogen, 8.5mg kg^{-1} Bray I P, exchangeable Ca, Mg, K, of 2.80 cmol kg^{-1}, 1.60 cmol kg^{-1} and 0.03 cmol kg^{-1}, respectively. The effective cation exchange capacity (ECEC) of the soil was 5.45 cmol kg^{-1}. the experimental site received a total rainfall of 1975.9 mm and 2601.3 mm in 1998 and 1999 respectively (Table 1.)

The field was slashed ploughed and 3 m x 2m plots were then marked out with a space in between plots maintained at 1m. The trial was 2 x 8 factorial experiment arranged in a randomized complete block design replicated three times. The treatment comprised ginger varieties and soil amendments: Ginger varieties:

Variety 1= yellow ginger (UGI), and Variety 2 = Maran

Soil amendment:

Soil amendment comprised the recommended dose of inorganic fertilizer and inorganic fertilizer mixed with poultry manure (PM) at various proportions as shown below:

1. 4 t ha^{-1} PM mixed with 45% F
2. 4 t ha^{-1} PM mixed with 30% F
3. 4 t ha^{-1} PM mixed with 15% F
4. 2 t ha^{-1} PM mixed with 45% F
5. 2 t ha^{-1} PM mixed with 30%
6. 2 t ha^{-1} PM mixed with 15%
7. F (Recommended inorganic fertilizer) (FFD 2002)
8. No amendment applied (Control)

The recommended rate of inorganic fertilizer for ginger production on theUltisol of southeastern Nigeria is 300 kg ha^{-1} NPK 15:15:15 (FFD 2000). Seed pieces (portions of the rhizome) of about 10g sett obtained from large ginger rhizomes were sown on tractor ploughed and harrowed field at an intra row spacing of 0.20 m and inter row spacing of 0.20 m. appropriate quantities of inorganic fertilizer (NPK 15:15:15) bought from Agro-Supply Centre Umuahia were mixed with appropriate quantities of poultry manure purchased from Michael Okpara University of Agriculture, Umudike Poultry Farm. The poultry manure had analysis value of 1.2%N, 0.8%P, 0.9% K and C:N 15. The soil amendments were applied at 5 days after planting by broadcasting. Mulching of the plots to the thickness of about 5 cm was therefore carried out using wilted guinea grass (*Panicum maximum*) shoots. In 1998/1999 cropping season the experiment was established in May and harvested in Januray 1999 (30 weeks after planting,(WAP) while in 1999 the trial was also planted in May and harvested in January 2000. number of tillers per stand and plant height were recorded at 20 WAP on five plants from the inner-most row of each plot. Ginger was harvested at 30 WAP, and crop yield obtained from the net plot. Cost of input/operations were recorded. National Root Crops Research Institute farm gate price of harvested ginger was also recorded. The data for the two cropping seasons were pooled and analysed using the general linear model of SAS software (SAS, 1985).

RESULTS

Ginger Yield:

The effect of levels of poultry manure (PM) and inorganic fertilizer mixtures and inorganic fertilizer applied alone on ginger yield is shown in Table 2. Application of soil amendment significantly ($P < 0.05$) influenced ginger yield, however there was no significant difference ($P > 0.05$) between the yields of the two ginger varieties. Soil amendment x ginger variety interaction was also not significant. Highest ginger yield of 22.52 t ha^{-1} was obtained with 4 t ha^{-1} PM mixed with 45 kgha^{-1}NPK 15:15:15, which was significantly 17.81 t ha^{-1} obtained with full dose of inorganic fertilizer and no fertilizer (control) respectively.

Complementary use of inorganic fertilizer and organic manure (PM) resulted to significantly ($P < 0.05$) higher plant height over both the controla nd inorganic fertilizer alone in Maran variety. In UG1 variety, completentary use of inorganice fertilizer and organic manure (PM) did not have consistent effect on the plant height.

Benefit cost analysis:
The revenue profile and the benefit cost ratio by treatment is given in Table 5 while Table 6 shows the production cost by treatment. Complementary use of inorganic fertilizer and poultry manure consistently resulted to higher benefit cost ratio over both inorganic fertilizer alone at the conrol. The highest benefit cost ratio for both ginger varieties were obtained with 4t PM mixed with 45 kg ha^{1}

Ginger yields obtained with inorganic fertilizer alone and the control were statistically comparable. Number of tillers per ginger plant, recorded 20 weeks after planting (WAP) was not influenced by soil amendment (Table 3). There was also no soil amendment x ginger variety interaction. However ginger variety UGI had more tillers per plant than Maran variety (Table 3). The effect of soil amendments on ginger plant height is shown in Table 4. Application of soil amendment significantly ($P < 0.05$) influenced the ginger plant height. Ginger variety x soil amendment interaction was significant at $P < 0.05$.

DISCUSSION

Complementary use of inorganic fertilizer and poultry manure resulted to higher ginger yield over inorganic fertilizer alone. Highest ginger yield of 22.52 t ha^{-1} was obtained with 4 t ha^{-1} PM mixed with 45 kg ha^{-1} NPK 15:15:15, which was significantly different from both 17:16 t ha-1 and 17.18 t ha-1 obtained with full dose of inorganic fertilizer and no fertilizer application (control) respectively. This result is in agreement with Ano and Ikwelle (2000), and Mokwunye, (1978). Soils of the experimental site and indeed most Nigeria soils are highly weathered and have low activity clays (Ano, 1990). The total amount of rainfall between May and August for the two seasons (1998/1999, 1999/2000) were 1267.8 mm and 1577.5 mm respectively (Table 1). Consequently when mineral fertilizers are applied to the soil under high rainfall conditions prevalent in the area, significant percentage of the fertilizers is lost to leaching. This explains why yield increases expected on application of inorganic fertilizer alone was not achieved. There is therefore an urgent need to review the inorganic fertilizer recommendation for ginger production on this soil. On the other hand, when inorganic fertilizer is mixed with organic manure and the mixture is applied to the soil, the cation exchange capacity (CEC) of the soil have been reported to have increased due among other things to the increase in soil organic matter (Yadav, et al 2000). Such increase in CEC will reduce nutrient loss through leaching. Moreover, organic manure component of the soil amendment in mixtures of inorganic fertilizer and organic manure would mineralize over time, consequently making availability of nutrient assured through out the crops growing period (Yadav et al; 2000). Crops

under such situations are therefore, expected to flourish better than when the nutrient is available for a short time before it is lost to leaching as in the case of inorganic fertilizer. This explains why complementary use of inorganic fertilizer and poultry manure gave significantly higher yield in both ginger varieties and higher plant height in Maran variety than either inorganic fertilizer alone or control (no application). No consistent effect of the soil amendment on the plant height of UGI variety was observed. This was attributed to variety x amendment interaction. Application of soil amendment did not affect the number of tillers per ginger plant indicating that some other factors other than nutrient availability could be influencing this plant characteristic.

Higher benefit cost ratios obtained with mixtures of inorganic fertilizer and poultry manure over inorganic fertilizer alone could not only be attributed to the relatively higher yield obtained with mixtures of inorganic fertilizer and poultry manure but also to the relatively lower production cost associated with complementary use of inorganic fertilizer and poultry manure compared to inorganic fertilizer alone.

Table 1. Rainfall data of the experimental site for 1998 and 1999

Month	Year			
	1998		1999	
	Rainfall (mm)	No of rain days	Rainfall (mm)	No of rain days
January	0.4	1	45.6	4
February	1.8	1	98.1	4
March	35.6	5	203.4	10
April	114.2	9	192.0	13
May	311.3	18	319.9	14
June	402.6	21	296.6	19
July	243.2	21	284.4	23
August	310.7	20	282.2	18
September	287.6	23	395.3	24
October	195.8	15	433.7	26
November	70.1	3	50.1	4
December	2.6	1	0.0	0
Total	**1975.9**	**138**	**2601.3**	**159**

(Source: National Root Crops Research Inst. Meteorology Station, Umudike).

Table 2. Effect of soil amendment [mixtures of inorganic fertilizer and poultry manure (PM)] on yield of two ginger varieties (mean of two seasons).

Soil amendment*	Ginger Ginger UGI	Yield t ha^{-1} Variety Maran	Mean
4 t ha^{-1} PM mixed with 45% F	22.07	22.10	2.09
4 t ha^{-1} PM mixed with 30% F	23.24	21.64	22.44
4 t ha^{-1} PM mixed with 15% F	23.29	21.75	22.52
2 t ha^{-1} PM mixed with 45% F	20.35	20.38	20.37
2 t ha^{-1} PM mixed with 30% F	21.45	21.04	21.25
2 t ha^{-1} PM mixed with 15% F. F	21.51	20.71	21.11
No amendment (Control)	17.75	16.57	17.16
Mean	19.91	15.70	17.81
LSD 0.05	21.20	19.99	
Soil amendment A	=3.32 t ha^{-1}		
Variety (V)	=NS		
A x V	=NS		

NS =not significant at P = 0.05; * F = 300 kg ha^{-1} NPK 15:15:15, 45% F = 135 kg ha^{-1} NPK 15:15:15; 30% F =90 kg ha^{-1} NPK 15:15:15; 15% =45 kg ha^{-1} NPK 15:15:15

Table 3. Number of tillers per ginger plant measured at 5 months after planting as influenced by soil amendment (mean of two season).

	Tillers ginger plant^{-1} Ginger variety		
Soil amendment*	UGI	Miran	Mean
4 t ha^{-1} PM mixed with 45% F	9.0	9.0	9.0
4 t ha^{-1} PM mixed with 30% F	10.0	7.0	8.5
4 t ha^{-1} PM mixed with 15% F	8.0	8.0	8.0
2 t ha^{-1} PM mixed with 45% F	9.0	7.0	8.0
2 t ha^{-1} PM mixed with 30% F	7.0	7.0	7.0
2 t ha^{-1} PM mixed with 15% F F	8.0	7.0	7.5
No amendment	8.0	7.0	7.5
Mean	9.0	8.0	8.5
LSD 0.05 Variety (V) =0.7	8.5	7.5	
Soil amendment (A) =NS			
V x A =NS			

NS =not significant at P =0.05; *F = 300 kg ha^{-1} NPK 15:15:15, 45% F =135 kg ha^{-1} NPK 15:15:15 ; 30% F= 90 kg ha^{-1} NPK 15:15:15; 15% F= 45 kg ha^{-1} NPK 15:15:15

Table 4. Ginger plant height measured at 5 months after planting as influenced by soil amendment (mean of two seasons).

Soil amendment*	Height (cm) Ginger UGI	Variety Maran	Mean
4 t ha^{-1} PM mixed with 45% F	56.70	57.80	57.25
4 t ha^{-1} PM mixed with 30% F	56.85	54.70	55.75
4 t ha^{-1} PM mixed with 15% F	56.25	57.55	56.90
2 t ha^{-1} PM mixed with 45% F	56.10	55.30	55.70
2 t ha^{-1} PM mixed with 30% F	52.70	53.09	52.90
2 t ha^{-1} PM mixed with 15% F	51.95	56.64	54.30
F	52.45	48.09	50.05
No amendment	55.15	53.85	51.62
Mean	54.77		
LSD 0.05			
Soil amendment (A)	=3.53 cm		
Variety (V)	=NS		
(V) x A = 5.00 cm			

NS= not significant at P =0.05; * F = 300 kg ha^{-1} NPK 15:15:15, 45% F= 135 kg NPK 15:15:15
30% F= 90 kg ha^{-1} NPK 15:15:15; 15% =45 kg ha^{-1} NPK 15:15:15

Table 5. Effect of soil amendment on the benefit cost ratio of production of two ginger varieties (mean of two seasons)

Soil amendment*	Total realiseable revenue (N/ha)	Total variable cost (N/ha)	Benefit cost ratio
4 t ha^{-1} PM mixed with 45% F	1546300	194460	7.95
4 t ha^{-1} PM mixed with 30% F	1570800	192840	8.14
4 t ha^{-1} PM mixed with 15% F	1576400	191220	8.24
2 t ha^{-1} PM mixed with 45% F	1425900	193160	7.38
2 t ha^{-1} PM mixed with 30% F	1487500	191540	7.77
2 t ha^{-1} PM mixed with 15% F	1477700	189920	7.78
F	1201200	197800	6.07
No amendment	1246700	187000	6.67

* F = 300 kg ha^{-1} NPK 15:15:15, 45% F= 135 kg ha^{-1} NPK 15:15:15
30% F= 90 kg ha^{-1} NPK 15:15:15; 15% =45 kg ha^{-1} NPK 15:15:15
** 1 t ginger = N 70,000: N 110 =$ 1.

Table 6. Cost of Analysis of the different soil amendments (Mean of two seasons

Cost of operation/ Input (Nha^{-1})	4 t/ha^{-1} PM + 45% F	4 t/ha^{-1} PM + 45% F	4 t/ha^{-1} PM + 45% F	Soil amendment* 2 $t\,ha^{-1}$ 45% F	4 t/ha^{-1} 2 t/ha^{-1} PM + 30% F	2 t/ha^{-1} PM + 45% F	F	C
Land preparation	2000	2000	2000	2000	2000	2000	2000	2000
Ginger Planting material	$1.75x10^5$	$1.75x10^5$	$1.75x10^5$	$1.75x10^5$	$1.75x10^5$	$1.75x10^5$	$1.75x10^5$	$1.75x10^5$
Ginger planting	3000	3000	3000		3000	3000	3000	3000
Soil amendment:				3000			10800	-
Fertilizer	4860	3240	1620		3240	1620		
Poultry manure	1600	1600	1600	4860	800	800	-	-
Amendment application	2000	2000	2000	800	1500	1500	1000	
Mulching Collection And application	2000	2000	2000	1500 2000	2000	2000	2000	2000
Weeding	1000	1000	1000	1000	1000	1000	1000	1000
Harvesting	3000	3000	3000	3000	3000	3000	3000	3000
Total variable cost	194460	191220	192840	193160	191540	189920	197800	187000

* PM = Poultry mature; F = 300 kg ha^{-1} MPK 15:15:15;
C = no application; N 110 = $1;
Cost of fertilizer and poultry manure includes purchase price and cost of transportation.

REFERENCES

Agboola, A.A. and Unamma, R.P.A. (1994). Maintenance of soil fertility under tradional farming systems. Proceedings of a National Organic fertilizer Seminar, held at Durba Hotel, Kaduna, March 26-27, 1991. Fertilizer Procurement and Distribution Dept,Fedearal Ministry of Agriculture and Natural Resources, Abuja pp 7-20.

Ano, A.O. (1990). Potassium fixation, speciation, distribution and exchange thermodynamics in soils of eastern Nigeria. Ph.D Thesis Univeristy of Ibadan, Ibadan, Nigeria.

Ano, A.O. and Ikwelle, M.C. (2000). On-farm evaluation of complementary use of poultry manure and inorganic fertilizer for cassava/maize/ telfaria intercrop. Paper presented at the International Symposium on Balanced Nutrient Management Systems for the Moist Savanna and Humid Forest Zones of Africa, Cotonou, Benin. Oct. 9-12, 2000.

Federal Fertilizer Department (200). Fertilizer use and Management practices for crops in Nigeria (eds Aduayi, E. A., Chude, V.O., Adebusuyi, B.A. and Olayiwola, S.O.) Fedearal Fertilizer Department, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria.

Mokwunye, U. (1978). Effect of farm yard manure and NPK fertilizers on crop yields and soil residual phosphorus in 24 years of cropping in Samaru. Nigeria Journal of Soil Science 12:169-179.

Obigbesan, G.O. and Amalu, U.C. (1985). Impact of long term land use with fertilizer application on the soil properties of a commercial cassava farm. In: Sobulo, R.A. and Udo, E.J. (eds) Proceedings of International Society of Soil Science (Commissions IV and VI). Soil Science Society of Nigeria, Ibadan, Nigeria, pp 234-247.

Statistical Analysis System (1985). Statistical Analysis System (SAS) User's Guide: Statistics, Version 5. SAS Institute, Cary, NC, USA.

Unamma, R.P.A., Odurukwe, S.O. Okereke, H.E., Ene, LSO and Okoli, O.O. (1985) Farming Systems in Nigeria: Report of Benchmarks Survey of the Farmiong Systems of the eastern Agricultural Zone of Nigeria. AERLS, National Root Crops Research, Institute, Umudike, Nigeria.

Yadav, R.L. Dwivedi, B.S. Prasad, K., Tomar O.K., Shurpali, N.J. and Pandey, P.S. (2000). Yield trends and changes in soil organic-C and available NPK in a long-term rice-wheat system under integrated use of manures and fertilizers. Field Crops Research 68 : 219-246.