PRODUCTIVITY OF CASSAVA, SORGHUM AND GROUNDNUT INTERCROP USING POULTRY MANURE WITH CHEMICAL FERTILIZER REPLACEMENT COMBINATIONS

Ibeawuchi,I.I.[1], Duruigbo, C.I[1] , Ihenacho,L.U.[2] , Ihejirika, G.O[1] , Ofor, M.O.[1] , Obilo, O.P.[1] and J.C. Obiefuna[1]

1.Department of Crop Science and Technology, Federal University of Technology Owerri, Nigeria

2.Imo State Polytechnic Umuagwo Imo State, Nigeria.

E-mail: i-ibeawuchi@Yahoo.com.uk

Phone: +234803794289.

ABSTRACT

This study was conducted to investigate the effects of NPK 15:15:15 fertilizer replacement combinations with poultry manure on cassava/groundnut/sorghum intercrop at the Imo State Polytechnic Umuagwuo Teaching and Research farm Owerri, South east Nigeria. The experiment was laid out using a Randomized Complete Block Design (RCBD) with four replications. The treatment combinations are: NPK 15:15:15 at 0.4kg/ha plus poultry manure at 0 tons/ha, NPK 15:15:15 at 0.3 kg/ha plus 2.5 tons/ha poultry manure, NPK 15:15:15 at 0.2 kg./ha + 5 tons/ha poultry manure, NPK 15:15:15 at 0.1kg/ha +7.5 tons/ha poultry manure. NPK 15:15:15 at 0 kg/ha + 10 tons/ha poultry manure and the control. Crop growth and yield data were measured and analyzed statistically using analysis of variance. Results indicated that the NPK 15:15:15 at 0kg/ ha + 10 tons/ha poultry manure gave the highest cassava yield of 13.38 tons/ha, sorghum 0.113 tons/ha and groundnut 0.073 tons/ha respectively. Also the highest biomass yield of groundnut of (47.9 kg/ha) was achieved in NPK 0.3 + poultry manure at 2.5 tons/ha while sorghum (297 kg/ha) was obtained in the NPK 0 + 10 tons/ha poultry manure. Soil textural class changed from sandy clay class to loamy sand at post-harvest soil analysis.

Key-words: NPK 15:15:15M poultry manure replacement, cassava, sorghum and groundnut.

INTRODUCTION

Soil fertility management on small-scale farms in the tropics has become a major concern as a result of continued land degradation and rapid population growth (F.A.O, 1981; Swaninathan, 1983 and U.N, 1989).The continuous cropping systems as being practiced by farmers in the humid and Sub-humid tropics has resulted to rapid decline in soil organic matter due to clearing (Juo *et al*, 1995b)

Continuous cultivation of land also causes a significant decline in soil P^H, exchangeable calcium, and magnesium levels and more serious problem is encountered when acidifying fertilizers are used (Ojeniyi 1995, Adepetu *et al*, 1979; Juo and kang, 1989; Juo *et al* 1995a) Cultivated highly weathered soils commonly suffer from multiple nutrient deficiencies and nutrient balances are generally negative (Tandon 1993, Mokwunye *et al* 1996). The use of inorganic fertilizers has not been helpful under intensive agriculture due to its own problems of soil acidification and nitrogen eutrophication. Bowen *et al* (1999) observed that the environmental and economic cost of using chemical fertilizers for roots and tuber crop production in developing countries has become the focus of attention for researchers. The prohibitive cost of mineral fertilizers and the environmental pollution associated with its usage calls for a gradual replacement of its use in combination with organic manure such as poultry manure.

Smith *et al* (2001) reported that the use of animal waste such as poultry manure for boosting soil fertility is economically justified.Ogbalu (1999) observed that the traditional sources of nutrients in compound farms for crop growth such as Cow dung, goat droppings and poultry manure are locally affordable and culturally accessible to resource- poor farmers than chemical fertilizers.

Also Duruigbo *et al* (2007) reported an increased yield of yam/maize/ cassava intercrop using 15 tons/ha of poultry manure. The complementary use of organic manure and mineral fertilizers has been proved to be a sound soil fertility management strategy in many countries of the world (Lombin *et al,* 1991). High and sustained crop yield can be obtained with judicious and balanced N: P: K: fertilizer in combination with poultry manure amendments (kang and Balasubranaian, 1990). There is need to integrate various practices of soil fertility maintenance which must include; mineral fertilizer, organic manure and intercropping which provides a fast and good ground cover and allows for efficient root exploitation of soil nutrients at various depths (Sterner, 1984).

Traditionally, farmers in the South-east agro-ecological zone of Nigeria practice intercropping to maintain soil fertility, increase variety of food products and stable ecosystem. Crops like cassava, yam, maize, plantain, are major crops while melon, cowpea, and vegetables are minor crops (I.I.T.A. 1990). Cassava, one of the most important food crops widely grown in Sub-Saharan Africa is well suited to intercropping with short duration crops like maize, sorghum, millet, melon, Okra, groundnut and several leafy vegetables.

There is an urgent need to ascertain the complimentary use of poultry manure and inorganic fertilizer to increase the productivity of cassava/sorghum/groundnut intercrop to boost food security and environmental safety on a sustainable basis. The current study shall evaluate the growth and yield of cassava/sorghum/groundnut intercrop in replacement combination with mineral fertilizer and poultry manure.

MATERIALS AND METHODS

The experiment was conducted at the Imo State Polytechnic Teaching and Research Farm Umuagwo Sit Owerri situated on latitude 07^0 02^E and longitude 07^0 07^E and 5^0 19N. Owerri is located in the tropical rainforest agro-ecological zone of South-east Nigeria with a mean annual rainfall of about 2,500mm, temperature of 27^0c-32^0c and a relative humidity of 89 percent. The experiment was carried out using a Randomized Complete Block Design with six treatments replicated four times. The test crops include; cassava, groundnut and sorghum all intercropped and applied with the following treatments.

1. NPK 15: 15:15 at 0.4 tons/ha + 0 poultry manure/ha.
2. NPK 15: 15: 15 at 0.3 tons/ha + poultry manure at 2.5 tons/ha.
3. NPK 15: 15: 15 at 0.2 tons/ha + poultry manure at 5.0 tons/ha
4. NPK 15: 15: 15 at 0.1 tons/ha + poultry manure at 7.5 tons/ha.
5. NPK 15: 15: 15 at 0 ton/ha +poultry manure at 10 tons/ha.

All the fertilizer and poultry manure treatment combinations were applied two weeks after planting using band placement method.

Cassava stems measuring 25cm in length was planted inclined at 45^o on beds at a spacing of 1m x 1 m giving a plant population of 10000 plants/ha. Groundnut seeds was sown at two seeds per hole using a spacing of 50cm x 50cm which was later thinned down to one seedling per hill to give a plant population of 20000 plants/ha.

Sorghum seeds were planted at one seed per hole in between the cassava hills at a spacing of 1 m x 1 m to give a plant population of 10000plants/ha.Crop growth and yield parameters for cassava, groundnut and sorghum were measured. All data collected were subjected to analysis of variance while mean separation was done using the least significant differences at 5% level of probability.

RESULTS AND DISCUSSION

Soil Properties and Crop Growth Parameters

There were remarkable variations in the pre-planting soil physical and chemical properties when compared with the post-harvest soil chemical properties (Table 1). Result indicated that the pre-plant soil textural class was sandy clay but was found to be loamy sand at post-harvest soil physical analysis which possess a unique attribute such as texture, structure, porosity pore size distribution, infiltration capacity, effective rooting depth, internal drainage and good soil temperature that supports crop growth (Lowery *et al* 1996, Arshad and

Grossman 1996; Toppet *et al* 1997), also the soil P^H 5.25 (at pre-planting) increased remarkably to P^H 6.51 (at Post-harvest) when 0 NPK fertilizer and 10 tons/ha poultry manure were applied. This agreed favorably with work done by Duruigbo *et al* (2007) who reported that 15 tons/ha poultry manure applied to the soil increased soil P^H significantly (p=0.05) from P^H 4.14 to P^H 5.80 The mechanism involved in the neutralization of soil acidity by organic manure has been reported by (Pocknee and Summer 1997, Yan *et al* 1996; Bessho and Bell, 1992; Hue and Amiens 1989).

The increased residual nutrient status such as nitrogen, phosphorus, potassium, and magnesium observed at post-harvest period shows that the combination of mineral fertilizer and poultry manure could carry a second cropping without further applications of fertilizer or manure. This observation is in harmony with similar work done by Jinadasa *et al* (1997), who reported that poultry manure has a residual effect on the soil after a cropping season.

The mean plant heights for cassava, groundnut and sorghum are presented in (Table 2). Results showed that 10 tons/ha poultry manure rate significantly (P = 0.05) gave the highest cassava stand height of 48.6cm (8WAP), 118.40 cm (12WP) and 149.90cm (16 WAP) respectively. Also the 10 tons/ha poultry manure without mineral fertilizer gave the highest sorghum stand height of 56.60 cm (8 WAP) 181.40cm (12 WAP) and 227.10cm (16WAP) respectively. The groundnut stand height also was tallest at 10tons/ha poultry manure with 181.17cm (8 WAP), 28.57cm (12 WAP) and 34.50cm (16 WAP) respectively. The mean number of leaves for cassava, sorghum and groundnut is shown in (Table 3). Mean cassava number of leaves was highest in the NPK 0.1 plus 7.5 tons per hectare poultry manure, both at 4 and 8 weeks after planting, with the 10 tons/ha poultry manure treatment recording the highest number of cassava leaves (69.80). The least number of leaves was obtained in the control without manure or NPK fertilizer. However for groundnut the control gave the highest number of leaves at 8 weeks after planting. At 16 weeks after planting the treatment with 0.2 fertilizer plus 5.0 tons/ha poultry manure gave the highest number of leaves followed by the 10 tons/ha poultry manure treatment.

Fresh Biomass Yields of Sorghum and Groundnut

Table 4 shows the fresh biomass yield of sorghum and groundnut, in which the 10 tons/ha poultry manure gave the highest biomass yield for groundnut which was not affected by the cropping system. However, the biomass yield of sorghum was influenced by the treatments with 10 tons/ha poultry manure giving the highest mean biomass yield of 297kg/ha.

Component Yields of Cassava, Sorghum and Groundnut

Table 5 shows the aggregate yields of cassava, sorghum and groundnut. Highest cassava yield of 13.38 tons/ha was achieved in the 10 tons/ha poultry manure just as the highest yield of sorghum 0.113 tons/ha and groundnut 0.07 tons/ha was also recorded in the 10 tons/ha poultry manure treatment respectively. The abundance of nitrogen in the poultry manure may have been responsible for the increased crop yields as reported by (Haque and Jacne, 2001) who observed that nitrogen is a constituent of protein and nucleic acid that is useful in plant growth. Poultry manure is also known to supply significant amounts of nitrogen, phosphorus, potassium and micro-nutrients. The yield of cassava has been found to be similar to its sole yield (C.I.A.T, 1980) however the poor yield of groundnut when intercropped with sorghum and cassava as observed in this study may perhaps be attributed to the high canopy architecture of sorghum and cassava which tends to prevent free light on groundnut, an observed earlier by Flach (1982) who reported that plants grow slower in less optimum conditions. Finally this study have shown that plant growth parameters such as plant height, number of leaves, biomass production and yield of cassava, sorghum and groundnut was significantly (P = 0.05) increased with zero NPK + 10 tons/ha poultry manure while the control had the least value in terms of the various crop growth and yield parameters.

CONCLUSION

This study was carried out to investigate the effects of NPK 15: 15: 15 fertilizer replacement combinations with poultry manure on cassava/groundnut sorghum intercrop in Owerri. The experiment revealed that the use of 10 tons/ha poultry manure without mineral fertilizer gave the highest performance in respect of crop growth and yield parameters followed closely by the NPK 0.1 plus 7.5 tons/ha poultry manure treatment. It was also observed that taller crops such as sorghum and cassava suppressed the growth of groundnut leading to its poor yield. Also the post-harvest soil analysis indicated that the soil textural class was changed from sandy clay/sandy soil to loamy sand respectively while bulk density reduced to 0.084 as against the initial pre-plant value of 1.01. Finally, it is hereby strongly recommended for farmers to apply 10 tons/ha poultry manure without mineral fertilizer to boost aggregate yields of cassava, sorghum and groundnut intercrop.

AKNOWLEDGEMENTS

We appreciate the assistance of Professors, J. C. Obiefuna, M. C. Ofoh, and Dr. D. O. Ohajianya for their technical advice which contributed immensely to the quality of this research work.

Table 1. Pre-Planting Soil Physical and Chemical Properties

	% Sand	Silt	Clay	P^H	Om%	%N	Ca	Ms	P	K	CEC	BD	Textural
Class	82.0	8.0	10.0	5.25	1.06	0.2	0.32	0.13	5.20	0.80	4.32	1.01	Sandy Clay
Post-harvest Soil Physical and Chemical Properties													
Control	86.8	4.50	8.46	5.85	0.82	0.03	0.09	0.03	15.20	0.51	3.64	1.18	Sandy Soil
NPK 0.4+PM O	86.2	4.23	8.62	5.70	0.83	0.03	0.11	0.04	15.65	0.43	3.25	1.17	-do-
NPK 0.3+PM 25	86.4	4.15	8.40	5.65	0.84	0.03	0.10	0.04	15.80	0.45	3.30	1.12	Loamy Sand
NPK 0.2+ PM 5	85.1	4.02	8.32	5.56	0.87	0.03	0.19	0.04	15.98	0.32	3.11	1.10	-do-
NPK 0.1+PM 7.5	85.6	3.86	8.46	5.44	0.89	0.02	0.13	0.06	15.92	0.32	3.14	1.02	-do-
NPK 0 + PM 10	84.8	3.36	11.84	6.51	0.94	0.02	0.36	0.80	16.48	0.88	0.021	0.084	-do-

Table 2. Mean Plant Heights (cm) of Cassava and Groundnut

At 4 8 12 and 16 weeks after planting WAP

	Cassava				**Sorghum**				**Groundnut**		
TREATMENTS	**4**	**8**	**12**	**16**	**4**	**8**	**12**	**16**	**8**	**12**	**16**
CONTROL	11.30	30.6	57.9	75.7	54.5	19.9	73.1	142.1	13.4	25.7	28.9
NPK 0.4+PMO	6.85	30.8	61.2	111.4	5.9	33.9	102.3	142.1	13.2	25.4	31.2
NPK 0.3+PM25	10.37	49.9	82.8	119.8	7.33	42.0	122.8	188.2	17.31	22.6	29.7
NPK 0.2+ PM50	10.2	33.2	86.1	120.4	6.7	31.5.	137.2	164.9	16.7	27.1.	28.6
NPK 0.1+PM7.5	11.2	46.7	91.8	136.9	7.3	46.6	139.6	175.0	18.1	25.0	34.3
NPK 0.1 + PM 10	9.3	48.6	118.4	149.9	6.85	56.6	181.4	227.1	18.2	28.5	34.5
LSD (0.05)	2.44	18.68	29.52	36.55	1.08	8.46	17.20	32.02	2.94	4.45	13.53

Table 3. Mean Number Of Leaves For Cassava, Sorghum And Groundnut

At 4 8 12 and 16 weeks after planting (WAP)

	Cassava				**Sorghum**				**Groundnut**		
TREATMENTS	**4**	**8**	**12**	**16**	**4**	**8**	**12**	**16**	**8**	**12**	**16**
CONTROL	9.52	15.45	31.1	29.4	4.00	5.70	6.40	8.05	51.20	14.55	23.07
NPK 0.4+PMO	8.17	18.67	31.8	37.0	4.45	6.25	5.70	7.05	39.50	14.12	20.48
NPK 0.3+PM25	2.50	8.02	20.08	33.9	48.30	7.35	5.58	7.90	40.60	13.19	22.08
NPK 0.2+ PM50	6.87	23.28	38.1	57.9	4.35	7.05	5.75	7.35	50.20	16.43	25.01
NPK 0.1+PM7.5	10.73	20.8	49.7	64.7	4.55	7.73	6.35	8.08	43.70	14.59	23.01
NPK 0 + PN10	6.35	18.85	48.9	69.8	4.75	7.75	6.48	9.83	43.70	17.17	23.93
LSD (0.05)	1.79	4.04	14.79	23.85	0.72	0.63	0.66	1.43	9.27	4.06	6.18

Table 4. **Mean Fresh Biomass Yield of Sorghum and Groundnut (kg/ha)**

	Biomass Yield (Kg/ha)	
	Groundnut	Sorghum
CONTROL	24.8	0.87
NPK 0.4+PMO	27.7	141.5
NPK 0.3+PM25	47.9	194.5
NPK 0.2+ PM50	24.7	187.5
NPK 0.1+PM7.5	23.2	194.0
NPK 0 + PN10	42.8	297.0
LSD (0.05)	41.91	220.20

REFERENCES

Adepetu, J.A.; A.O. Obi and E.A. Aduayi (1979): Change in soil fertility under continuous cultivation and fertilization in South-western Nigeria. Nigeria Journal of Agricultural Science (1) P15. 20

Arshad, M.A.; B. Lowery and B Grossman (1996): Physical tests for monitoring soil quality. In methods for assessing soil quality (eds).J.W. Doran and Jones. Special publication number 49. Madison WI. Soil Science Society of America pp 123-141

Bessho, T and Bell L.C. (1992): Soil and Solution phase changes and mung bean response during amelioration of aluminum toxicity with organic matter. Plant and soil. (140) pp 183 – 196.

Bowen, W.H.; Cabrera, V. Barrera and G. Baigoma (1999): Simulating the response of potato to applied nitrogen In impact on a changing world C.I.P programme report 1997-98. Lima, Peru. International Potato Centre (CIP).

CIAT (Centro International Agricultural Tropico) (1980): Annual report for 1979. Columbia pp101

C.I. Duruigbo, J.C. Obiefuna and E.U. Onweremadu (2007): Effect of poultry manure rates on soil acidity in an ultisol. International Journal of Soil Science (2): P154-158 2007. ISSN 1816-4978. published by Academic Journals Inc. USA

FAO (Food And Agricultural Organization (1981): Agriculture: Horizon 2000 Vol. 23. Development Economique et Social. F.A.O. Rome

Flach, M (1982): Ecological competition among the main moisture rich starchy staples in the tropics and subtropics. Proceeding 5th symposium of the International Society for tropical roots and tuber crops. Manila.

Haque, I and A.A. Jakhro (2001): Soil and fertilizer potassium In "Soil Science" National Book Foundation Islamabad, Pakistan pp261-263

Hue, N.V. and I. Amiens (1989): Aluminum detoxification with green manures. Comm... Soil Science, Plant Anal. 20: pp1499-1511

I.I.T.A. (International Institute of Tropical Agriculture) (1990): Annual report for 1989. IITA Ibadan, Nigeria.

Juo, A. S. R., K. Franzluebbers, A. Dabiri and B. Ikhile (1995b): Change in soil properties during long term fallow and continuous cultivation after forest clearing in Nigeria; Agriculture Eco-systems and Environment Vol. 56: pp 9-18.

Juo, A S. R, A. Dabiri and K. FRanzluebbers (1995a): Acidification of a kaolinitic alfisol under continuous cropping and nitrogen fertilization in West Africa. Plant and Soil 171 pp 245-253.

Jinadasa, K.B. P.N. Milham, C.A .Hawkins, P.S. Comish, P.A. Williams, C.J. Kaldo and J. P.Conroy (1997). Survey of cadimium levels in vegetables and soils of greater Sydney, Australia. Journal of Environmental quality 26: pp924-933.

Juo, A.S.R. and B.T. Kang (1989): nutrient effect of modification of shifting cultivation in West Africa. P. 289-299. in Mineral nutrient in tropical forest and Svanna eco-systems. J. Procter (ed) special publication No. 9. British Ecological Society. Blackwell Scientific publications London U.K

Kang B.T. and V. Balasubramania (1990): Long term fertilizer trials on Alfisols in West Africa. In Transactions of XIV International Soil Science Congress, Kyoto, Japan. Vol 4 International Soil.

Lombin, G.A. Abdullahi and Herron G.M. (1991): Long term fertility studies at Samar, Nigeria. In effect of farm-yard manure on monocropped cotton, sorghum and groundnut on a rotation of the three crops under continuous cultivation. Samaru Vol. 72: 14pp.

Lowery, B., M.A. Arshad, R. Lal and W.J. Hickey (1996): Soil water parameters and soil quality. In Methods for assessing soil quality ed.,J.W. Doran and A.J. Jones, Special publication. No 49 Madison wI. Soil Science Society of America PP 143-155.

Mokwunye, A.U., A. de Jager and E.C.A. Smailing (1996): Restoring and maintaining the productivity of West African soils. Key to sustainable development. International Fertilizer Development Center (IFDC) Musele Shoals Alabama, 94p.

Ogbalu, O.K. (1999): The effect of different traditional sources of nutrient on the infestation of pepper fruits by the pepper fruit fly in Nigeria. Journal of Agronomy and Crop Science (82): pp 65-71.

Ojeniyi, S.O. (1995): that our soils may not die. 10th ,inauguration Lectrure Federal University of Technology Akure 32pp.

Pocknee S. and Summer E. (1997) cation and nitrogen contents of organic matter determines its liming potential. Soil Science Society of America Journal 61. pp86-92.

Smith, M.A.K., S.B.O. Makinde and S.O. Ojeniyi (2001): Residual effects of goat dung on weed interference and yield of okra (Abelmoschus esculentus L. Moench. Journal of Agric forestry and fisheries (In press).

Sterner K.G (1984): Intercropping in tropical small holder Agriculture with special reference to West Africa. 2nd Edition G.TZ Eschborn.

Swaminathan M.S. (1983) Our greatest challenges. Feeding the hungry world In chemistry and the world food supply the new frontiers.

Tandon, H.L.S. (1993): Soil fertility and fertilizer use: An over-view of research for increasing and sustaining crop productivity. Workshop on the integration of natural and man-made chemicals In sustainable Agriculture in Asia. International Council of Scientific Union, New Delhi Sept 13-19, 1993

Topp, G.C., W.D. Reynolds, F.J. Cook, J.M. Kirby and M.R. Carter (1997): Physical attributes of soil quality. In soil quality for crop production and ecosystem health ed. E.G. Gregorich and M.R Carter, Amsterdam: Elsevier pp21-58.

United Nations (1989): Prospects of world urbanization 1988.

Dept of International Econommic and Social Affairs. Population studies No. 112 United Nations New York. U. S. A.

Yan, F. Schubert, S., and Mengel K. (1996): Soil P^H increase due to biologically decarboxylation of organic onions. Soil bioloy and Biochemistry 28: pp617 – 624.