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Productivity of Intercropped Green (*Amaranthus cruentus*)/Waterleaf (*Talinum triangulare*) with Poultry Manure Rates in Southeastern Nigeria

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Abstract: A split-plot in a Randomized Complete Block Design was used to conduct the experiment in 2003 and repeated in 2004. The main treatments applied were 5 rates of poultry manure, which include (0 kg ha $^{-1}$) as control 250, 5000, 7500 and 10,000 kg ha^{-1}. The sub treatments were different cropping systems which include intercropped green and waterleaf, sole green and sole waterleaf. Results indicate no significant differences in heights (cm) among all the treatments that had poultry manure at all rates of application but differed significantly ($p \leq 0.05$) with the control that had zero poultry manure. Intercropping *Amaranthus cruentus* with *Talinum triangulare* at the application of 7500 kg ha^{-1} poultry manure was significantly different ($p \leq 0.05$) from all the sole crops and intercrops with or without poultry manure application. This gave the highest economic yield of 3633 kg ha^{-1} intercropped green, 3517 kg ha^{-1} intercropped waterleaf and 3530 kg ha^{-1} and 3299 k ha^{-1} for sole green and waterleaf, respectively. However, there was diminishing return on the yield after, indicating that addition of more poultry manure beyond 7500 kg ha^{-1} had no effect on crop productivity. Also, intercropping with application of 7500 kg ha^{-1} poultry manure gave the highest land equivalent ratio (LER) of 2.06 and monetary yield of ₦1,262,500.00 ha^{-1} and was significantly different ($p \geq 0.05$) from the other treatments. The lowest monetary yield of ₦247,500.00 ha^{-1} was obtained from sole cropped *Amaranthus cruentus*. The use of poultry manure rates especially 7500, 5000 and 10,000 kg ha^{-1} may be recommended depending on the sole cropping of green and waterleaf. The LER and monetary yield indicate that a farmer can make a good living by engaging in the production of green and waterleaf vegetables especially during the dry seasons of the year.

Key words: Poultry manure rates, productivity, intercropped Amaranthus cruentus, Talinum triangulare

INTRODUCTION

Amaranthus cruentus commonly called green is a highly popular vegetable crop for both rural and urban farmers and dwellers. It is known for its C4 cycle of photosynthesis where the growth rate is optimized by high temperature, bright light and adequate water and soil minerals. The vegetable *Amaranthus* is used in making soup and stew and the cooked leaves are eaten with milk or fat to which salt is added (Tindal, 1975; Schippers, 2000) and more so, it is used in feeding farm animals (Dupriez and De Leener, 1989). It has a high nutritional value because of the high level of essential

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micronutrients like carotene and vitamin C, iron and calcium. Further more, it is nutritionally rich in lysine an essential amino acid that is lacking in diets based on cereals and tubers. In addition, the protein found in young plants can be beneficial for people without access to meat or other protein sources (Scheppers, 2000). The resource poor farmer makes green his vegetable and meat.

Talinum triangulare (waterleaf) is a non-conventional vegetable crop of the Portulacaceae family which originated in tropical Africa and it is widely grown in West Africa, Asia and South America (Cardoso, 1997; Schippers, 2000). The leaves and young shoots are used to thicken sauce and it is consumed in Brazil and in the Southeastern part of Nigeria. It makes a reasonable substitute for spinach. Waterleaf is well adapted to the local hot and humid weather and its survival on infertile soils makes its cultivation an important economic activity for small growers (Schippers, 2000). Observation over time has shown that it is heat resistant, tolerant to drought and light shade.

The high need and requirement for vegetable in our food for good health led to this experiment of intercropping of the two vegetable crops. However, horticultural and arable crop production based on the use of biological derived traditional fertilizers is consistent with low external input sustainable agriculture which is being advocated for worldwide. The use of poultry manure for vegetable crop production and intercropping such vegetables as *Amaranthus cruentus* and *Talinum triangulare* is in agreement with the idea of low external input for crop production otherwise known also as high input agriculture can be sustainable. In Nigeria and many other parts of the world, organic manure is often used for field and garden crop production and for soil rehabilitation and sustenance of its fertility. In subsistence farming, most back yard garden crops enjoy the benefit of organic manure from household wastes for the supply of water, essential nutrients, good growth and development of the crops.

Most annual crops respond well to the application of organic manure and it can sustain yield under continuous cropping on most soils unlike equivalent amounts of NPK fertilizers (Maynard, 1991). The potentials of organic manure, crop residues and mulches that are decayable for building up soil organic matter and nutrient supply of the soil is particularly important in our today's agriculture, especially in the tropics where chemical fertilizers are no longer as readily and economically available as they were few years ago (Lal and Kang, 1982). Presently, high prices of inorganic fertilizer, products such as urea and NPK fertilizers have encouraged the farmers to both search for and use alternatives. Such alternatives primarily include bags of poultry manure bought at local market or poultry farms (IDRC, 1999). Poultry manure is an important resource in sustainable and organic crop production.

Also, due to population pressure on cropable land, continuous cropping is becoming a dominant activity in our farming communities. More so, our tropical soils are fragile and easily degraded in chemical, physical and biological qualities as a result of continuous farming activities on crop able land. The soil destruction is aggravated with persistent use of inorganic fertilizers, which helps to increase soil acidity and cause physical degradation of the soil and crop yields may decrease drastically. Organic manure is a soil builder. In order to produce high quality vegetable and at the same time rehabilitate and sustain our soil fertility under continuous cropping, this work was carried out to study the effects of poultry manure rates on the productivity of *Amarantus cruentus* intercropped with *Talinum triangulare* on Owerri ultisols in South eastern Nigeria.

MATERIALS AND METHODS

The research was carried out from August to September 2003 and repeated from January to May 2004 at the training and research farm of the Federal University of Technology, Owerri (5°27'N, 7°02'E) on an elevation of 91.0 m, located in the heart of the rainforest zone of South Eastern Nigeria. The mean annual rainfall locate within he meteorological station located within the university was 1.953 mm and mean annual temperature and relative humidity during the study periods were 28°C and 88% respectively. Soil particle analysis (0- 20 cm) of the plough, layer revealed that it had 91% sand, 6.8 clay and 2.2% silt fraction. The chemical analysis showed that it had 1.22% organic matter. 0.06% N, 10.53 (ppm) P Bray II method. pH (water 4.45 and exchangeable bases magnesium, calcium and potassium of 0.40, 0.61 and 0.03 Cmol kg^{-1}, respectively.

The poultry manure was weighed out at the rate of 0, 2500, 5000, 7500 and 10,000 kg ha^{-1}, respectively. A split-plot in a randomized complete block design with 3 replication was used to conduct the experiment. Each main plot measured 10×1 m and this was spit into 3, making the subplots. Each subplot measured 3×1 m with 0.5 m spacing between each subplot and each main plot. A 1 m gap between blocks was allowed. This gave a total of 45 plots, made up of 5 main plots, 3 subplots and 3 replications.

Nursery

The *Amaranthus cruentus* and *Talinum triangulare* seeds were raised in the nursery for two months in June-July and November-December 2003 for the August-November 2003 cropping and January-May 2004 cropping, respectively. The seedlings stayed 8 weeks before they were transplanted to the experimental field. While in the nursery 300 kg per plot farmyard manure were applied to support the growth of the seedlings.

Transplanting

The seedlings were transplanted to the experimental field in the evening of 5th August 2003 and 3rd January 2004, respectively. This was done at a height of 8-10 cm for green and 4-5 cm for waterleaf at a spacing of 30×30 cm. This gave a total of 27 stands for sole crops and 54 stands for the intercrop plots.

Watering the experimental plots was done twice a day in the morning and evening. This was done to help sustain the crops since the experiment was carried out during the dry periods of the year. Weeding was manually done with hoes at 3, 6 and 9 weeks after transplanting. The weight was obtained using a weighing balance.

Data were collected on plant height (cm) for *Amaranthus cruentus* and *Talinum triangulare* at 2, 4 and 6 WATp with measuring rule. The number of leaves of green and waterleaf were counted and recorded at 2, 4 and 6 WATp. Leaf area was measured with the use of graph paper. The graph paper was used and a leaf laid on it and traced with pencil along the margin. Leaf area was then determined by counting the number of squares occupied by the traced area. This was done at 2, 4 and 6 WATp.

Vegetable Yield

The yield of the two intercropped vegetable crops green and waterleaf, respectively were harvested every two weeks starting from 4 WATp.

Land Equivalent Ration

This was calculated using the sole crop and intercropped yield ratios.

$$\text{LER} = \frac{\text{Intercropped green}}{\text{Sole green}} + \frac{\text{Intercropped water leaf}}{\text{Sole water leaf}}$$

Monetary Value

This was determined using the prevailing market prices per head of the vegetables during the 2003 and 2004 cropping seasons at Eke-ukwu Owerri (Main Market Owerri), Relief Market and New Market all in Owerri, Nigeria.

Post Harvest Soil Analysis

The soil was analyzed at the end of each experiment to note the level of soil fertility improvement that was left after harvest was done. The chemical characteristics were organic matter determined by Walkley and Black method: Potassium (K), Magnessium (Mg) and Calcium (Ca) obtained by flame photometry: Phosphorus (P) determined by Bray 1-P method: pH using the pH meter and %N determined by Micro Kjeldahl method.

Data Analysis

Data were analyzed using the randomization scheme for split plot in Randomized Complete Block Design with 3 replications as specified by Wahua (1999). Treatment means were compared using the Least Significant Difference and Duncan's Multiple Range Test at 1 and 5%, respectively.

RESULTS AND DISCUSSION

Plant Height

The effect of poultry manure rates and cropping system on the height of green and waterleaf (Table 1). Results show that at 2 WATp, there were no differences between all the crops with or without poultry manure application. The plant height however increased at 4 WATp and height of sole green plants with 7500 and 10,000 kg ha^{-1} were significantly higher than the intercropped vegetables while the waterleaf sole showed no significant difference amongst them. Plant heights at 6WATp showed no significant differences between the sole green and intercropped green with 7500 and 10,000 kg ha^{-1} poultry manure application. They were significantly different ($p \geq 0.05$) with sole waterleaf. The increases in height at 6WATp, may be attributed to the mineralization of the essential nutrients released by the poultry manure and subsequent nutrient uptake by the vegetables.

Economic Yield of the Vegetables

Table 2 shows the economic yield of the *Amaranthus cruentus* and *Talinum triangulare*. Results indicate that at 0 kg ha^{-1} of poultry manure, sole green had the highest yield of 967 kg ha^{-1} and was significantly different from all the plots without poultry manure application.

For treatments with 2500 kg ha^{-1} poultry manure, sole green had the highest yield of 1600 kg ha^{-1} followed by intercropped green that had 1317 kg ha^{-1}. At the rate of 5000 kg ha^{-1} of poultry manure, intercropped waterleaf and sole waterleaf had the highest yield than intercropped green and sole green

Table 1: Effect of poultry manure rates and cropping system on the growth of green and waterleaf 6 weeks after transplanting (WATp)

	Cropping system			
	Sole		Intercropped	
Poultry manure rates (kg ha^{-1})	Waterleaf	Green	Waterleaf	Green
0	23.5	8.4	20.4	7.3
2500	27.9	9.9	25.6	8.7
5000	28.4	10.6	26.5	9.2
7500	30.1	2.8	29.8	10.5
10,000	32.3	12.9	31.8	10.2
LSD (0.01)				
Cropping system	0.534			
Poultry manure	0.542			

Table 2: Mean economic yields (kg ha^{-1}) for *Amaranthus cruentus* and *Talinum triangulare*

	Cropping system			
	Sole		Intercropped	
Poultry manure rates (kg ha^{-1})	Waterleaf	Green	Waterleaf	Green
0	0.67	993	878	667
2500	1600	1042	1317	1027
5000	1803	2433	1707	2533
7500	3530	3399	3633	3517
10,000	3317	2280	2197	2100
LSD (0.01)				
Poultry manure	230			
Cropping system	NS			

and they were significantly different ($p \geq 0.05$) from the sole or intercropped green, for 7500 kg ha^{-1} poultry manure there was no significant difference, amongst all treatments either sole or intercropped. At the rate of 10000 kg ha^{-1} poultry manure, 2217 kg ha^{-1} and was statistically different only to sole waterleaf.

The effect of poultry manure rates can easily be seen from the changing quantities or yield of the harvested vegetables with addition of higher rates of poultry manure. The overall results show that sole green yielded better when 2500 kg ha^{-1} poultry manure was added per hectare. Also, the application of 5000 kg ha^{-1} poultry manure produced high yield of sole and intercropped waterleaf were not significantly different from the yield of sole intercropped green. Although the yield of all sole and intercropped green and water leaf on application of 5000 kg ha^{-1} were significantly different from the control and 2500 kg ha^{-1} manure application. From these results, the application of 7500 kg ha^{-1} poultry manure had no differences for either sole or intercropped green and waterleaf but witnessed a decrease in yield at the increase of poultry manure to 10000 kg ha^{-1}. This result agreed with the Ibeawuchi (2003) that poultry manure contains essential plant nutrients necessary for sustained growth and yield of vegetables.

Yield Advantage/crop Productivity

The yield result in Table 2 was used to calculate the land equivalent ratio (LER) of the sole and intercropping system (Table 3). Intercropping green and waterleaf with the application of 7500 kg ha^{-1} poultry manure gave the highest LER of 2.06 indicating a yield advantage of 106% over sole cropping green or waterleaf for the intercropping system, the LER against poultry manure rates followed a diminishing return curve if it were to be plotted indicating that LER is governed by yield value of the cropping systems. In the same manner, the % yield advantage followed the same trend.

Intercropping without poultry manure application had yield advantage of 58% over sole cropping. This is why the small-scale farmer will not do without intercropping. The intercropping advantage is in line with Preston (2001) who reported that intercropping has yield advantage over sole cropping.

Monetary Value for the Various Treatments

The monetary yield of the cropping system was affected by the increase in manure rate and followed the yield trend (Table 4). The higher the quantity of vegetable head harvested per plot the

Table 3: Land Equivalent Ratio (LER) for the sole and intercropped green and waterleaf and yield advantage

	Poultry manure rates (kg ha^{-1}) and LER				
Cropping system	0	2500	5000	7500	10,000
Sole green	1	1	1	1	1
Sole waterleaf	1	1	1	1	1
Waterleaf green	1.58	1.91	1.99	2.06	1.91
Yield advantage	58%	91%	99%	106%	91%

Table 4: Mean monetary yield for the sole and intercropped green and waterleaf

Poultry manure rates (kg ha^{-1})	Sole green yield (kg ha^{-1})	Total monetary (₦: K)	Sole water leaf yield (kg ha^{-1})	Total monetary (₦: K)	Intercropped green/ waterleaf (kg ha^{-1})	Total monetary (₦: K)
0	96.7	241,750.00	993	248,250.00	878/667	386,450.00
2500	1600	400,000.00	1042	260,750.00	1317/1022	584,750.00
5000	1803	450,750.00	2433	608,250.00	1707/2533	1,060,000.00
7500	3530	882,500.00	3399	849,750.00	3633/3517	1,787,500.00
10,000	2217	554,250.00	2280	570,000.00	2197/2100	1,074,250.00

1 head of green weighing 200 g (0.2 kg) ₦50, 1 head of waterleaf weighing 200 g (0.2 kg) N50, Source: Market surveys 2003 Dec. and 2004 May, (I) Owerri Main Market; (ii) Relief Market, Owerri

higher the money realized. For all the sole cropping systems, there were no significant difference between any of them but they differs with the application of poultry manure rates and intercropping. From the data in Table 4, poultry manure and intercropping green and waterleaf gave the highest monetary yield of ₦1,787, 500.00 ha^{-1}. Intercropping and application of 5000 and 10,000 kg ha^{-1} followed this. Poultry manure which monetarily yield ₦1,060,000.00 ha^{-1} and ₦1,074,250.00 ha^{-1}, respectively, showing a decrease in monetary value either way.

Also, the sole cropping of green and waterleaf with the application of 7500 kg ha^{-1} poultry manure was better than all the sole cropping with ₦882,500.00 ha^{-1} and ₦849,750.00 ha^{-1} for sole green and sole waterleaf, respectively. The control in all the cropping system had the lowest monetary value. The overall result indicates that intercropping waterleaf+green at the application of 7500 kg ha^{-1} poultry manure was better than any of the manure rates in both yield, land use efficiency, yield advantage and monetary value. Therefore, the intercropping of green with waterleaf enterprises with the rightful quantity of poultry manure input can sustain a farmer and make him to be an employer of labour.

CONCLUSIONS

The use of poultry rates especially 7500, 5000 and 10,000 kg ha^{-1} may be recommended depending on the sole cropping of green and waterleaf. The LER and monetary yield indicate that a farmer can make a good living by engaging in the production of green and waterleaf vegetables especially during the dry seasons of the year.

REFERENCES

Cardoso, M.O., 1997. Cariru (*Talinum triangulare*) Jacq Willd. Hortalicas Nao-convenicionais da Amazonia. Embrapa Servico de produc inform Brasil. DF. pp: 39-45.

Dupriez, H. and P. Deleener, 1989. African Gardens and Orchards. Macmillan Publishers, pp: 239-248.

Ibeawuchi, I.I., 2003. Effect of four organic manure types on the yield and yield components of tatasai pepper (*Capsicum annum* L.) in Southeastern Nigeria. J. Sci. Business Agric., 1: 20-24.

IDRC (International Development Research Centre) (1999): Urban Agriculture in West Africa contributing to Food Security and Urban Sanitation. IDRC/CTA., pp: 126-291.

Lal, R. and B.T. Kang, 1982. Management of organic matter in soils of the tropics and subtropics. Intl. Soil Roc., 3: 153-178.

Maynard, A.A., 1991. Intensive Vegetable Production using comforted Animal Manure. Connecticut, Bull, Agric. Expt. Sta. No. 894, pp: 34.

Preston, S., 2001. Intercropping Principles and Production Practices. ATTRA Publications. Agronomy Systems Guide.

Schippers, R.R., 2000. African Indigenous Vegetables-An overview of the Cultivated species. Chattehan UK. NRI/ACP. EU., pp: 9-135.

Tindal, H., 1975. Commercial Vegetable Growing. Oxford University Press, pp: 223-253.

Wahua, T.A.T., 1999. Applied Statistics for Scientific Studies. Afrika-link Press, Ibadan, Nigeria, pp: 108-248.