OPTIMUM YAM SETT WEIGHT AND POULTRY MANURE RATE FOR WARE YAM PRODUCTION IN MIXTURES

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ABSTRACT
One of the major constraints in ware-yam production under yam/maize/cassava intercrop is the appropriate sett size and manurial needs required to produce them in mixtures. This research work was carried out at the Federal University of Technology Teaching and Research Farm Owerri in Southeastern Nigeria. The experiment was carried out using a 3 x 4 factorial in Randomized Complete Block Design with three replications. The treatments consist of three yam sett weights (250, 500 and 750g) and manured with four poultry manure rates (0, 5, 10 and 15tons/ha) respectively. Yams (10,000 plants/ha) and maize (20,000 plants/ha) were planted simultaneously on flats while cassava TMS 4(2) 1425 (10,000 plants/ha) was introduced 8 weeks after planting yam and maize. Data on various growth and yield parameters for yam, maize and cassava were collected and analyzed using the General linear model procedure of statistical analysis system (SAS). Mean separation was done using least significant differences at 50% level of significance. The pre-planting soil fertility was very low. The poultry manure rate of 15 tons/ha and yam sett weight of 750g significantly (P=0.0001) gave the highest percentage (23.73%) ware yams, which also gave the highest dry grain maize yield of 1.95 tons/ha and highest fresh cassava tuber yield of 21.71 tons/ha and is hereby recommended.

Keywords: Yam Sett weight, poultry manure ware-yam, yam/maize/cassava inter crop.

Introduction

Ware yams are specifically grown for consumption and range from 1kg to 10kg or above in weight. Ware yam production is complex and requires more capital outlay and economic input than seed yam production. In Nigeria and most yam producing countries, the importance of yams has been increasing with respect to food security, nutritional diversification, and provision of income, employment and alleviation of rural poverty (Baudoin and Lutaladio, 1998).

Orkwor and Ekanayake (1998) reported that in Nigeria yams could constitute up to 32% of gross income derived from annual cropping. In response to increasing demand for ware-yams, cropping systems and processing methods are undergoing development and innovation. In year 2000 nearly 4 million hectares were planted with yams throughout the world (FAOSTATS, 2000) with more than 69% of the total area located in Nigeria.
Nigeria's share of world yam production went from 40% in 1985-1987 to 74% in 1995-1997. Between 1.5 to 2 Million hectares of land are put to yams annually in Southern parts of Nigeria (FPDD, 2005).

The planting material or seed yam used for ware yam production under sole-crop situation is between 250-1500g weights. Such tubers are specifically produced as seed yams or selected from the farmers produce. It is estimated that planting material constitutes well over 33% of cost for ware-yam production. In West Africa particularly in Nigeria, the increase of area planted with yams represents an expansion in yam cultivation from its traditional growing area in the humid forests to the moist savannahs (Manyong et al 1996). Predominantly yam is grown as a base-crop with other arable crops such as maize, vegetables, cassava or permanent crops such as plantain, banana, oil palm and other tree crops found in the forest zone of West Africa It was also observed that as yam production moves out of homestead farms to large scale farms the number of intercrops with yam decreases (Orkwor, 1990).

In yam-based cropping systems yams are planted first on the crest of mound or ridge, while cassava is introduced later at 8-12 weeks depending on the varieties and area of production (Unamma *et al* 1987), upstream research at the National Root Crops Research Institute Umudike has screened most of the crops found field in mixtures of farmer's field in the zone and found that cocoyam, garden egg, *Telfairia,* okra and "egusi" (melon) were compatible with yam/maize/cassava intercrop when scientifically arranged in the field (Unamma *et al,* 1988). Cassava is an important carbohydrate source utilized for food, feeds and industrial raw materials (Onwueme, 1979).

Nweke *et al* (1994) reported that farmers tend to use low to medium branching cassava species in a yam – based intercrop in order to reduce shading effect of the profuse branching species on yam. In assessing the suitability of cassava for intercropping Fresco (1993) observed that cassava displays elasticity in adaptation to a wide range of climatic and edaphic conditions, in adjustment of maturity cycles to suspend growth without destroying the storage organs which makes it suitable for diverse niches in the cropping systems.

Maize is one of the commonly grown cereal crop in Nigeria with an annual production of three million metric tones. It is grown commercially as a sole crop in the savannas but usually is intercropped with yam, cassava cowpea and vegetables in the humid tropics (Cardwell, 1995). In Nigeria, about 80% of the maize grown is intercropped with a range of other crops such as cassava, vegetable and maize.

The decline of crop yields under continued cultivation despite the use of mineral fertilizers has been attributed to factors such as acidification, soil compaction and loss of soil organic matter (Juo *et al* 1995). There is urgent need for the use of organic materials to replenish soil nutrient to sustain a yam-based cropping system and improve the soil physical, chemical and biological properties. The addition of organic amendments to the soil such as poultry manure is not only an economic imperative but also a management necessity needed to reverse the current trend of soil physical, chemical and biological degradation (Obi and Ebo 1995).

Organic manure also combats toxic metal concentration by forming stable complexes with high molecular weight especially on soils that are prone to iron and aluminum toxicity (Sanchez, 1976). The use of poultry manure for boosting soil fertility is economically justified (Smith *et al*, 2001) which is also similar to the view by Ogbalu (1999) who observed that the traditional sources of nutrients in compound farms for crop growth such as cowdung, goat droppings and poultry manure are locally available and affordable to farmers than chemical fertilizers.Also farmers have strongly claimed that yam tubers grown with manures store longer than those produced with organic fertilizers. (Asadu 1995b). The prohibitive cost of mineral fertilizers and the environmental pollution associated with its usage calls for an urgent need to look into other alternative sources of nutrient.

Traditionally farmers produce ware – yams using whole or medium sized ware yams that could be cut into sets of 300-500g. Cut setts are known to take longer time to sprout and are prone to disease attack (Orkwor and Ekanayake, 1998). Hence the use of whole tubers for ware yam ensures uniform sprouting, reduced cost of chemical treatment and uniform maturity (Ikeorgu and Nwokocha, 2001). In response to the increasing demand for ware yams, both for consumption, conferment of titles and for new yam festivals there is need to investigate the appropriate yam sett weight and poultry manure rate needed to produce ware yams.

MATERIALS AND METHODS

Location

The field experiment was conducted at the Federal University of Technology Teaching and Research Farm Owerri, Nigeria, during the 2001 cropping season. The climate of the area is a humid tropical type characterized by wet and dry seasons. The rainy season usually begins in mid March and ends in November with a little dry spell (August break) occurring in August. The dry seasons starts in mid November and ends in mid March. The mean annual rainfall is about 2500mm and is bimodal with peaks in July and September (Nwosu and Adeniyi 1980). The area has a rainforest vegetation with soils characterized by deep porous red soils derived from sandy deposits in the coastal plains which are highly weathered, low in mineral reserve and natural fertility, hence farmers in the area practice bush fallowing as a means of improving soil fertility (Ononiwu, 1990).

Laboratory Analysis of Soil and Poultry Manure Samples

The pre-plant soil physical and chemical analysis was carried out in the Crop Science Laboratory of the Federal University of Technology Owerri. Also the Nutrient contents of the poultry manure used in the experiment was also analyzed in the laboratory using the following procedures: Bulked soil samples were collected randomly from the experimental site using a soil augur from a depth of 0-15cm (top soil)and 15-30cm (subsoil) respectively. The soil samples were air-dried in the laboratory ground and sieved using a 2mm mesh. The particle size fractions were determined by the hydrometer method of Bouyoucos (1951) using Sodium- hexa-metaphosphate as a dispersant. The soil P^H was determined in distilled water and in INKcl on a, ratio of 1:2.5 soil/solution using the P^H meter. The organic carbon contents of the soil was ascertained using 2g soil sample and by the dischromate wet oxidation method of Walkley and Blacks. The total nitrogen contents of the soil was determined using the modified macro Kjeldahl's method (Bremner and Mulvancy, 1982), by crushing and sieving soil samples, through a 0.5mm mesh. The Bray No. 2 method was used to extract available phosphorus, while exchangeable cations was determined on extracts obtained after leaching samples with 1N neutral ammonium acetate solution. Exchangeable potassium and sodium contents were estimated on the flame photometer while calcium and magnesium contents were determined by the versenate titration method. Effective cation exchange capacity was done by summation of exchangeable cations and acidity (IITA, 1979). The exchangeable acidity was 'determined by 1N Kcl extraction procedure. The base saturation was ascertained by expression the sum of the exchangeable cations as a percentage of the Effective Cation Exchange Capacity values. The chemical analysis of the poultry manure as well as the post-harvest soil physical and chemical analysis was equally carried out in the laboratory using the above mentioned procedures.

Planting of Yam / Maize / Cassava

Based on the experimental Design which is a 3x4 factorial in Randomized co,plete Block, with three replications, the various yam sett sizes namely 250g, 500g, and 750g and poultry manure rate namely 0, 5,000kg,10,000kg and 15,000kg were set up in the area, with yams spaced at 1m x 1m, cassava (TMS 4(2) 1425 planted at 1m x 1m while maize (DMR – ESRY) was planted at 1m x 1m respectively. The pyramidal staking method was used for yam. Data on various crop growth and yield parameters was measured for yam, maize and cassava and subjected to analysis of variance using the general linear model of SAS 1998. Means were separated using least significant differences at 5% level of probability.

RESULTS AND DISCUSSION

Soil Properties

The pre-planting soil physical and chemical analysis is shown in table 1. The soil P^H, organic carbon and total nitrogen contents are low. The low effective cation exchange capacity, and base saturation suggests the dominance of 1:1 clay and high level of aluminum content. Generally the soil shows poor fertility and belongs to the sandy loam textural class. These results confirms earlier work by Ohiri (1992) who reported that soils in Imo, Abia and Akwa Ibom States belong to group II characterized by low P^H, organic carbon and low exchangeable cations. This low P^H level as observed in this experiment represents a limiting factor for increased crop productivity especially for tuber crops (Ohiri and Ano, 1985). The nutrient contents of the poultry manure used in the experiment is presented in table 2, where the analysis shows high contents of organic matter (50.53%), nitrogen (1. 37%), organic carbon (27.15%) calcium (6.95%), magnesium (1.95%) and C:N ratio stood at 19.8:1 respectively. The rich nutrient contents of the poultry manure as observed in the laboratory analysis has confirmed work done by Gupta *et al* (1997) who reported that poultry manure is a very rich animal manure and could increase crop yield.

CROP GROWTH AND YIELD PARAMETER

Maize stand height was significantly ($P < 0.0001$) influenced by poultry manure rate of application with the tallest (203.2cm) maize recorded in the 750g yam sett weight and 15 tons/ha poultry manure rate. The control produced the shortest maize stands irrespective of yam sett weights (Table 3). The increased maize stand height from 51.30cm (control) to 203.20cm in the 750g plus 15 tons/ha poultry manure could be attributed to the high nutrient extraction capacity of maize in mixture and due to the inter-specific competition between maize cassava and yam. Such competition for light causes maize to grow taller and this agreed favourably with similar work by Beets (1976) who observed that maize in mixture tend to grow taller to compete for sunlight needed for its photosynthetic activity. Maize dry grain yield (table 4) differed significantly ($P= 0.0001$) due to yam sett weight and poultry manure rate with highest maize dry grain yield of 1.95 tons/ha achieved in the 750g yam sett weight plus 15 tons/ha poultry manure rate.

The zero manure treatments (control) gave the least maize dry grain yield. Table 5, shows the mean fresh cassava tuber yield where poultry manure significantly ($P=0001$) influenced cassava tuber yield with highest yield of 21.71 tons/ha achieved in the 750g yam sett weight plus 15 tons/ha poultry manure rate. The control (zero manure) recorded the least fresh cassava tuber yield irrespective of the yam sett weights.

Table 6, shows the effect of poultry manure and yam sett weight on percentage large tubers (ware yams) produced. Results indicated that yam sett weight and poultry manure rate significantly ($P= 0.0001$) influenced the number of large tubers (ware yams) harvested per plot. The highest percentage ware yams was produced using 750g, yam sett weight and 15 tons/ha poultry manure while the control had no large yam tuber produced. This yield increase of yam tubers in response to sett weight agreed with earlier work by (Orkwor 1990) who reported severally that the greater the sett weight used in planting, the greater the weight of tubers produced. According to Nwoke *et al* (1973) the main effect of large sett size is to produce a vigorous initial growth of root, vine and leaves which give the plant an advantage that last throughout the growing season. Generally the use of 15 tons/ha poultry manure plus 750g yam sett weight was found to produce more ware yams. The other component crops such as maize and cassava produced good yield. Hence this experiment revealed that increased yam sett weight with higher rate of poultry manure could be used by our resource-poor farmers to produce ware yams as well as appreciable economic yields of cassava and maize as an intercrop and is highly recommended.

CONCLUSION

This experiment have revealed that poultry manure is capable of enhancing the poor fertility status of sois in Southeast agroecological zone in Nigeria and boost the yields of yam/maize/cassava intercrop on sustainable basis. The key finding of this research work is that the use of 15tons/ha of poultry manure coupled with 750g yam sett size is capable of producing more ware yams, and is thus strongly recommended. It was also observed that poultry manure possess liming properties and hence could be used to neutralize soil acidity based on the result of this study.

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Table 1. Pre-planting Soil Physical and Chemical Analysis

	Soil Horizon (Top Soil) (0-15cm	Sub-Soil (15-30)
P^H in H20 (1:2.5 soil/water	4.7	4.8
P^H in Kcl)1:2.5 soil/water	4.6	4.5
Percent Organic Carbon	1.75	0.99
Total Nitrogen (%)	0.08	0.06
Available Phosphorus (cmol/kg)	9.5	7.6
Calcium (cmol/kg)	1.55	0.7
Magnesium (cmol/kg)	1.55	0.85
Potassium (cmol/kg)	0.04	0.03
Sodium (cmol/kg)	0.003	0.02
Total exchangeable acidity	2	1.62
E. C. E. C.	3.14	2.4
Base saturation (%)	54	50
Percent silt	3	5
Percent clay	14	15
Percent sand	83	80
Soil textural class. Sandy Loam		

Table 2. Chemical Properties of the poultry Manure in the Experiment

Magnesium (%)	1.95
Calcium (%)	6.95
Potassium (%)	0.52
Sodium (%)	0.2
Phosphorus (%)	1.3
Nitrogen (%)	1.37
Organic carbon (%)	27.2
Organic matter (%)	50.5
Carbon: Nitrogen Ratio	19. 8:1

Table 3, Effect of Yam Sett Weight and Poultry manure on Maize Height (cm)

Treatments **Yam sett wt (g)**	**Poultry manure (t/ha)**				
	0	5	10	15	Mean
250	56.36	158.8	171	206.3	148.1
500	51.16	140.2	182	201.5	143.6
750	46.5	149.9	186	201.7	146.6
Mean	51.3	149.6	179	203.2	
LSD(0.05)	Yam Sett = 16.03 (n.s)				
LSD(0.05)	Poultry Manure = 18.5 ($p<0.0001$)				
LSD(0.05)	Yam Sett x Poultry Manure = 32.06 (n.s)				

Table 4. Effect of Yam Sett Weight and Poultry Manure Rate on Maize Dry Grain Yield (tons/ha)

	0	5	10	15	Mean
250	0.2	0.86	2.05	2.32	1.36
500	0.42	0.97	1.37	2.29	1.26
750	0.49	1.18	1.6	1.23	1.13
Mean	0.37	1	1.68	1.95	
LSD(0.05)	Yam Sett - 1.78 (n.s)				
LSD(0.05)	Poultry Manure = 1.84 (P 0.0001)				
LSD(0.05)	Yam Sett x Poultry Manure = 4.74 (n.s)				

Table 5, Cassava Fresh Tuber Yield as Influenced by Yam Sett Weight and Poultry Manure Rate.					
Treatments					
Yam sett wt (g)		Poultry manure (t/ha)			
	0	5	10	15	Mean
250	6.3	16.03	18.9	21.7	15.73
500	7.23	16.33	17.7	22.83	16.02
750	6.47	17.17	19.2	20.60	15.86
Mean	6.67	16.5	18.6	21.71	
LSD(0.05)	Yam Sett = 1.78 (n.s)				
LSD(0.05)	Poultry Manure = 1.84 (p < 0.0001)				
LSD(0.05)	Yam Sett x Poultry Manure = 4.74 (n.s)				

Table 6. Effect of Yam Sett Weight and Poultry Manure Rate on Percentage Large Tubers (ware yams)					
Treatments	Poultry Manure ton/ha				
Yam Sett (g)	0	5	10	15	Mean
250	0.00	2.00	3.33	3.67	2.25
500	0.00	11.97	13.9	18.03	10.98
750	0.00	16.9	1.73	23.73	15.59
Mean	0.00	10.29	13	15.14	
LSD (0.05) Yam sett = 1.44 (P < 0.0001)					
LSD (0.05) Poultry Manure 1.66 (P < 0.0001)					
LSD (0.05) Yam Sett x Poultry Manure = 2.88 (P =< 0.0001)					

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