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Full Length Research Paper

The effect of poultry manure and NPK fertilizer on yield and yield components of crops based on different cropping systems in south west Nigeria

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Field experiments were conducted in two villages (Oniyo and Moloko Ashipa) representing two agro ecologies in the south west area of Nigeria during 2000 and 2001 cropping seasons. The objective was to determine the effects of NPK fertilizer and poultry manure on the yield and yield components in cassava/maize/melon systems. The factors were (1) cropping systems: cassava/maize/melon, sole cassava, sole maize and sole melon; and (2) fertilizers: no fertilizer, NPK 15-15-15 (400 kg/ha), poultry manure (5 t/ha), 2.5 t/ha poultry manure + 200 kg/ha NPK 15- 15-15 and mineral fertilizer (NPK 15-15-15). Intercropping had no significant effect on cassava root yield but it reduced maize and melon seed yield compared to sole cropping. Land equivalent ratio (LER) values were however higher under intercropping than sole cropping. Crop yields were statistically the same under NPK alone and NPK + poultry manure but significantly higher than both poultry manure alone and control in both locations.

Key words: Poultry manure, NPK, Cropping system, intercrop.

INTRODUCTION

Bush fallowing has been an efficient, balanced and sustainable agricultural system for soil productivity and fertility restoration in the humid tropics. Its success, however, depends on unlimited availability of land and small farming population. The system is presently unsustainable due to high population pressure and other human activities which have resulted in reduced fallow period (Steiner, 1991). Intensive cropping is becoming more common and the primary function of soil productivity and fertility restoration through fallow has become less effective (Okigbo, 1982). Increased cropping intensity has however been found to accentuate such changes as erosion of top soil, degradation in soil physical condition, deteriorating nutrient status and changes in the number and composition of soil organisms (Okigbo, 1982). The judicious management and conservation of the soil to guide against these problems that eventually lead to decreased crop yield under intensive cropping have become major areas of agronomic research (Brechin and McDonald, 1994) .

The use of inorganic fertilizer has not been helpful under intensive agriculture because it is often associated with reduced crop yield, soil acidity and nutrient imbalance (Kang and Juo, 1980; Obi and Ebo, 1995; Ojeniyi, 2000). Soil degradation which is brought about by loss of organic matter accompanying continuous cropping becomes aggravated when inorganic fertilizers are applied repeatedly. This is because crop response to applied fertilizer depends on soil organic matter (Agboola and Omueti, 1982) . The quantity of soil organic matter in the soil has been found to depend on the quantity of organic material which can be introduced into the soil either by natural returns through roots, stubble, slough off roots nodules and root exudates or by artificial application in the form of organic manures which can otherwise be called organic fertilizers.

The need to use renewable forms of energy and reduce costs of fertilizing crops has revived the use of organic fertilizers worldwide. Improvement of environmental conditions and public health important reasons for advocating increased use of organic materials (Seifritz,

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Table 1. Initial soil test values of sites used for field studies at Oniyo and Moloko-Ashipa.

Soil parameter	Oniyo	Moloko-Ashipa
% Clay	3	5
% Silt	15	13
%Sand	82	82
PH	5.2	5.7
Organic C (g/kg)	4.74	6.24
Total N (g/kg)	0.84	0.92
Ca (cmol/kg)	1.48	2.14
Mg (cmol/kg)	1.12	1.30
K (cmol/kg)	0.16	0.18
Na (cmol/kg)	0.50	0.27
CEC (cmol/kg)	3.14	4.00
Available P (mg/kg)	7.48	4.71

1982; Ojeniyi, 2000; Maritus and Vlelc, 2001). The benefits derivable from the use of organic materials have, however, not been fully utilized in the humid tropics partly due to the huge quantities required in order to satisfy the nutritional needs of crops, transportation as well as the handling costs which constitute major constraints. Complementary use of organic manures 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 NPK fertilization combined with organic matter amendment (Kang and Balasubramanian, 1990). A system integrating different practices of soil fertility maintenance is required and this will include the use of mineral fertilizer, organic manures and intercropping which provides a fast and good ground cover and also allows the roots to exploit soil nutrients at various depths (Steiner, 1991). The traditional farmers seem to have unconsciously designed their cropping system with a view of maintaining the fertility status of the soil because intercropping produces a stable and sustainable agroecosystem in the humid tropics. Farmers in the south western part of Nigeria practice intercropping with a wide range of crops consisting usually of a major crop and other minor crops. Crops like cassava, maize, yam and plantain are planted as major crops while melon, cowpea and vegetables are minor crops in various parts of the region (IITA, 1990). Cassava, one of the most important food crops widely grown in several countries in sub-saharan Africa, is well suited to intercropping with short-duration crops such as maize, melon, cowpea, okra and several leafy vegetables. The crops are selected on the basis of differences in growth habits and can be combined in either simple or complex mixtures. Complex mixtures consisting of three or more crop species are known to give higher financial and calorie returns (IITA, 1990). In view of the foregoing, a study was conducted to determine the effects of NPK fertilizer and poultry manure on the yield and yield components of cassava, maize and melon under sole and inter cropping systems.

MATERIALS AND METHODS

Field experiments were conducted during the 2000 and 2001 cropping seasons in the adopted villages (Oniyo and Moloko-Ashipa) of the Institute of Agricultural Research and Training (IAR&T). Oniyo (latitude 8° 20′N; longitude 4° 20′E) is in the derived savanna agro-ecological zone of Southwestern Nigeria. The average annual rainfall varies from 1000 to 1150 mm and distributed over seven months with a short dry spell in August. Moloko- Ashipa (latitude 7° 01′N; longitude 3° 33′E) is in the lowland rainforest agro ecological zone of Southwestern Nigeria. The average annual rainfall varies from 1000 to 1350 mm and has a bimodal distribution. The farm sites for the experiments have been previously cropped to crops such as maize, cassava and cowpea with little or no mineral fertilizers application and inconsistent fallow periods. The dominant soil of the experimental areas in Oniyo and Moloko-Ashipa is Alfisol (USDA, 1975). The soils are well to moderately well drained and have a low nutrient status.

Before planting in 2000, surface soil samples (0-15 cm) were collected from fifteen points from both sites and were then bulked for routine analysis. The nutrient contents of the soils are presented in Table 1. The poultry manure applied contained 1.98% N, 1.74% P, 5.25% Ca, 2.00% K and 4.79% Mg. The experiments were laid out as a 4 x 4 factorial in randomized complete block design (RCBD) with four replications. The factors were (1) cropping systems: cassava/maize/melon, sole cassava, sole maize and melon; (2) fertilizer: no fertilizer, 5 t/ha poultry manure (PM), 2.5 t/ha poultry manure + 200 kg/ha NPK15- 15-15 and 400 kg/ha NPK15-15-15. The treatments comprised all possible combinations of four cropping systems and fertilizer levels. The plot size was 4 m x 5 m. Sites were ploughed and harrowed, and the plots were laid out according to the design of the study. Organic fertilizer was applied a week before planting. It was uniformly spread on the plots and lightly worked into the soil with hoe. Inorganic fertilizer was applied 3 weeks after planting by ringing around maize plant. Cassava (*Manihot esculenta* Crantz) variety TMS 30572, a popular improved variety among local farmers was planted. Maize (*Zea mays* L.) variety planted was DMR-LSR-W while a local variety of melon (*Colocynthis citrullus* L) was used. Planting was done on the flat in May of each year at Oniyo and Moloko-Ashipa. Cassava, maize and melon were planted at the same time. Cassava was pla-

Table 2. Effect of cropping systems, NPK and poultry manure on yield and yield components of maize in at Oniyo.

Treatments	Grain yield (t/ha) 2000	Grain yield (t/ha) 2001	Cob weight (g) 2000	Cob weight (g) 2001	Cob length (cm) 2000	Cob length (cm) 2001	Weight of 1000 grains (g) 2000	Weight of 1000 grains (g) 2001
Cropping systems								
Sole cropping	2.13a	2.19a	59.53a	59.03a	13.31a	12.56a	147.8a	141.6a
Intercropping	1.99b	1.93b	56.99b	55.27b	12.33b	10.81b	149.2a	144.5a
Fertilizers								
No fertilizer	0.93c	1.25c	50.06d	45.91d	9.450d	7.750d	120.8d	113.8d
NPK	2.61a	2.39a	62.85b	60.24b	13.84b	12.76b	160.9b	143.7b
Poultry manure	1.99b	2.06b	54.33c	58.84c	12.40c	11.49c	150.7c	133.8c
NPK + Poultry manure	2.79a	2.53a	65.81a	63.61a	15.58a	14.73a	165.6a	160.9a

Values followed by the same letter(s) in a column are not significantly different at P=0.0 5 (DMRT).

Table 3. Effect of cropping systems, NPK and poultry manure on yield and yield components of maize at Moloko-ashipa.

Treatments	Grain yield (t/ha) 2000	Grain yield (t/ha) 2001	Cob weight (g) 2000	Cob weight (g) 2001	Cob length (cm) 2000	Cob length (cm) 2001	Weight of 1000 grains (g) 2000	Weight of 1000 grains (g) 2001
Cropping systems								
Sole cropping	2.12a	2.21a	58.36a	58.09a	14.04a	11.14a	148.5a	138.9a
Intercropping	1.91b	2.00b	56.98b	56.60b	12.80b	9.400b	143.9a	137.2a
Fertilizers								
No fertilizer	0.85c	0.95c	49.83d	52.94c	10.04d	7.113c	116.2d	109.4d
NPK	2.50a	2.49a	62.24b	59.65b	14.31b	11.30a	155.1b	147.7b
Poultry manure	2.04b	2.19b	53.98c	53.65c	13.46c	10.76ab	149.6c	131.1c
NPK + poultry manure	2.66a	2.60a	64.64a	63.14a	15.88a	11.90a	163.9a	163.8a

Values followed by the same letter(s) in a column are not significantly different at P=0.0 5 (DMRT).

nted at a spacing of 1 m x 1 m to obtain a plant population of 10,000 plants ha^{-1} while maize and melon were planted at a spacing of 1 m x 1 m at 2 plants/stand to achieve a plant population of 20,000 plants ha^{-1}, respectively. The plots were weeded manually whenever necessary throughout the experimental period. Maize was harvested at maturity and air dried to 12% moisture content. Melon was also harvested at maturity and processed thereafter. Cassava was harvested 12 months after planting. Data were collected on maize plant height at harvest, leaf area, cob weight cob length weight of 1000 grains, grain yield, average melon ball weight, melon seed yield, average weight of cassava tuber and root yield. Land equivalent ratio (LER) was calculated using the formula of Fisher (1977). The data were subjected to statistical analysis according to the procedure for factorial in randomized complete block design Means were compared using Duncan's Multiple Range Tests (DMRT)

RESULTS

Cropping systems significantly affected all the characters investigated except the weight of 1000 grains from both locations. Intercropping reduced maize growth, yields and yield components relative to sole cropping over two seasons for both locations (Table 2). Application of NPK and poultry manure significantly increased grain yields and other parameters investigated. Complementary application gave the highest values. Maize grain yield followed the same trend in both location for the planting seasons and the trend was NPK + poultry manure > NPK > poultry manure > no fertilizer. Grain yields were not statistically different under complementary application of NPK and poultry manure fertilizer and application of NPK fertilizer alone (Tables 2 and 3).

Melon when planted sole gave significantly higher seed yield and average ball weight than when intercropped with cassava and maize. At both locations, no fertilizer (control) gave the least seed yield. Seed yield was not significantly different between the application of NPK fertilizer alone and complementary application of NPK fertilizer and poultry manure.

Data on cassava fresh tuber yield and average number of tubers per plot are shown in Table 4. Cropping system effect was not significant for fresh tuber and average number of tubers per plot at 2000 and 2001 from both stations. There were significant differences among the fertilizers applied for fresh tuber yield and average number of tubers per plot. Averaged across cassava fresh tuber yield from both stations in 2000 and 2001, comple-

Table 4. Melon seed yield and average ball weight as affected by cropping system, NPK and poultry manure.

Treatments	Oniyo				Moloko-Ashipa			
	Melon seed yield (kg/ha)		Average ball weight (g)		Melon seed yield (t/ha)		Average ball weight (g)	
	2000	2001	2000	2001	2000	2001	2000	2001
Cropping system								
Sole cropping	193.5a	208.1a	710.1a	848.7a	207.4a	208.0a	672.6a	759.1a
Intercropping	101.7b	94.96b	627.9b	779.5b	97.04b	97.11b	597.0b	669.6b
Fertilizers								
No fertilizer	101.7c	101.2c	485.7c	685.9c	105.5c	103.6c	513.8d	595.5c
NPK	163.2a	177.3a	715.5b	859.8ab	173.5a	177.3a	676.4b	745.3b
Poultry manure	157.1b	155.9b	704.9b	810.5b	153.4b	157.2b	621.1c	721.9b
NPK + Poultry manure	167.9a	171.3a	770.0a	9000.2a	176.5a	170.3a	727.9a	794.7a

Values followed by the same letter(s) in a column are not significantly different at P=0.0 5 (DMRT).

Table 5. Fresh root yield and average number of tubers of cassava as affected by cropping systems, NPK and poultry manure.

Treatments	Oniyo				Moloko-Ashipa			
	Cassava tuber yield (t/ha)		Average wt of tubers/plant (g)		Cassava tuber yield (t/ha)		Average wt of tubers/plant (g)	
	2000	2001	2000	2001	2000	2001	2000	2001
Cropping system								
Sole cropping	21.34a	22.70a	137.4a	138.3a	21.34a	20.48a	141.4a	146.7a
Intercropping	20.40a	20.92a	135.2a	133.0a	20.40a	20.20a	142.8a	143.7a
Fertilizers								
No fertilizer	13.99c	14.44c	110.2c	112.3d	13.99c	10.49d	117.0c	115.8c
NPK	23.95b	23.58b	132.4ab	142.4b	23.95a	23.61b	149.8ab	155.3ab
Poultry manure	20.29b	23.09b	129.1b	127.4c	20.29b	21.51c	141.4b	148.9b
NPK + Poultry manure	25.25a	26.14a	135.7a	160.6a	25.25a	25.75a	160.4a	160.9a

Values followed by the same letter(s) in a column are not significantly different at P=0.0 5 (DMRT).

Table 6. Mean values of Land Equivalent Ratio (LER) for the two years.

Location	Sole cropping			Intercropping
	Maize	Melon	Cassava	
Oniyo	0.75	0.69	0.74	2.18
Moloko-Ashipa	0.70	0.68	0.66	2.04
Mean LER	0.73	0.69	0.70	2.11

mentary application of poultry manure and NPK fertilizer gave the highest values compared to the application of NPK fertilizer or poultry manure alone. However, no fertilizer (control) gave the least values.

The average values of Land Equivalent Ratio (LER) based on the sole crop yields of individual crop for the two years are shown in Table 6. For both years, the intercrop combination gave LER greater than 2. On the average, the highest LER (2.12) was got under complementary application of NPK fertilizer and poultry manure followed by NPK fertilizer alone (2.03) and poultry manure alone (1.83). The least LER was recorded under no fertilizer (control) from Oniyo (1.43) and Moloko-Ashipa (1.41).

DISCUSSION

The results have indicated that regardless of agroecology and fertilizer application, the yield of maize was reduced by the associated cassava and melon, as reported by other workers (Okpara and Omaliko, 1995; Muoneke and Asiegbu, 1997). The reduction was attributed to inter-specific competition for nutrients, moisture and/or space. The poor performance of melon when intercropped with maize and cassava has been attributed mainly to shading by the taller maize and cassava. Ikeorgu (1984) observed that yields from melon grown in mixtures are often lower than 50% of those from sole crops. It was also noted in a trial conducted in IITA (1974) that melon component in a cassava/maize/melon mixture performed poorly because of shading effect of higher component crops. In traditional agriculture, melon is rarely planted solely; it is often intercropped with cassava, maize, yam and other food crops where it performs the role of a cover crop and it helps to smother weeds early in the growing season (Ikeorgu, 1984). It also reduces soil temperature and evaporation, thus conserving soil moisture. Ghuman and Lal (1987) observed that soil surface remained moist in the intercrop during an unexpected dry spell of 6-8 days when compared to situations under monoculture of maize and yam. They also found that maize intercropped with melon never showed any sign of even temporary wilting on hot afternoons, in contrast with monoculture check.

Intercropping had no significant effect on cassava yields. The fact that cassava is a long duration crop and has an initial slow growth rate allows it to recover from the earlier competition effects when intercropped with maize and melon. Some studies have shown that cassava yield was reduced by intercropping while other reports did not indicate any significant reduction in yield in comparison with sole crop. Sinthuprama (1978) reported that cassava growth was initially retarded when intercropped with maize but it was possible to get a high proportion of its sole crop yield. CIAT (1980) also found that the yield of cassava intercropped with groundnut was similar to sole crop yield. CIAT (1977) reported low cassava yields in studies evaluating the performance of cassava in cassava/maize, cassava/sweet potato and cassava/cocoyam associations. The cassava crop also gave 78% of its sole crop yield giving a land equivalent ratio (LER) of 1.71 in trials carried out in central America. In some situations the total LER was as high as 2.00. Yield advantages of between 58 and 77 percent were also recorded in cassava/maize association in southern Nigeria (IITA, 1982).

Cassava, maize and melon performed best in terms of growth and yield under poultry manure + NPK fertilizer treatments in both years. This is in agreement with the findings of Titiloye (1982) who reported that the most satisfactory method of increasing maize yield was by judicious combination of organic wastes and inorganic fertilizers. Agboola (1970) advocated for better farming systems which employ a combination of fertility building practices appropriate to local conditions for crop production in south west Nigeria. It has been observed that addition of manure increases soil water holding capacity and this means that nutrient would be made available to crops where manure has been added to the soil (Costa et al., 1991). Fuchs et al. (1970) also reported that nutrients from mineral fertilizers enhance the establishment of crops while those from mineralization of organic manure promoted yield when both fertilizers were combined. Murwira and Kirchman (1993) observed that nutrient use efficiency might be increased through the combination of manure and mineral fertilizer. The yield of maize and melon under NPK fertilizer treatment was comparable to that form NPK + poultry manure treatment because nutrients are readily released form inorganic fertilizer and these crops were able to utilize it for growth and yield. Crop yield were lower under poultry manure probably because of low mineralization of nutrient from this source. Titiloye (1982) found that organic waste / fertilizer alone could hardly be depended upon as the sole source of nutrient for a short duration crop like maize. On the average, the combined application of NPK fertilizer and poultry manure appeared satisfactory for obtaining high grain yield of maize, seed yield of melon and fresh tuber yield of cassava. The trend of cassava yield was NPK + poultry manure>NPK alone>poultry manure > no fertilizer. This indicates that cassava was still able to utilize residual nutrients from both NPK and poultry manure to produce bigger tubers in the fertilized plots after early season maize and melon had been harvested. The choice of crops for this study was based mainly on the popularity of the crops among farmers in the south west area of Nigeria. Cassava is particularly suitable for intercropping because it is a long duration crop. The faster growing maize exploits the microenvironment early in the growing season while melon, a low canopy crop served a dual purpose of protecting the soil against erosion and soil loss. This study has shown that intensification of cropping with complementary use of organic and inorganic fertilizer is a good way of making judicious and efficient use of applied nutrients.

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