ISSN: 2695-2556 (Online)
ISSN: 2651-5679 (Print)

AKSU Journal of Agriculture and Food Sciences 8(2) 52-71

Performance Evaluation of Cocoyam-based Intercropping Systems to Different Rates of Fertilizers in Obio Akpa, South Eastern Nigeria

[*1] Patrick I. Udounang and [2]Florence O.Umoh

[1]Department of Crop Science, Faculty of Agriculture, Akwa Ibom State University

[2]Department of Soil Science, Faculty of Agriculture, Akwa Ibom State University

[*]Corresponding Author Email: patunang@yahoo.com Tel: +2348028455194

Abstract

A field experiment was conducted at the Teaching and Research farm, Akwa Ibom State University Obio Akpa Campus during the 2021 and 2022 cropping seasons to assess the performance of cocoyam-based intercropping systems to different rates of organic and inorganic fertilizers. The experiment was a split-plot factorial laid out in a Randomized Complete Block Design with three replications. The treatments were six (6) rates of fertilizers (0kg/ha, NPK 200kg/ha, NPK 400kg/ha, Poultry Manure (PM) 2.5t/ha, PM 5.0t/ha, Mixture – NPK 200kg/ha + PM 2.5t/ha) and six (6) crop mixtures (Sole Cocoyam, Sole Melon, Sole Maize, Cocoyam + Maize, Cocoyam + Melon and Cocoyam + Melon + Maize) arranged in split plot. Result indicated significant differences (P< 0.05) among the various crop mixtures and fertilizer levels at 2, 4, 6 Months after planting (MAP) on the plant height, stem girth of cocoyam, plant height of maize and vine length of melon. PM 2.5t/ha favoured leaf Area, stem girth of cocoyam and maize with crop mixtures of cocoyam + maize, cocoyam + melon, cocoyam + melon + maize in both cropping seasons. NPK 200kg/ha and NPK400kg/ha gave higher values of cocoyam and maize height whereas PM 2.5t/ha recorded higher vine length of melon in sole cropping. PM 5.0t/ha gave higher values of corm yield, cormels yield, weight of cormels, number of cormels and length of cormels in sole cocoyam. For cocoyam + melon, higher values of corm yield, weight of corms, weight of cormels, number of cormels were obtained with PM 5.0t/ha. For cocoyam + maize, higher values of corm and cormel yields were obtained with Poultry Manure5.0t/ha and NPK400kg/ha respectively. The PM rate of 5.0 t/ha gave higher values of corm yield, weight of corm, weight of cormels and number of cormels with cocoyam + melon + maize in both seasons. For maize, PM 2.5t/ha gave higher values of grain yield with cocoyam + maize, cocoyam + melon + maize crop mixtures. For melon, PM 5.0t/ha and NPK 400kg/ha gave higher values with cocoyam + melon and cocoyam + Melon + maize respectively.

Key words: Poultry Manure, NPK 15:15:15, Cocoyam, Melon, Maize

1.0 Introduction

Crop production as well as development and crop growth which culminates into yield, has been influenced by soil fertility and the attendant degradation issues. It is an established fact that crop production depends largely on the soil fertility and the available as well as natural resource endowment within the ecological zone. In the tropics and the sub-regions, decline in soil fertility is attributable to the prevailing soil degradation occurrences whereas most tropical crops require certain amount of nutrients drawn from the fertile soil for growth and productivity (Wong *et al.,* 2003). Tropical soils are therefore adversely affected by sub-optimal soil fertility and erosion, deterioration of nutrients status and changes in soil organisms (Economic Commission for Africa, 2011). Non-marginal lands that are inadvertently non-productive, have been converted to fertile farmlands through effective soil fertility management practices involving the use of manures, inorganic fertilizers and soil amendments. Fertilizers are generally known to increase yields per hectare of crops in a planting regime (Ikeh *et al.,*2012; Udounang *et al.,* 2022). It could therefore be said that fertilizers are essentially chemical nutrients (organic and inorganic) desired by crops at different levels and time for good growth and yield. The nutrient elements in fertilizers are important in boosting crop production (Udounang *et al.,* 2018).

In recent times, there has been a decline in soil fertility in Nigeria which invariably affects farm production and hence a hindrance to farmers from obtaining good yields in crops. According to Smil (2000), the use of inorganic fertilizers improves the crop yields by way of increasing soil fertility and nutrient availability. Organic fertilizers and inorganic fertilizers can stimulate crop growth and improve its mineral uptake thus affecting the subsequent yield (Udounang *et al.,* 2019; Azza *et al.,* 2006).

Intercropping is a form of mixed cropping. It involves the growing of two or more crops simultaneously in the same season on the same piece of land. It is a production practice that is commonly adopted by farmers in most developing countries including Nigeria (Ofori and Stern, 1987). The strategies adopted in intercropping involves the planting of deep-rooted crops with shallow rooted crops or planting tall crops with shorter crops that require partial shades. The most common goal in the practice is the production for greater yield on a given piece of land using limited resources or ecological processes that would otherwise not be utilized by single crop (Oluma, 2010; Akpainyang *et al.,* 2022; Edem 2021). The system involves numerous associated crops such as cocoyam, maize, cowpeas, plantains and vegetables depending on the agro ecological zone (Doku 1988; Edem 2015).

The cultivation of Cocoyam is often associated with the practice of intercropping and cocoyam is one of the most staple food crops in Africa. In Nigeria, it is considered to take third position after yam and cassava. It is grown basically for the corms and cormels, though the leaves, petiole are often eaten as vegetables. It has been observed that cocoyam grown as sole performed well with both organic and inorganic fertilizers giving best growth and yield with NPK 200kg/ha and with organic manure (poultry manure) at 2.5tonnes/ha (Udounang, 2007; Umoh, 2022). Similar works on tillage practices (Udounang, 2015) gave affirmation results that cocoyam does well with mounds in comparison with ridges and flat. The potential performance of cocoyam in an intercropping system especially with crops of relative importance and the combined effect of fertilizer rates need more investigation. The aim of the research therefore is to study performance of cocoyam in an intercropping system using different rates of both organic and inorganic fertilizers.

2.0 Materials and Methods

The field experiment was carried out at the Teaching and Research farm, Akwa Ibom State University. The site is located on latitude $4^0$30S and 5^0 30N, longitude 7^0 30W and 8^0 00E with an altitude of 38.1m above sea level. It has about 2500mm mean rainfall annually. The rainfall pattern is bimodal with long (March - July) and short (September - November) rainy seasons separated by a short dry spell of uncertain length usually during the month of August. The mean annual temperature is 30^0 C with relative humidity ranging from 75 – 79% and mean sunshine hour of 12 (Peters *et al.*1989). The experiment was laid out in a randomized complete block design with three replications. The main treatment were four (4) crop mixtures (Sole Cocoyam; Cocoyam + Maize; Cocoyam + Melon; Cocoyam + Melon + Maize) whereas the sub-treatment were six (6) fertilizer rates (0kg/ha; NPK 200kg/ha; NPK 400kg /ha; poultry manure (PM) 2.5t/ha; PM 5.0t/ha; Mixture - NPK200kg/ha + PM 2.5t/ha). The plot sizes were 23 x 6 m and 3 x 6 m respectively.

The cocoyam setts with average weight of 0.3kg were planted on the crest of the mounds at a spacing of 1 x 1 m giving 10,000 plants density/hectare. Three maize seeds were planted per stand on the side of the mound at 1 x 0.5 m spacing and later thinned to 2 plants per stand. Three melon seeds were planted per stand on the crest of the mounds at a spacing of 1x1m and later thinned to 2 plants per stand. The poultry manure was sun cured and de-caked for about 3 days before application. The NPK fertilizer with the PM were applied in band at 2 months after planting (MAP). Weeding was done manually at 2 months' interval after planting while harvesting was done at 4 months after planting for maize, melon and 8 MAP for cocoyam.

The following growth and yield parameters were collected – plant height, leaf area, stem girth for growth and corm yield, cormel yield and number of cormel per plant for yield parameters. The data obtained were subjected to analysis of variance and treatment means were separated using F- LSD at 5% probability level

3.0 Results

3.1 The Effects of Crop Mixture and Fertilizer Rates on Cocoyam

Generally, the results indicated differences at 5% probability level with the crop mixtures and the fertilizer levels at 2, 4 MAP on cocoyam height (Table 3.1). The crop mixtures showed significant differences ($P< 0.05$) at 2, 4, 6 MAP whereas fertilizer levels indicated significant differences ($P< 0.05$) at 2, 6 MAP respectively.

With the sole cocoyam and cocoyam + melon crop mixture, NPK 200kg/ha fertilizer rate gave higher values of cocoyam height at 2, 4, 6 MAP in both planting seasons. Lower values of cocoyam height were obtained with mixture (NPK200 + PM 2.5t/ha) applied on sole and cocoyam + melon crop mixture at 2, 4, 6 MAP in both seasons. With crop mixtures of cocoyam + maize and cocoyam + maize + melon, PM 2.5t/ha gave a higher value of cocoyam height whereas NPK400kg/ha gave the least value at 2, 4, 6 MAP in both planting seasons.

The effect of crop mixtures and fertilizer rates on the leaf area of cocoyam is shown in table 3.2. Result indicated significant differences ($P<0.05$) at 2, 6 MAP on fertilizer rates and 6 MAP in crop mixtures in both planting seasons. At 2 MAP, NPK 200kg/ha gave a higher value of the leaf area whereas PM 2.5t/ha recorded the highest value of leaf area at 4, 6 MAP with sole cocoyam. For crop mixtures of cocoyam + melon, cocoyam + maize and cocoyam + maize + melon, PM 2.5t/ha gave higher values of leaf area at 2, 4, 6 MAP in both seasons.

Table 3.3 shows the effect of crop mixtures and fertilizer rates on the stem girth of cocoyam. Results showed significant differences ($P<0.05$) on crop mixtures at 2, 4 MAP and fertilizer rates at 2, 4, 6 MAP in both planting seasons. For sole cocoyam and crop mixtures of cocoyam + melon, cocoyam + maize, PM 2.5t/ha gave the highest value of stem girth of cocoyam at 2, 4, 6 MAP in both years whereas, NPK 200kg/ha gave higher values of stem girth with cocoyam + maize + melon at 4, 6 MAP in both years respectively.

3.2 The Effects of Crop Mixture and Fertilizer Rates on Maize

The effect of crop mixtures and fertilizer rates on the height of maize is shown on Table 3.4. Results showed significant differences on the crop mixtures and fertilizer rates at 2, 4, 6 WAP in both seasons. NPK 400kg/ha gave higher values of height of maize with sole maize, cocoyam + maize, cocoyam + maize + melon whereas PM 5.0 t/ha gave least value with cocoyam + maize and cocoyam + maize + melon at 2, 4, 6 WAP in both seasons.

Table 3.5 showed the effect of crop mixtures and fertilizer rates on the leaf area of maize. Results showed significant differences on the fertilizer rates at 2, 4 WAP in both planting seasons. With sole maize, NPK 400kg/ha gave higher values of leaf area at 2, 4 WAP whereas Pm 5.0t/ha recorded a higher value at 6 WAP in both years. For cocoyam + maize and cocoyam + maize + melon, NPK 400kg/ha gave higher values of leaf area of maize at 2, 4, 6 WAP in both seasons.

The effect of crop mixtures and fertilizer levels on the stem girth of maize is shown in table 3.6. Results showed no significant difference ($P<0.05$) on the crop mixtures and fertilizer rates. However, the fertilizer rates of PM 2.5t/ha gave higher values of stem girth with sole crop, cocoyam + maize and cocoyam + maize + melon at 2, 4, 6 WAP in both seasons. Table 3.7 showed the effect of crop mixtures and fertilizer rates on the vine length of melon. The results indicated significant differences ($P<0.05$) on the crop mixtures and fertilizer rates in both planting seasons. For sole cropping system, the mixed fertilizer rates (NPK 200kg/ha + PM 2.5) gave higher values of vine length at 2, 4 WAP in comparison with the control, whereas NPK 200kg/ha recorded a higher value at 6 WAP. The mean values increase at 2, 4, 6 WAP to 92.8, 152.9 and 246.4 cm respectively for the sole crop. For the crop mixture of melon + cocoyam, NPK 200kg/ha fertilizer rate gave a higher value at 2 WAP, whereas PM 5.0t/ha recorded higher values of vine length at 4, 6 WAP respectively. For melon + maize + cocoyam crop mixtures, PM 2.5t/ha gave a high value of 87.0 cm at 2WAP. At 4 WAP, NPK 200kg/ha recorded 142.5cm whereas NPK 400kg/ha gave 239.3cm at 6 WAP respectively with melon + maize + cocoyam. The mean values of the vine length increased at 2, 4, 6 WAP in the crop mixtures adopted within the planting seasons.

Table 3.8 showed the effect of crop mixtures and fertilizer rates on the yield and yield components of cocoyam. Results indicated significant differences ($P<0.05$) on the corm yield, weight of corms and cormels on both crop mixtures and fertilizer rates respectively, whereas corm and cormels length, number of cormels showed significant differences ($P<0.05$) on the fertilizer levels. For sole cocoyam, PM 5.0t/ha gave a higher value of corm yield, weight of corm and number of cormels whereas cormels yield, weight of cormels were favoured with NPK 200kg/ha and NPK 400kg/ha respectively in both seasons. Fertilizer mixture (NPK 200 kg/ha + PM 2.5t/ha) gave higher values of corm and cormels length in both planting seasons. For cocoyam + melon, PM 5.0t/ha gave high values of corm yield, weight of corm and cormels and number of cormels in both seasons. NPK 400kg/ha gave high values of cormels yield, length of corm and cormels in both seasons. For cocoyam + maize, NPK 400kg/ha gave high values of corm, cormels yield and number of cormels. PM

2.5t/ha gave high values of weight of corm, length of corm and cormels whereas fertilizer mixture (NPK 200 kg/ha + PM 2.5 t/ha) recorded high weight of cormels in both planting seasons. For cocoyam + maize + melon, higher values of corm yield, weight of corm and cormels were recorded with PM 5.0 t/ha. Cormel yield, length of corm and cormels were favoured with PM 2.5t/ha whereas number of cormels were high with NPK 400kg/ha in both seasons.

Table 3.9 showed the effect of crop mixtures and fertilizer rates on the yield and yield components of maize. Results indicated significant differences ($P<0.05$) on the grain yield of maize on both crop mixtures and fertilizer rates whereas filling cob percentage showed significant differences ($P<0.05$) on the fertilizer rates applied. For sole maize, NPK 400kg/ha gave high values of weight of un-dehusked maize and filling cob percentage; PM 2.5t/ha gave higher values of weight of dehusked maize, weight of grain per cob and grain yield; NPK 200kg/ha favoured the length of cob in both planting seasons. For maize + cocoyam, NPK 200kg/ha recorded high values of weight of undehusked and dehusked maize, length of cob and weight of grains per cob. PM 5.0 t/ha gave high values of filling cob percentage whereas PM 2.5t/ha recorded high value of grain yield in both planting seasons. For maize + melon + cocoyam, NPK 200kg/ha recorded high values of weight of undehusked, filling cob percentage, length of cob. NPK 400kg/ha gave high values of weight of dehusked whereas PM 2.5t/ha recorded high values of weight of grains per cob and grain yield in both seasons.

3.3 The Effects of Crop Mixture and Fertilizer Rates on Melon

Table 3.10 showed the effect of crop mixtures and fertilizer rates on the yield and yield components of melon. Results indicated significant differences ($P<0.05$) on the mean number of pods and total weight of the pods in both crop mixtures and fertilizer rate treatments whereas length of pods and circumference of pods showed significant differences ($P<0.05$) in the fertilizer rates and crop mixture treatment respectively. For sole melon, NPK 200kg/ha gave high value of mean number of pods, PM 2.5t/ha recorded high value of melon seed yield, PM 5.0t/ha gave high value of length and circumference of pods and fertilizer mixture (NPK 200 kg/ha + PM 2.5 t/ha) recorded higher total weight of pods in both planting seasons. For melon + cocoyam, NPK 200kg/ha recorded high values of mean number of pods and melon seed yield, PM 5.0t/ha gave higher values of length of pods, circumference of pods and total weight of pods whereas fertilizer mixture (NPK 200 kg/ha + PM 2.5 t/ha) recorded high melon seed yield in the two planting seasons. For melon + maize + cocoyam, NPK 200kg/ha gave high values of mean number of pods, NPK 400 kg/ha recorded high values of circumference of pods and total weight of pods, PM 5.0t/ha gave higher length of pods whereas melon seed yields were high with fertilizer mixture (NPK 200 kg/ha + PM 2.5 t/ha) in both seasons.

Table 3.1: Effect of crop mixtures and fertilizer levels on the height of Cocoyam

Treatments		Months After Planting (cm) (MAP)					
		2		4		6	
Crop mixtures	**Fertilizer levels**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Sole cocoyam	0kg/ha	51.2	49.5	75.7	74.2	91.9	92.0
	NPK200kg/ha	60.23	58.2	90.6	92.1	121.5	122.6
	NPK400kg/ha	59.27	56.3	90.4	91.4	120.1	120.8
	PM 2.5t/ha	55.13	55.9	85.4	86.1	113.4	140.2
	PM 5.0t/ha	54.87	53.5	75.2	74.8	93.9	95.2
	NPK200 +PM 2.5	47.33	48.4	73.7	72.5	91.7	92.4
Mean		**54.7**	**53.6**	**81.8**	**81.8**	**105.4**	**110.5**
Co + Me	0kg/ha	50.8	48.2	76.2	76.0	101.6	110.0
	NPK200kg/ha	61.0	62.0	91.2	93.1	130.6	131.2
	NPK400kg/ha	63.9	64.2	90.1	91.2	122.0	128.5
	PM 2.5t/ha	54.2	54.6	81.3	80.4	109.4	109.8
	PM 5.0t/ha	50.7	51.0	76.0	75.2	101.0	107.4
	NPK200 +PM 2.5	51.3	52.1	75.4	74.8	100.0	105.0
Mean		**55.3**	**55.3**	**81.7**	**81.7**	**110.8**	**115.3**
Co + Ma	0kg/ha	48.4	48.7	69.9	68.5	93.8	94.1
	NPK200kg/ha	51.4	52.1	77.6	78.2	102.3	104.3
	NPK400kg/ha	50.6	50.2	76.0	76.4	101.2	102.5
	PM 2.5t/ha	64.0	63.8	96.3	94.4	128.0	127.8
	PM 5.0t/ha	55.4	56.2	84.6	85.2	112.7	111.8
	NPK200 +PM 2.5	55.3	55.8	83.7	83.9	111.0	108.7
Mean		**54.2**	**54.4**	**81.4**	**81.1**	**108.2**	**108.2**
Co + Ma + Me	0kg/ha	50.4	49.2	75.0	74.5	98.7	99.1
	NPK200kg/ha	51.9	50.8	77.7	78.0	103.8	101.6
	NPK400kg/ha	40.3	41.3	80.4	80.6	81.6	81.3
	PM 2.5t/ha	54.9	55.0	82.9	83.2	111.5	107.4
	PM 5.0t/ha	58.0	58.2	87.7	89.1	117.4	116.8
Mean	NPK200 +PM 2.5	46.5	47.0	69.3	68.5	93.9	94.1
		50.4	**50.2**	**78.8**	**78.9**	**101.2**	**100.05**
LSD (0.05) Crop mixture		13.0	13.1	15.7	16.2	13.3	12.4
LSD (0.05) Fertilizer levels		10.3	10.2	NS	NS	18.3	18.4

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium;
PM = Poultry Manure

Table 3.2: Effect of crop mixtures and fertilizer levels on the leaf area of cocoyam

Treatments		Months After Planting (cm^2) (MAP)					
		2		4		6	
Crop mixtures	**Fertilizer levels**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Sole cocoyam	0kg/ha	770.6	780.1	1633.6	1634.6	2450.4	2449.6
	NPK200kg/ha	937.6	930.2	1965.3	1966.2	2948.0	2955.0
	NPK400kg/ha	913.0	901.4	1659.6	1661.2	2489.4	2451.2
	PM 2.5t/ha	889.3	878.9	2008.4	2004.8	3012.6	3025.1
	PM 5.0t/ha	833.8	840.5	1773.4	1770.4	2660.1	2589.2
	NPK200 +PM	901.2	890.4	1920	1921.1	2880.4	2780.4
Sub Total	2.5	5245.8	5221.2	10960.8	10957.8	16441.2	16250.4
Mean		**874.3**	**870.2**	**1826.8**	**1826.3**	**2740.2**	**2708.4**
Co + Me	0kg/ha	731.8	730.4	1515.8	1510.5	2273.7	2272.4
	NPK200kg/ha	1052.3	1055.6	1924.3	1925.0	2886.4	2877.5
	NPK400kg/ha	848.7	840.5	1704.8	1710.2	2557.3	2577.3
	PM 2.5t/ha	1144.7	1201.0	1970.2	1989.4	2955.3	3001.4
	PM 5.0t/ha	976.5	984.2	1615.9	1605.2	2423.0	2413.6
	NPK200 +PM	1097.6	1101.4	1891.1	1884.2	2836.6	2786.4
Sub Total	2.5	5451.8	5913	10622.4	10624.2	15933.0	15928.2
Mean		**975.3**	**985.5**	**1770.4**	**1770.7**	**2655.5**	**2654.7**
Co + Ma	0kg/ha	657.9	661.2	1300.8	1301.1	1951.2	1960.1
	NPK200kg/ha	942.7	940.8	1905.7	1890.4	2858.6	2744.2
	NPK400kg/ha	817.3	811.6	1706.2	1699.5	2559.3	2601.2
	PM 2.5t/ha	1963.8	1096.1	1961.8	1980.3	2942.8	2975.8
	PM 5.0t/ha	904.6	911.3	1585.8	1566.7	2887.4	2880.4
	NPK200 +PM	935.8	922.2	1924.9	1904.6	2378.7	2360.5
Sub Total	2.5	5222.4	5343.0	10385.4	10342.2	15577.9	15522.0
Mean		**870.4**	**890.5**	**1730.9**	**1723.7**	**2596.3**	**2587.0**
Co + Me + Ma	0kg/ha	875.6	866.5	1266.0	1301.1	1899.0	1886.8
	NPK200kg/ha	1006.6	1004.6	1816.0	1798.8	2724.0	2628.4
	NPK400kg/ha	927.9	917.4	1565.7	1499.2	2348.5	2339.2
	PM 2.5t/ha	1150.3	1210.8	1892.6	1821.2	2839.0	2914.5
	PM 5.0t/ha	1062.8	1044.5	1500.4	1455.6	2250.6	2250.1
	NPK200 +PM	1047.7	1026.6	1816.7	1801.2	2725.1	2645.2
Sub Total	2.5	6070.8	6070.4	9857.4	9677.1	14786.4	14664.2
Mean		**1011.8**	**1011.7**	**1642.9**	**1612.8**	**2464.4**	**2444.0**
LSD (0.05) Crop mixture		NS	NS	NS	NS	14.4	15.6
LSD (0.05) Fertilizer levels		14.7	15.1	NS	NS	9.24	9.54

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium;
PM = Poultry Manure

Table 3.3: Effect of crop mixtures and fertilizer levels on the stem girth of cocoyam

Treatments		Months After Planting (cm) (MAP)					
		2		4		6	
Crop mixtures	**Fertilizer levels**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Sole cocoyam	0kg/ha	10.4	10.2	18.2	18.1	27.3	26.8
	NPK200kg/ha	12.3	12.0	21.5	21.0	32.3	31.6
	NPK400kg/ha	11.1	11.3	20.2	19.8	30.3	29.9
	PM 2.5t/ha	14.4	14.2	22.9	22.7	34.3	34.0
	PM 5.0t/ha	10.4	10.1	19.9	19.0	29.9	28.1
	NPK200 +PM 2.5	11.6	11.8	20.1	19.9	31.0	30.1
Sub Total		70.2	69.6	123.6	120.0	185.4	180.0
Mean		**11.7**	**11.6**	**20.6**	**20.0**	**30.9**	**30.0**
Co + Me	0kg/ha	7.9	7.4	18.9	18.1	28.3	27.8
	NPK200kg/ha	11.3	11.0	21.2	21.0	31.8	31.4
	NPK400kg/ha	9.1	9.0	20.2	20.1	30.3	30.0
	PM 2.5t/ha	12.4	12.6	22.3	22.2	33.5	34.1
	PM 5.0t/ha	9.7	8.9	19.6	18.9	29.5	29.7
	NPK200 +PM 2.5	10.6	9.6	20.7	20.4	31.1	31.0
Sub Total		61.2	58.2	123.0	120.6	104.8	183.6
Mean		**10.2**	**9.7**	**20.5**	**20.1**	**30.8**	**30.6**
Co + Ma	0kg/ha	8.6	8.7	18.1	18.0	27.2	27.0
	NPK200kg/ha	9.9	9.7	20.5	20.2	30.8	30.6
	NPK400kg/ha	10.2	10.0	19.6	18.6	29.5	28.2
	PM 2.5t/ha	11.4	12.0	21.3	22.1	31.9	32.3
	PM 5.0t/ha	9.5	9.3	19.8	18.9	29.8	28.6
	NPK200 +PM 2.5	9.7	9.5	20.2	20.0	30.4	30.1
Sub Total		59.4	58.8	119.4	117.6	179.4	176.4
Mean		**9.9**	**9.8**	**19.9**	**19.6**	**29.9**	**29.4**
Co + Me + Ma	0kg/ha	8.6	8.4	18.7	18.3	28.0	28.2
	NPK200kg/ha	10.7	10.6	19.9	20.0	29.9	29.7
	NPK400kg/ha	9.5	9.7	19.2	19.1	28.8	28.3
	PM 2.5t/ha	11.0	11.2	19.7	20.1	29.6	29.8
	PM 5.0t/ha	8.9	8.8	19.0	18.6	28.6	27.6
	NPK200 +PM 2.5	10.5	10.2	19.5	19.4	29.3	29.1
Sub Total		58.8	58.8	115.8	115.2	174.0	172.2
Mean		**9.8**	**9.8**	**19.3**	**19.2**	**29.0**	**28.7**
LSD (0.05) Crop mixture		9.2	9.1	NS	NS	13.47	12.6
LSD (0.05) Fertilizer levels		11.6	11.5	19.73	NS	11.84	10.7

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium; PM = Poultry Manure

Table 3.4 - Effect of crop mixtures and fertilizer levels on the height of maize

Treatments		Months After Planting (cm) (MAP)					
		2		4		6	
Crop Mixtures	**Fertilizer levels**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Sole maize	0kg/ha	19.9	19.2	43.3	44.4	67.5	68.4
	NPK200kg/ha	24.8	25.2	49.5	49.4	74.6	76.2
	NPK400kg/ha	29.8	30.1	59.9	59.8	92.5	93.2
	PM 2.5t/ha	27.9	28.3	51.3	52.2	80.3	84.4
	PM 5.0t/ha	24.1	25.`0	48.7	48.8	70.6	71.4
	NPK200 +PM 2.5	26.3	27.4	52.5	50.1	76.6	80.1
Sub Total		153.0	156.24	305.4	304.2	462.0	473.7
Mean		**25.5**	**26.04**	**50.9**	**50.7**	**77.0**	**78.95**
Co + Ma	0kg/ha	19.3	19.8	40.3	40.5	85.7	84.6
	NPK200kg/ha	23.7	24.4	47.4	49.8	71.0	72.2
	NPK400kg/ha	22.7	23.5	44.9	45.4	69.8	68.2
	PM 2.5t/ha	23.4	24.0	47.2	49.3	70.1	69.8
	PM 5.0t/ha	22.5	23.1	45.1	46.1	68.5	68.1
	NPK200 +PM 2.5	26.0	27.2	51.2	52.2	76.4	77.1
Sub Total		137.4	141.6	276.0	283.2	441.6	439.8
Mean		**22.9**	**23.6**	**46.0**	**47.2**	**73.6**	**73.3**
Co + Ma + Me	0kg/ha	18.1	18.5	39.0	38.8	63.4	60.4
	NPK200kg/ha	25.0	24.7	50.1	50.0	74.5	72.6
	NPK400kg/ha	24.3	24.1	48.9	48.6	72.3	70.8
	PM 2.5t/ha	23.8	23.5	47.8	46.8	69.6	68.2
	PM 5.0t/ha	23.6	23.1	47.6	46.2	72.2	70.6
Sub Total	NPK200 +PM 2.5	25.0	24.8	50.2	50.1	74.1	72.4
Mean		139.8	138.6	283.8	280.5	426.0	414.6
		23.3	**23.1**	**47.3**	**46.75**	**71.0**	**69.1**
LSD (0.05) Crop mixture		5.1	4.4	8.8	8.4	9.4	8.6
LSD (0.05) Fertilizer levels		6.3	5.6	5.4	5.1	4.8	3.7

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium; PM = Poultry Manure

Table 3.5: Effect of crop mixtures and fertilizer levels on the leaf area of maize

Treatments		Months After Planting (cm^2) (MAP)					
		2		4		6	
Crop Mixtures	**Fertilizer Levels**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Sole maize	0kg/ha	50.7	50.2	178.4	176.4	444.1	443.2
	NPK200kg/ha	52.9	51.7	213.7	214.1	455.4	454.1
	NPK400kg/ha	66.1	65.8	208.6	208.1	466.6	467.2
	PM 2.5t/ha	47.6	46.5	194.5	193.5	424.3	425.1
	PM 5.0t/ha	50.9	50.4	207.0	207.1	466.7	466.8
	NPK200 +PM 2.5	41.2	40.6	157.9	156.8	381.8	380.7
Sub Total		309.6	304.8	1160.4	1155.6	2638.8	2637.0
Mean		**51.6**	**50.8**	**193.4**	**192.6**	**439.8**	**439.5**
Co + Ma	0kg/ha	48.6	47.8	179.6	178.4	448.8	446.8
	NPK200kg/ha	53.1	52.6	214.0	213.6	478.5	477.6
	NPK400kg/ha	46.2	46.6	185.3	186.2	417.0	416.4
	PM 2.5t/ha	45.4	45.2	181.4	182.4	411.5	412.3
	PM 5.0t/ha	34.3	33.6	137.1	135.2	311.9	310.6
	NPK200 +PM 2.5	38.8	38.5	154.8	155.4	335.9	334.4
Sub Total		266.4	264.0	1052.4	1051.2	2403.6	2397.6
Mean		**44.4**	**44.0**	**175.4**	**175.2**	**400.6**	**399.6**
Co + Ma + Me	0kg/ha	40.7	40.2	152.7	152.2	405.4	402.4
	NPK200kg/ha	44.6	43.8	179.0	178.5	408.3	408.8
	NPK400kg/ha	43.6	43.1	190.3	191.1	417.4	418.4
	PM 2.5t/ha	39.9	38.8	155.2	155.8	368.1	367.2
	PM 5.0t/ha	42.9	41.2	167.0	168.2	404.8	405.1
	NPK200 +PM 2.5	36.6	36.4	146.5	147.1	331.7	333.2
Sub Total		248.4	243.0	990.6	992.4	2335.8	2334.6
Mean		**41.4**	**40.5**	**165.1**	**165.4**	**389.3**	**389.1**
LSD (0.05) Crop mixture		NS	NS	NS	NS	NS	NS
LSD (0.05) Fertilizer levels		3.9	2.6	3.06	3.10	NS	NS

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium; PM = Poultry Manure

Table 3.6 - Effect of crop mixtures and fertilizer levels on the stem girth of maize

Treatments		Months After Planting (cm^2) (MAP)					
		2		4		6	
Crop Mixtures	**Fertilizer Levels**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Sole maize	0kg/ha	2.3	2.3	4.6	4.4	7.0	6.7
	NPK200kg/ha	2.6	2.7	5.3	5.2	8.0	7.9
	NPK400kg/ha	2.3	2.2	4.4	4.4	6.8	6.7
	PM 2.5t/ha	2.8	2.9	5.7	5.6	8.4	8.2
	PM 5.0t/ha	2.2	2.1	4.4	4.3	6.6	6.4
	NPK200 +PM 2.5	2.3	2.2	4.4	4.3	7.0	6.8
Sub Total		14.4	14.4	28.8	28.2	43.8	42.6
Mean		**2.4**	**2.4**	**4.8**	**4.7**	**7.3**	**7.1**
Co + Ma	0kg/ha	2.1	2.1	4.5	4.4	6.3	6.1
	NPK200kg/ha	2.3	2.2	4.6	4.5	7.0	6.9
	NPK400kg/ha	2.1	2.1	4.8	4.7	6.6	6.4
	PM 2.5t/ha	2.4	2.5	4.6	4.5	7.2	7.1
	PM 5.0t/ha	2.2	2.3	4.5	4.4	6.6	6.4
	NPK200 +PM 2.5	2.3	2.2	4.7	4.6	6.7	6.5
Sub Total		13.2	13.2	27.6	27.0	40.2	39.0
Mean		**2.2**	**2.2**	**4.4**	**4.5**	**6.7**	**6.5**
Co + Ma + Me	0kg/ha	2.0	2.0	4.0	4.0	6.2	6.0
	NPK200kg/ha	2.2	2.1	4.5	4.6	7.0	6.9
	NPK400kg/ha	2.1	2.2	4.3	4.4	6.4	6.2
	PM 2.5t/ha	2.2	2.3	4.4	4.5	6.8	6.5
	PM 5.0t/ha	2.1	2.0	4.2	4.3	6.3	6.1
Sub Total	NPK200 +PM 2.5	2.1	2.1	4.3	4.4	6.4	6.2
Mean		12.6	12.6	25.8	25.8	39.0	37.8
		2.1	**2.1**	**4.3**	**4.3**	**6.5**	**6.3**
LSD (0.05) Crop mixture		NS	NS	NS	NS	NS	NS
LSD (0.05) Fertilizer levels		NS	NS	NS	NS	NS	NS

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium; PM = Poultry Manure

Table 3.7: Effect of crop mixtures and fertilizer levels on the vine length of melon

Treatments		Months After Planting (cm) (MAP)					
		2		4		6	
Crop Mixtures	**Fertilizer levels**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Sole melon	0kg/ha	89.9	89.7	133.5	132.4	201.4	201.1
	NPK200kg/ha	91.3	91.4	152.5	152.2	268.5	268.1
	NPK400kg/ha	92.7	92.5	156.4	156.1	249.5	249.2
	PM 2.5t/ha	94.4	94.7	158.5	160.8	246.4	261.1
	PM 5.0t/ha	92.1	91.2	154.2	155.2	259.5	258.2
	NPK200 +PM 2.5	96.1	95.1	162.2	162.1	253.2	251.4
Sub Total		556.8	554.4	917.4	918.6	1478.4	1488.6
Mean		**92.8**	**92.4**	**152.9**	**153.1**	**246.4**	**248.1**
Co + Me	0kg/ha	87.7	86.6	129.4	129.1	189.7	182.4
	NPK200kg/ha	89.4	89.1	148.3	147.8	234.3	234.0
	NPK400kg/ha	88.9	88.4	146.5	145.8	237.4	237.1
	PM 2.5t/ha	87.8	88.8	144.6	144.1	239.2	244.6
	PM 5.0t/ha	88.3	88.1	148.6	146.4	242.4	240.1
	NPK200 +PM 2.5	88.1	87.4	146.3	145.5	236.3	235.3
Sub Total		530.4	528.0	864.0	858.6	1379.4	1373.4
Mean		**88.4**	**88.0**	**144.0**	**143.1**	**229.9**	**228.9**
Co + Me +Ma	0kg/ha	85.1	84.4	124.1	122.5	178.4	177.5
	NPK200kg/ha	86.1	86.2	142.5	142.1	230.2	239.4
	NPK400kg/ha	85.5	85.1	140.6	141.3	239.3	230.2
	PM 2.5t/ha	87.0	87.8	139.3	140.2	231.2	231.1
	PM 5.0t/ha	84.1	84.0	137.9	138.2	230.6	230.4
	NPK200 +PM 2.5	76.5	76.2	122.9	123.0	214.5	213.6
		504.6	503.4	807.6	807.0	1324.2	1321.8
Sub Total Mean		**84.1**	**83.9**	**134.6**	**134.5**	**220.7**	**220.3**
LSD (0.05) Crop mixture		7.4	6.2	5.1	6.3	7.6.	7.3
LSD (0.05) Fertilizer levels		9.4	7.5	9.1	7.5	9.4	8.4

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium;
PM = Poultry Manure

Table 3.8 - Effect of crop mixtures and fertilizer levels on the yield and yield components of cocoyam

Treatments		Yield and Yield Components											
		Corm yield (t/ha)		Cormels yield (t/ha)		Wt. of corm (gms)		Wt. of Cormels (kgs)		No. of cormels		Length of Cormels (cm)	
Crop mixtures	Fertilizer levels	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Sole cocoyam	0kg/ha	4.1	3.1	3.8	3.5	0.52	0.37	0.61	0.54	6.7	5.6	8.7	7.8
	NPK200kg/ha	5.6	5.2	5.2	4.4	0.14	0.31	0.34	0.40	8.0	7.5	7.7	6.8
	NPK400kg/ha	5.9	5.3	4.1	4.0	0.48	0.46	0.83	0.48	8.0	7.3	8.2	7.6
	PM 2.5t/ha	5.9	5.4	3.4	3.3	0.40	0.42	0.32	0.36	4.0	4.5	6.9	6.5
	PM 5.0t/ha	6.7	6.0	4.3	4.2	0.82	0.80	0.59	0.62	10.6	9.8	9.4	9.2
	NPK200 +PM	3.9	3.3	2.9	3.0	0.63	0.56	0.5	0.48	7.6	6.7	9.6	8.1
Sub Total	2.5	32.4	28.3	24.0	22.4	2.99	2.92	3.2	2.88	45.0	41.4	53.4	46.0
Mean		**5.4**	**4.7**	**4.0**	**3.7**	**0.50**	**0.49**	**0.54**	**0.48**	**7.5**	**6.9**	**8.9**	**7.7**
Co + Me	0kg/ha	4.8	3.7	2.8	2.4	0.38	0.41	0.47	0.45	7.0	6.5	7.1	6.4
	NPK200kg/ha	5.9	5.4	4.3	4.5	0.33	0.38	0.46	0.54	7.0	7.8	6.8	7.6
	NPK400kg/ha	6.2	5.8	5.5	5.0	0.44	0.50	0.42	0.48	6.0	6.7	10.9	9.7
	PM 2.5t/ha	6.5	6.1	2.7	2.5	0.67	0.70	0.45	0.51	8.0	7.8	8.6	8.4
	PM 5.0t/ha	7.8	8.2	3.0	2.9	0.80	0.84	0.67	0.70	9.0	8.0	8.6	8.3
	NPK200 +PM	4.9	4.4	3.2	3.5	0.45	0.51	0.34	0.40	6.0	6.8	6.6	6.8
Sub total	2.5	36.0	33.6	21.6	20.8	3.07	3.34	2.81	3.08	43.2	43.6	48.6	47.2
Mean		**6.0**	**5.6**	**3.6**	**3.5**	**0.51**	**0.56**	**0.47**	**0.51**	**7.2**	**7.3**	**8.1**	**7.9**
Co + Ma	0kg/ha	3.5	3.2	2.5	2.8	0.26	0.28	0.31	0.30	6.0	5.6	6.9	6.4
	NPK200kg/ha	4.2	4.0	3.5	4.0	0.31	0.42	0.30	0.31	6.0	7.2	7.1	6.6
	NPK400kg/ha	6.1	5.5	3.5	3.6	0.30	0.40	0.37	0.37	7.0	7.5	7.5	7.0
	PM 2.5t/ha	5.8	6.2	3.3	3.2	0.64	0.61	0.35	0.39	6.0	7.2	8.4	8.1
	PM 5.0t/ha	5.9	5.7	2.7	3.0	0.36	0.47	0.32	0.34	7.0	8.0	7.5	7.0
	NPK200 +PM	4.1	3.8	2.6	2.8	0.61	0.56	0.39	0.38	4.0	4.6	6.9	6.2
Sub Total	2.5	29.4	28.4	18.0	19.4	2.51	2.74	2.04	2.09	36.0	40.1	44.4	41.3
Mean		**4.9**	**4.7**	**3.0**	**3.2**	**0.42**	**0.46**	**0.34**	**0.35**	**6.0**	**6.7**	**7.4**	**6.9**
Co + Me + Ma	0kg/ha	1.9	2.3	1.3	2.3	0.23	0.21	0.31	0.30	5.0	4.2	6.4	5.4
	NPK200kg/ha	3.8	4.0	2.2	2.7	0.40	0.48	0.41	0.40	6.0	5.4	6.6	7.0
	NPK400kg/ha	4.5	4.9	3.0	4.0	0.36	0.45	0.33	0.37	8.0	7.2	7.8	8.0
	PM 2.5t/ha	5.0	5.6	5.5	6.0	0.54	0.61	0.30	0.35	6.0	5.4	7.9	8.2
	PM 5.0t/ha	5.5	6.1	3.3	4.1	0.60	0.68	0.44	0.48	7.0	6.2	7.2	7.8
	NPK200 +PM	4.2	4.4	2.5	3.0	0.44	0.54	0.42	0.41	6.0	5.6	6.2	5.4
Sub Total	2.5	25.2	27.3	17.4	22.1	2.56	2.97	2.23	2.31	37.8	34.0	42.0	41.8
Mean		**4.2**	**4.6**	**2.9**	**3.7**	**0.41**	**0.50**	**0.37**	**0.39**	**6.3**	**5.7**	**7.0**	**7.0**
LSD (0.05) Crop mixture		5.1	3.2	NS	6.3	7.0	5.8	7.2	8.4	NS	4.2	NS	3.4
LSD (0.05) Fertilizer levels		3.3	2.4	NS	NS	3.8	3.6	3.0	2.6	4.1	3.5	4.2	5.1

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium; PM = Poultry Manure

Table 3.9 - Effect of crop mixtures and fertilizer levels on the yield and yield components of maize

Treatments		Yield and Yield Components											
Crop mixtures	Fertilizer levels	Wt. of un-dehusked (kg)		Wt. of dehusked (kg)		Filling cob percentage		Length of cob (cm)		Wt. of grains/cob (kg)		Grain yield (t/ha)	
		2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Sole maize	0kg/ha	0.23	0.21	0.19	0.17	70.7	63.6	17.8	15.9	0.12	0.12	4.5	4.4
	NPK200kg/ha	0.24	0.23	0.19	0.18	80.7	74.6	18.9	17.6	0.15	0.16	5.2	5.1
	NPK400kg/ha	0.26	0.24	0.19	0.19	82.3	81.4	18.1	17.0	0.13	0.14	5.4	5.3
	PM 2.5t/ha	0.26	0.26	0.21	0.22	80.0	74.3	18.4	17.2	0.15	0.16	5.6	5.4
	PM 5.0t/ha	0.24	0.24	0.18	0.18	81.1	75.4	16.4	15.4	0.12	0.13	5.3	5.2
	NPK200+PM	0.26	0.24	0.17	0.17	82.3	78.5	18.0	16.8	0.13	0.14	5.0	4.8
Sub Total	2.5	1.50	1.42	1.14	1.11	477.0	447.8	107.4	99.9	0.78	0.85	31.2	30.2
Mean		**0.25**	**0.24**	**0.19**	**0.19**	**79.5**	**74.6**	**17.9**	**16.7**	**0.13**	**0.14**	**5.2**	**5.03**
Co + Ma	0kg/ha	0.26	0.22	0.20	0.18	67.0	70.2	18.1	15.4	0.12	0.13	5.1	4.4
	NPK200kg/ha	0.28	0.26	0.21	0.22	81.4	80.6	18.4	18.2	0.16	0.16	5.2	5.3
	NPK400kg/ha	0.25	0.24	0.20	0.20	80.5	76.8	17.6	17.9	0.13	0.14	4.2	4.1
	PM 2.5t/ha	0.24	0.26	0.20	0.21	80.0	74.6	17.0	16.3	0.14	0.15	5.4	5.5
	PM 5.0t/ha	0.24	0.22	0.19	0.19	81.7	82.0	17.2	16.6	0.14	0.15	4.9	4.8
	NPK200+PM	0.22	0.24	0.18	0.18	81.2	80.2	16.9	15.8	0.12	0.13	4.9	4.8
Sub Total	2.5	1.50	1.44	1.20	1.18	471.6	464.4	105.0	100.2	0.84	0.86	30.0	28.9
Mean		**0.25**	**0.24**	**0.20**	**0.20**	**78.6**	**77.4**	**17.5**	**16.7**	**0.14**	**0.14**	**5.0**	**4.82**
Co + Ma + Me	0kg/ha	0.22	0.22	0.18	0.17	70.6	68.5	17.0	15.8	0.12	0.11	4.9	4.8
	NPK200kg/ha	0.23	0.24	0.19	0.18	81.4	82.1	17.6	18.4	0.13	0.14	4.8	4.7
	NPK400kg/ha	0.23	0.24	0.20	0.22	79.8	71.2	17.6	18.1	0.13	0.14	4.7	4.6
	PM 2.5t/ha	0.23	0.26	0.19	0.19	80.0	80.4	16.7	16.0	0.15	0.16	5.4	5.5
	PM 5.0t/ha	0.23	0.23	0.17	0.17	80.6	81.1	16.8	16.2	0.11	0.12	4.6	4.4
	NPK200+PM	0.23	0.22	0.17	0.16	79.1	70.6	17.1	16.8	0.11	0.11	4.7	4.6
Sub Total	2.5	1.38	1.41	1.08	1.09	471.0	453.9	102.6	101.3	0.78	0.78	29.4	28.6
Mean		**0.23**	**0.24**	**0.18**	**0.18**	**78.5**	**75.7**	**17.1**	**16.9**	**0.13**	**0.13**	**4.9**	**4.77**
LSD (0.05) Crop mixture		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.8	6.2
LSD (0.05) Fertilizer levels		NS	NS	NS	NS	9.1	7.4	NS	NS	NS	NS	5.6	3.8

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium;
PM = Poultry Manure

Table 3.10: Effect of crop mixtures and fertilizer levels on the yield and yield components of melon

Treatments		Yield and Yield Components									
Crop mixtures	**Fertilizer levels**	**Length of pod (cm)**		**Circumference of pod (cm)**		**No. of pod**		**Melon seed yield (t/ha)**		**Total wt. of pods/ha (t/ha)**	
		2021	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Sole melon	0kg/ha	10.7	10.4	11.3	11.1	1.8	2.0	0.34	0.32	8.4	7.8
	NPK200kg/ha	11.1	11.4	12.5	12.4	3.2	3.3	0.40	0.42	10.2	9.5
	NPK400kg/ha	10.9	11.0	12.6	12.5	2.3	2.5	0.37	0.37	8.3	8.4
	PM 2.5t/ha	11.6	11.7	12.7	12.6	2.8	2.9	0.42	0.44	8.8	8.9
	PM 5.0t/ha	11.9	12.0	12.8	12.7	2.7	2.6	0.27	0.29	8.7	8.5
	NPK200+PM	10.8	10.6	12.3	12.1	2.0	2.2	0.37	0.34	10.3	9.8
Sub Total	2.5	67.2	67.1	74.4	73.4	15.0	15.5	2.16	2.18	55.2	52.9
Mean		**11.2**	**11.18**	**12.4**	**12.2**	**2.5**	**2.6**	**0.36**	**0.4**	**9.2**	**8.8**
Co + Me	0kg/ha	10.3	10.4	11.8	11.5	1.5	1.7	0.30	0.33	7.1	8.0
	NPK200kg/ha	11.5	11.2	12.2	12.4	2.5	2.6	0.38	0.40	7.2	8.2
	NPK400kg/ha	10.2	10.0	11.9	12.0	2.1	2.0	0.33	0.36	3.9	4.2
	PM 2.5t/ha	11.5	11.2	12.5	12.7	2.2	2.3	0.32	0.35	6.8	7.1
	PM 5.0t/ha	11.6	11.5	12.5	12.7	2.4	2.5	0.25	0.30	10.4	10.1
	NPK200+PM	11.6	11.5	12.1	12.2	2.3	2.4	0.38	0.39	9.2	9.9
Sub Total	2.5	66.6	65.8	73.2	73.5	13.2	13.5	1.98	2.13	44.4	47.5
Mean		**11.1**	**10.96**	**12.2**	**12.3**	**2.2**	**2.3**	**0.33**	**0.36**	**7.4**	**7.9**
Co + Me + Ma	0kg/ha	10.9	11.1	10.9	10. 6	1.2	1.1	0.32	0.30	8.9	6.7
	NPK200kg/ha	11.2	11.4	11.2	11.4	1.8	2.0	0.27	0.26	3.0	3.6
	NPK400kg/ha	10.3	10.5	12.3	12.6	1.5	1.7	0.28	0.27	6.8	6.3
	PM 2.5t/ha	10.6	11.0	12.0	12.1	1.4	1.5	0.27	0.26	5.4	5.8
	PM 5.0t/ha	12.0	11.8	12.3	12.6	1.3	1.4	0.30	0.28	6.5	6.1
	NPK200+PM	10.4	10.2	11.6	11.9	1.4	1.5	0.32	0.31	3.9	4.0
Sub Total	2.5	65.4	66.0	70.2	71.2	8.4	9.2	1.74	1.68	34.8	32.5
Mean		**10.9**	**11.0**	**11.7**	**11.9**	**1.4**	**1.5**	**0.29**	**0.28**	**5.8**	**5.4**
LSD (0.05) Crop mixture		NS	NS	2.9	1.9	1.7	1.8	NS	NS	2.9	2.5
LSD (0.05) Fertilizer levels		6.4	4.1	NS	NS	3.1	4.4	NS	NS	3.7	2.8

Co = Cocoyam; Me = Melon; Ma = Maize; NPK = Nitrogen Phosphorus Potassium; PM = Poultry Manure

4.0 Discussion

The result indicated higher values of cocoyam height and maize height recorded with NPK200kg/ha and NPK400kg/ha respectively in both sole and crop mixtures in the both years of planting. This finding however agrees with Azza *et al.* (2006) and Efretuei (2020) that NPK fertilizers can stimulate crop growth and improve the mineral uptake of the plants. This was further collaborated by the findings of Smil (2000) who opined that the use of inorganic fertilizer improves crop yields by way of increasing soil fertility and nutrient availability. This explanation holds for the increase in leaf area, stem girth and the number of leaves of cocoyam, maize and melon plant. The attendant significant increases in plant height observed with increase in NPK fertilizer when compared with the control could be attributed further to the nitrogen content of the applied fertilizer. However, the presence of phosphorus as nutrient in the applied fertilizer increases the rate of absorption of nitrogen according to

Badran and Safwat (2004), Majeed and Ali (2011) which ultimately promotes vegetative growth and production.

The differences in plant heights and stem girths further reflects the existing differences in the competitive nature existing between the sole cropping and the adopted crop mixtures in the systems. It further suggests that the important factors of competition were probably light and nutrients. Intercropping cocoyam with maize and melon tends to promote vegetative phase of cocoyam and maize. The reduction in the leaf area index of the intercrop systems implies that the corm and cormels yields were positively associated with the leaf size on both cropping systems and this applies to maize (Ikeh, 2016). These agrees with the findings of Udounang *et al.* (2021) and Igbokwe (1983). Tayo (1982) also observed that the decrease in leaf area index with an advance in the age of cocoyam was however, due to senescence of old leaves and the outgrowth of the small ones.

The corm yield of cocoyam was higher with high organic manure (PM 5.0t/ha) when compared with the control. The lower rate of organic manure with the attendant lower corm yield can be attributed to the relative competition among the crops. However, cocoyam with melon crop mixtures enhanced cocoyam yield relative to sole cocoyam. This could be attributable to the short life span of melon and subsequent released of residual nitrogen from the leaves to the soil (Mba, 1983). This further support the findings of Akinyemi and Tijani-Eniola (1997) who opined the subsequent decay of melon foliage provides additional nutrients and improved soil conditions for cocoyam rapid growth and production. Murwira *et al.* (1993), Udounang (2019) and Ayoola *et al.* (2006) had reported improved nutrient use efficiency with organic fertilizer. Cocoyam being a root crop (Udounang, 2018), has a high requirement for potassium as yam and cassava (Obiebesan, 1976; Kay, 1987; Onwueme and Sinha, 1991). The potassium content of organic manure which is usually high and also dependent on the type, makes the mineral suitable for root crops. The corm, corm weight, number of cormels and total yield per hectare were optimised with higher rates of organic manure. This result confirms the findings of Ohiri *et al.* (1988) that cocoyam requires high poultry manure and higher rates of potassium depending on soil type. This assertion agrees with Udounang (2019), Adedirah and Banjoko (2003) who observed increase on crop yield with the use of organic fertilizers on crop.

In maize, the weight of dehusked, dehusked, cob filling percentage and length of cob and grain yield showed variations from sole to intercrop. The result showed higher yield components of maize under sole cropping compared to the crop mixtures. This indicates that crops in sole cropping does not experience much competition. The resultant effect of this findings therefore points to the fact that the nutrients requirement of maize in the crop mixtures were rather higher than that required when planted as sole. Baker (1979) further opined that the nutrient demand of the component crops was always higher than for the sole crops. Highest values of parameters were recorded with inorganic fertilizers, though organic fertilizers and their combinations showed variations in some specific parameters. Mokwunye (1980) reported when organic manure is applied together with mineral fertilizers, the later aids the decomposition of the former. Other researchers (Lombin and abdullahi, 1977; Lombin *et al*., 1994; Ayoola and Ademiyan, 2000) also observed that the use of poultry manure increased the efficiency of performance of inorganic fertilizer probably by serving as liming materials and providing secondary micronutrients not present in the organic fertilizers.

5.0 Conclusion and Recommendations

The findings generated from the study informs the following conclusion. Organic fertilizer mostly at PM 5.0t/ha promoted the yield and yield components of cocoyam (corms yields, cormel yields, weight of corm, weight of cormels, number of cormels and length of cormels) in both sole cocoyam and cocoyam crop mixtures. In sole maize and maize crop mixtures, organic manure PM 2.5t/ha gave higher weight of undehusked cobs, weight of dehusked cobs, and grain yield per hectare whereas inorganic fertilizers (NPK 200kg/ha and NPK 400kg/ha) favoured the filling cob percentage and length of cob. Generally, a combination of both organic and inorganic fertilizer has proven effective for maize yield and yield components.

References

Adediran, J. A. and Banjoko, V. A. (2003). Comparative effectiveness of some compost fertilizer formulations for maize in Nigeria. *Nigerian Journal of Soil Science*,13: 42-48.

Akinyemi, S. S. and Tijani- Eniola, H. (1997). Effect of melon population density intercropped with Plantain on weed control and intercrop productivity. *Nigerian Journal of Weed Science* 10: 27 -34.

Akpainyang, F. I., Okpara, D. A., Ekwerre, O. J. and Udounang, P. I. (2022). Effect of nutrient management and time of vine cutting on orange and white-fleshed sweet potatoe varieties in Southern Nigeria. *International Journal of Agricultural Policy and Research*, 10(2): 11 – 31.

Ayoola, O. T.and Adeniyan, O. N. (2006). Influence of poultry on yield and yield components of crops under different cropping systems in South West Nigeria. *African Journal of Biotechnology*, 5: 1386 – 1392.

Azza, A. M. M., Yassen, A. A. and Sahar, M. Z. (2006). Impact of boron fertilizer on growth under water regime. *World Journal of Agricultural Science*, 2 (4): 412 – 420.

Badran, F. S. and Safwat, M. S. (2004). Response of fennel plants to organic manure and bio-fertilizers in replacement of chemical fertilization in Egypt. *Journal of Agricultural Research*, 82(8): 247 -256.

Barker, E. F. I. (1979). Research on mixed cropping with cereals in Nigeria farming systems – a system for improvement. In: *International workshop on farming systems. Proceedings ICRISAT* Hyderabad, November, 18th – 21st, pp 287 – 301

Doku, E. V. (1988). West African tropical root crop farming systems. *Proceedings of the 3rd West African root crops workshop* held in Accra, Ghana, July 22–26th 1985. R. C. Therberge (ed) IITA, Ibadan, Nigeria.

Economic Commission of Africa (2011). State of the Environment in Africa. Economic Commission of Africa, Addis Ababa, Ethiopia. Eca/fssdd/01/06. http://www.uncea.org/water/state.environ.afri.

Edem, I. D., Nkereuwem, M. E. and Udounang, P. I. (2015). The challenge of Agronomist working in Sub-Sahara (SSA). The use of mineral fertilizers has not been able to solve the problem. *Applied Research Journal* 1(3): 118 – 120.

Edem, I. D., Udounang, P. I. and Ama, P. C. (2021). Rain water use efficiency of sweet potato under cattle-cud mulches in Uyo, Nigeria. *MOJ Ecology and Environment* 6(3): 88 – 96.

Efretuei, A. O. and Udounang, P. I. (2020). Maize yield response to inorganic Fertilizer rates in the Tropical rainforest of South Eastern Nigeria. *International Journal of Agriculture and Rural Development.* 23(1) 4858 – 4865.

Igbokwe, M. C. (1983). Growth and development of colocasia and xanthosoma spp under upland condition. *Proceedings of the 2nd symposium. ISTEC.AB,* Duala, Cameroun: 14 -19th August 1983. Pp 182 -184

Ikeh, A. O., Udounang, P. I., Ndaeyo, N. U., Akata, O. R. and Ukpe, I. O. (2012). Effect of complementary use of organic and inorganic fertilizers on the growth and yield of cucumber (*Cucumis sativus L*) on an ultisol. *Proceedings of the 46th Annual conference of the Agricultural Society of Nigeria.* Kano. Pp 1045 – 1049.

Ikeh, A.O., Udoh, E. I., Udounang, P. I., Akpan, E. A. and Peleyeju, K. O. (2016). Growth and storage root yield of Pro- Vit A cassava as influenced by time of intercropping with castor in Okigwe, Southeastern Nigeria. *Journal of Forestry, Environment and Sustainable Development.* 2(1): 153 – 160.

Kay, E. D. (1987). Root crops: *Crop and Product Digest No.2*, pp 227 – 228.

Lombin, H. C. and Abdullahi, K. A. (1977). In: Fertilizer use and management practices for crops in Nigeria produced by Federal Fertilizer Department, Abuja, 2002

Lombin, L. G., Adepetu, J. A. and Ayotade, K. A. (1994). In: Organic fertilizer in the Nigerian Agriculture: Present and Future, FPDD Abuja, Nigeria, pp 146 – 162.

Majeed, K. A. and Ali, S. A. (2011). Effect of foliar application of NPK 20:10:10 on some growth characters of food cultivars of Roselle (*Hibiscus sabdariffa* L). *American Journal of Plant Physiology* 6: 220 – 227

Mba, C. C. (1983). Egusi plant – *Colocynthis citrullus* and soil properties, In: Obiefuna, J. C. (1989). Biological weed control in plantains (*Musa AAB*) with egusi melon (*Colocynthis citrullus*). *Biological Agriculture and Horticulture* 6: 221 -227.

Mokwunye, U. (1980). In: Organic cycling in African soils. *Bulletin – FAO,* Rome, No. 43: 192 – 200

Murwira, H. K. and Kirchmenn, H. (1993). Soil organic matter dynamics and sustainability of tropical Agriculture. Pp189 – 198.

Obigbesan, G. O. (1976). Effect of potassium on tuber yield and nutrient uptake yam varieties. *Proceedings of the 4th symposium of the International Society for Root Crops.* IDRCCIAT, Columbia. Ed. Cook, Macintyre and Graham. 1976. Pp 104 – 107.

Ofori, F and Stern, W. R. (1987). Cereal – legume intercropping systems. *Advances in Agronomy* 14: 41 – 89.

Ohiri, A. C., Ogbonaya, J. C., Enyineya, A. M., Ojinaka, T. L. and Chukwu, G. O. (1988). *Annual Report, NRCRI*, Umudike, pp 75 – 77.

Oluma, G. (2010). Sustainable horticultural production through intercropping: A review. *Agricultural Biology* I.N.S. 1098 – 1103.

Onwueme, I. C. and Sinha, T. D. (1991). Field crop production in Tropical Africa. Pp 276 – 287

Smil, V. (2000). Phosphorus in the environment. National Flaws and Human Inferences. *Annual Review of Energy and Environment* 28: 609 – 620.

Tayo, O. T. (1982). Growth, yield and development of pigeon pea (*Cajanus cajan*) in lowland tropics. In: Effect of early loss of apical dominances. *Journal of Agricultural Science* 98: 79 – 84.

Udounang, P. I. (2007). Response of cocoyam-based intercropping systems to organic and inorganic fertilizers in Obio Akpa, South Eastern Nigeria. M.Sc. Thesis, University of Uyo, Uyo, Akwa Ibom State.

Udounang, P. I. (2015). Response of cocoyam-based intercropping systems to tillage practices and fertilization in Uyo, South Eastern Nigeria. Ph.D Dissertation, University of Uyo, Uyo, Akwa Ibom State.

Udounang, P. I. (2018). Effect of organic and inorganic fertilizer rates on the performance of cassava (*Manihot esculenta* Crantz) in Uyo, Akwa Ibom State. *Proceedings of the 5th National Annual Conference of the Crop Science Society of Nigeria.* Pp 757 – 765.

Udounang, P. I. and Ndaeyo, N. U. (2019). Effect of poultry manure application on cocoyam/maize intercropping systems in Obio Akpa, South Eastern Nigeria. *AKSU Journal of Agriculture and Food Sciences.* 2(1): 7 – 19.

Udounang, P. I., Udoh, F. S and Ndaeyo, N. U. (2019). Effect of selected crushed crop residues on the vegetative performance of fluted pumpkin (*Telafaria occidentalis* Hook, f) in Obio Akpa, South eastern Nigeria. *Proceedings of the 6th Annual National conference of Crop Science Society of Nigeria,* Federal University of Technology, Owerri

Udounang, P. I., Akata, O. R and Akpainyang, F. E. (2021). Effect of intercropping selected legumes on the growth and yield of maize (*Zea mays* L) in Obio Akpa– Southeastern Nigeria. *Journal of Agriculture, Forestry and Environment.* 8(1): 143 – 153.

Udounang, P. I., Ekwere, O. J and Akpainyang, F. E. (2022). Comparative effect of fertilization on cocoyam and component crops on cocoyam based intercropping systems in Uyo, Southeastern Nigeria. *International Journal of Agricultural Policy and Research.* 10(1): 16 – 25.

Umoh, F. O., Udounang, P. I. and Charlie, J. E. (2022). Effects of animal manure on the growth and yield of maize (*Zea mays L*) grown on ultisols in Obio Akpa, Akwa Ibom State, Nigeria. *AKSU Journal of Agriculture and Food Sciences* 6(3): 179 – 190.

Wong, P; Salmah, Y. H. M. and Cheman, Y. B. (2003). Physico-chemical characteristics of Roselle (*Hibiscus sabdariffa* L). *Nutritional Food Science* 32: 68 – 73.