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CONTENTS:

Evaluation of growth and nutritive value of *Panicum maximum* intercropped with *Centrosema pascuorum* and *Clitoria ternatea*.

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ABSTRACT

An experiment was conducted at the Pasture Unit, Teaching and Research Farm of Oyo State College of Agriculture and Technology, Igboora, Nigeria to evaluate the agronomic performance, *in vitro* gas production and post-incubative parameters of *Panicum maximum* intercropped with *Clitoria ternatea* and *Centrosema pascuorum.* The experiment was laid out in a randomized complete block design (RCBD) with three treatments and three replicates. The treatments include *Panicum maximum* intercropped with *Clitoria ternatea* (PCT), *Panicum maximum* intercropped with *Centrosema pascuorum* (PCP) and sole *Panicum maximum* (SP). Samples and measurements of the plant height (PH), tiller number, leaf length, leaf number and leaf width were taken 3, 6, 9 and 12 weeks after planting (WAP). The PH values were significantly (P<0.05) different. Sole *Panicum maximum* (SP) harvested at 12 WAP had highest (214.67cm) PH while the least value of 61.67cm was recorded in PCP at 6 WAP. The *in vitro* gas production of *P. maximum* as affected by the interaction between legume species and age at harvest (WAP) which were significantly (p<0.05) different ranged from 0.00ml/200mgDM in PCP at 8WAP and at 3hrs of incubation to 47.50ml/200mgDM in SP at 4WAP at the end of 48hours of incubation period. However, organic matter digestibility (OMD) ranged from 51.59% in SP at 4 weeks to 31.65% in PCP at 8 WAP. Intercrop of either of the two legumes (*Centrosema pascuorum* and *Clitoria ternatea*) with *Panicum maximum* improved and maintained the proximate composition, organic matter digestibility and metabolizable energy compared to the sole grass.

Keywords: Pasture, nutritive value, *Panicum maximum, Centrosema pascuorum, Clitoria ternatea*.

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INTRODUCTION

Nigeria is one of the four leading livestock producers in Sub-Sahara Africa. In the early 1990s, estimated livestock population in Nigeria was 14 million cattle, 23 million goats and 13 million sheep (RIM, 1990). However, these figures have since increased to 15.2 million cattle, 28 million goats and 23 million sheep (FAO, 2006). Livestock productivity is low because of poor nutrition, which is primarily derived from natural pastures and limited amounts from crop residues. Native pastures are the most widely available low cost feeds for ruminants in the tropics (Tchinda *et al*., 1993). The native pastures deteriorate rapidly as the season advance towards the dry season. One of these pastures in use is Guinea grass (*Panicum maximum)* and it is one of the most common grasses in the derived savannah region of Nigeria. Under good soil conditions, its yield and nutritional value is high (McDonald *et al*., 1988).

Time and frequency of harvesting, botanical composition, fertility of the soil and climatic conditions are the major factors that determine biomass yield and nutritive value of pastures (Yihalem *et al*., 2005; Tessema *et al*., 2010). Unfertilized grasses and those grown without legume companion had been described to be less nutritive as forage (Bamikole *et al*., 2004). In Nigeria, only arable crop farmers often use manure to grow their plants while livestock owners rarely cultivate pasture using fertilizers. The use of N-fertilizer to improve grassland is undesirable because it is uneconomical and could increase environmentally related problems (Bamikole *et al*., 2001) due to excessive release of nitrogenous compounds. The use of herbaceous or tree legumes have been reported (Ezenwa and Aken'ova, 1988; Bamikole and Ezenwa, 1999). Legumes are able to return soil fertility back by converting natural atmospheric air nitrogen and deposit it into the soil. Grasses or companion pasture species can be improved with herbaceous legumes with low cost and no residual negative effects. They are rich in protein which is usually the most limiting nutrients in tropical animal diets (Andrea and Pablo, 1999). Forage legumes can be grazed, harvested and fed fresh or stored as hay or silage (Harricharan *et al*., 1988).

A sustainable way of improving the feeding value of poor quality pastures is through supplementation with forage legumes (Andrea and Pablo, 1999). The capability to fix nitrogen into the soil and as such, enhancing the crude protein content of forage with resultant increase in yield and feed quality, make legumes an integral part of pastures (Aribisala, 2003; Sanginga and Mulongoy, 1992). The objectives of this study are to compare the growth and nutritive value of

Panicum maximum (Guinea grass) intercropped with *Centrosema pascuorum* (Centro) and *Clitoria ternatea* (Butterfly pea).

MATERIALS AND METHODS

The study was carried out at the Pasture unit of the Teaching and Research Farm, Oyo State College of Agriculture, Igbo-Ora. The area has a mean annual rainfall of 1230 mm in a bimodal distribution pattern. Mean monthly temperature ranges between 25.70 ^{0}C in July and 30.20 ^{0}C in February. The study was arranged in a randomized complete block design and it includes the following treatments: *C. pascuorum* + *P. maximum*; *C. ternatea* + *P. maximum*; and Sole *P. maximum.*

The proximate compositions of the forages were analyzed according to AOAC (2000). Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) were determined using the method of Van Soest *et* a*l*., (1991). Cellulose and hemicellulose were derived by calculation from NDF, ADF and ADL as follows: Hemicellulose = NDF – ADF, Cellulose = ADF – ADL. The *in vitro* gas production was determined following the procedure of Menke and Steingass (1988). Rates and extent of gas production were determined for each substrate from the following non-linear regression equation: GV (ml/200mg DM) = b $(1 - e^{-c\,(t-lag)})$ (Ǿrskov and McDonald (1979).

Data collected were subjected to Analysis of Variance (ANOVA) and treatment means were separated using Duncan Multiple Range Test at 5% level of significance (Duncan, 1955).

RESULTS AND DISCUSSION

The interactive effect of legume intercrop and age at harvest on the growth characteristics of *P. maximum* was presented on Table 2. Sole *P. maximum* had highest plant height (214.67 cm) at 12 weeks after planting while the least value (61.67cm) was obtained at 6 weeks after planting in the intercrop of *P. maximum* with *C. pascuorum*. Leaf length values ranged from 50.67 cm in sole *P. maximum* harvested after 3 weeks after planting to 140.67cm in the intercrop of *P. maximum* with *C. ternatea* at 12 weeks after planting. Highest leaf width (4.33cm) was obtained in *P. maximum* intercrop with *C. ternatea* at 9 weeks after planting, while the least value (2.70cm) of leaf width was recorded in 3 weeks after planting in *P. maximum* intercrop with *C. pascuorum* and *P. maximum* intercrop with *C. ternatea*. However, the tiller number ranged from 3.67 in *P. maximum* intercrop with *C. ternatea* at 3 weeks after planting to 12.33 in *P. maximum* intercrop with *C. ternatea* at 12 weeks after planting. Significant higher leaf number (41.67) was obtained in *P. maximum* intercrop with *C. ternatea* at 12 weeks after planting while the least value (10.00) occurred in *P. maximum* intercrop with *C. pascuorum* at 3 weeks after planting.

Table 3 presents the proximate composition and fibre fraction of *P. maximum* as affected by legume intercrop and age at harvest. Ether extract (EE), dry matter (DM), crude protein (CP), crude fibre (CF), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Acid Detergent Lignin (ADL), Cellulose (CEL) and Hemicellulose (HEM) contents were significantly different ($p<0.05$). Maximum ash content (8.50%) was obtained in *P. maximum* intercrop with *C. pascuorum* at 4 weeks after planting while the minimum ash (7.00%) was obtained in sole *P. maximum* at 8 weeks after planting. Highest (21.00%) and least (16.50%) EE contents were obtained in *P. maximum* intercrop with *C. pascuorum* at 4 and 8 weeks after planting respectively. Highest (85.50%) DM was obtained in *P. maximum* intercrop with *C. pascuorum* at 8 weeks after planting while the least DM (79.50%) was obtained in sole *P. maximum* at 4 weeks after planting. CP of this result ranged from 5.20% in sole *P. maximum* at 8 weeks after planting to 13.43% in sole *P. maximum* at 8 weeks after planting.

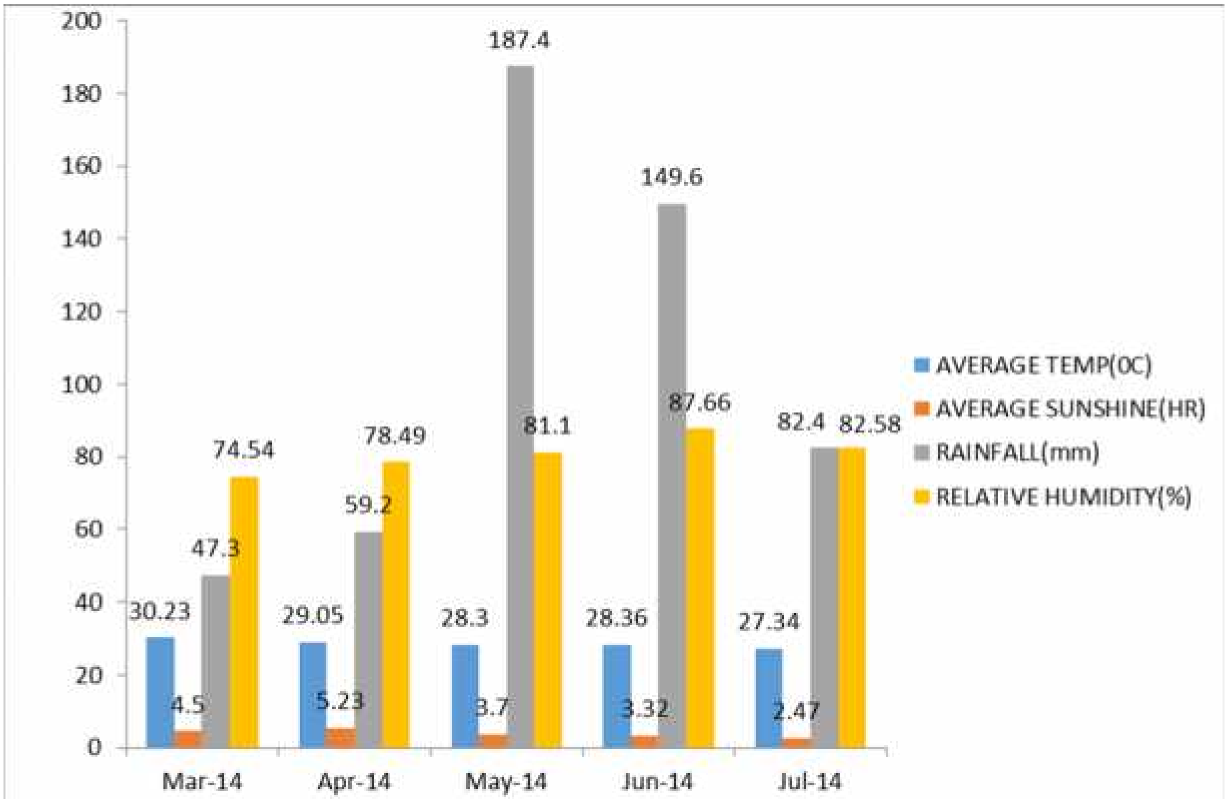

Figure 1: Monthly weather condition of the site between March and July, 2014.

Source: OYSCATECH Agro-meteorological Station

Table 1: Physico-chemical properties of the composite soil samples taken from the experimental site before planting

Chemical properties	Values
Ph	6.50
Macro-nutrients (%)	
Total Nitrogen	0.06
Organic Carbon	0.49
Available P (mg/kg)	6.08
Acidity (cmol/Kg)	0.06
CEC (cmol/Kg)	8.02
Base (%)	99.25
Exchangeable cations (cmol/kg)	
Sodium (Na)	0.77
Potassium (K)	0.48
Calcium (Ca)	5.57
Magnesium (Mg)	1.14
Micro-nutrients (mg/kg)	
Iron (Fe)	27.30
Copper (Cu)	1.50
Zinc (Zn)	6.90
Manganese (Mn)	166
Particle size (%)	
Sand	92
Silt	6.0
Clay	2.0

Table 2: Interactive effects of legumes and age at harvest on the agronomic performance of *P. maximum*

Effect of Legume	Age at harvest	PH(cm)	LL(cm)	LW(cm)	TN	LN
SP	3	72.57^{f}	50.67^{d}	2.77^{c}	5.67^{ab}	14.67^{b}
PCP	3	69.03^{f}	51.0^{d}	2.70^{c}	3.67^{b}	10.00^{b}
PCT	3	71.17^{f}	52.33^{d}	2.70^{c}	5.33^{ab}	12.33^{b}
SP	6	108.27^{de}	64.67^{cd}	3.27^{bc}	9.67^{ab}	28.33^{ab}
PCP	6	61.67^{f}	69.33^{bcd}	3.27^{bc}	7.00^{ab}	19.00^{b}
PCT	6	93.33^{ef}	69.50^{bcd}	3.37^{abc}	8.00^{ab}	27.00^{ab}
SP	9	172.33^{b}	90.67^{ab}	3.33^{abc}	8.67^{ab}	28.33^{ab}
PCP	9	135.67^{de}	91.33^{ab}	3.67^{ab}	10.67^{ab}	29.00^{ab}
PCT	9	150.00^{bc}	102.67^{a}	4.33^{a}	9.00^{ab}	28.67^{ab}
SP	12	214.67^{a}	83.67^{abc}	4.00^{ab}	4.33^{ab}	18.67^{b}
PCP	12	181.00^{ab}	98.67^{a}	4.00^{ab}	8.33^{ab}	28.33^{ab}
PCT	12	176.67^{b}	104.67^{a}	3.93^{a}	12.33^{a}	41.67^{a}
SEM		9.01	3.77	0.12	0.71	2.17

$^{a, b, c......f}$: Means in same column with different superscripts are significantly ($p<0.05$) different

SEM = Standard Error of Mean; SP: Sole Panicum; PCP: *P. maximum* x *C. pascuorum*; PCT: *P. maximum* x *C. ternatea*; 3, 6, 9 and 12 WAP: 3, 6, 9 and 12 weeks after planting

Table 3: Interactive effects of Legumes and age at harvest on the proximate composition and fibre fractions of *P. maximum*

Effect of legume	Age at harvest (weeks)	DM	EE	CP	CF	ASH	NDF	ADF	ADL	HEM	CEL
SP	4	79.50[b]	20.50[ab]	13.43[a]	74.00[abc]	7.50	68.00[b]	39.00[c]	8.00[ab]	29.00[b]	31.00[c]
SP	8	84.00[ab]	18.50[abc]	5.20[e]	73.00[bc]	7.00	76.00[a]	43.00[b]	40.00[ab]	33.00[a]	33.00[bc]
PCP	4	80.50[b]	21.00[a]	12.03[c]	76.00[ab]	7.50	70.00[b]	37.00[c]	4.00[c]	33.00[a]	33.00[bc]
PCP	8	85.50[a]	16.50[c]	6.40[d]	78.00[a]	7.00	78.00[a]	43.00[b]	8.00[ab]	33.00[a]	35.00[ac]
PCT	4	82.00[ab]	17.50[bc]	12.47[b]	71.00[c]	8.50	70.00[b]	38.00[cd]	6.00[bc]	32.00[a]	32.00[c]
PCT	8	84.00[ab]	17.50[bc]	6.40[d]	71.00[c]	8.50	69.00[b]	46.00[a]	10.00[a]	23.00[c]	36.00[a]
SEM		0.70	0.51	0.82	0.80	0.30	0.83	0.80	0.57	0.90	0.47

[a, b, c, d]: Means in same column with different superscripts are significantly ($p<0.05$) different
SEM = Standard Error of Mean; SP: Sole Panicum; PCP: *P. maximum* x *C. pascuorum*; PCT: *P. maximum* x *C. ternatea*; 4, 8, 9 and 12 weeks after planting: 4, 8 weeks after planting; DM: Dry matter; EE: Ether extract; CP: Crude protein; CF: Crude fibre; NDF: Neutral detergent fibre; ADF: Acid detergent fibre; ADL: Acid detergent lignin; HEM: Hemicellulose; CEL: Cellulose

Figure 2: Sequential *in vitro* gas production of *P. maximum* as affected by legume species and age at harvest.

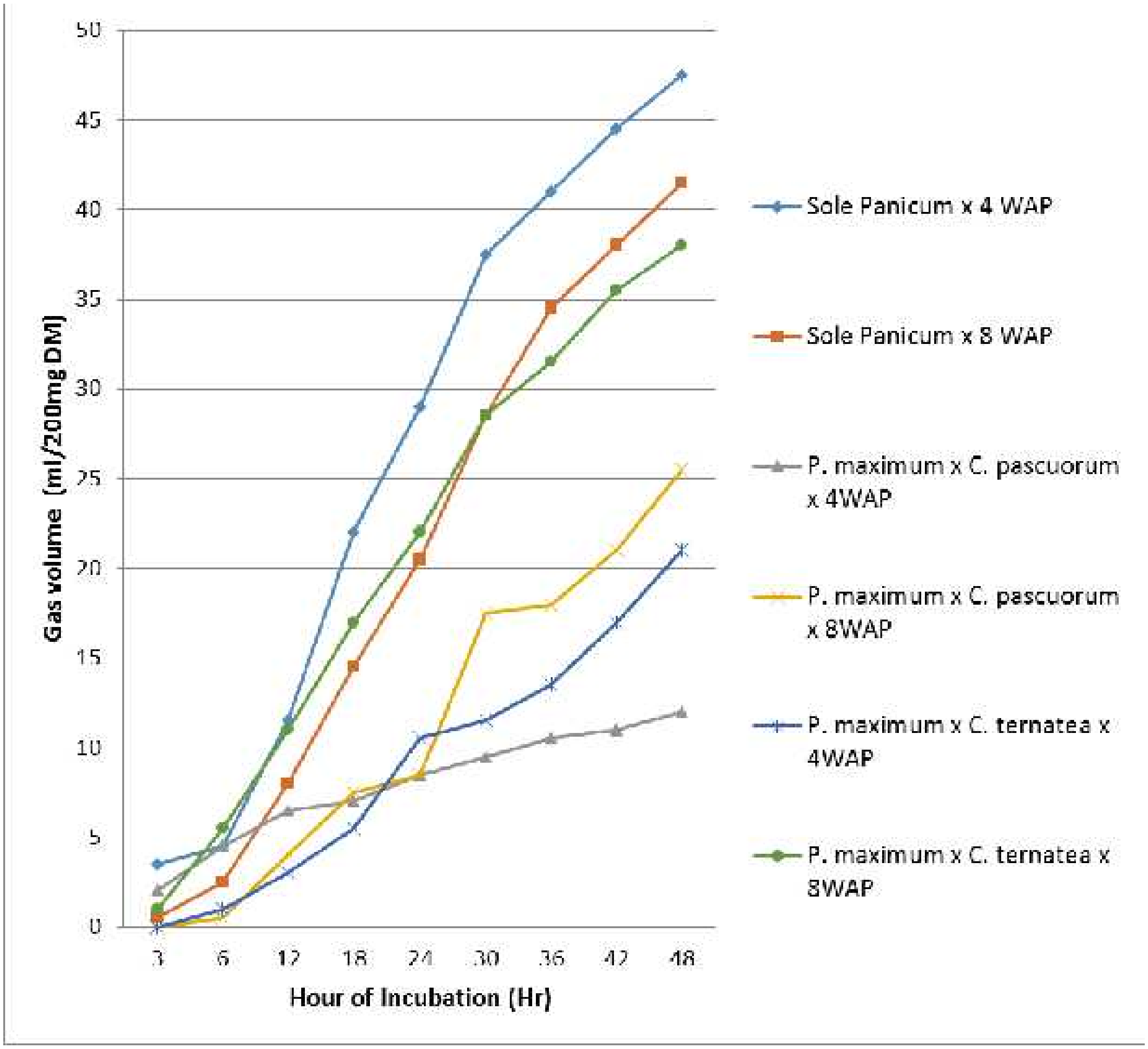

Table 4: Interactive effects of legume species and age at harvest on the post incubation parameters of *P. maximum*

Effect of Legume	Age at harvest (weeks after planting)	B (ml/200 mgDM)	c (ml/hr)	Lag (hr)	SCFA (μmol)	OMD (%)	ME (MJ/kg)
SP	4	84.69[a]	0.24[a]	1.88[b]	0.63[a]	51.59[a]	6.33[a]
SP	8	83.17[a]	0.01[a]	4.06[a]	0.40[b]	28.33[ab]	5.11[b]
PCP	4	15.67[c]	0.04[b]	5.52[a]	0.14[c]	32.73[c]	3.55[c]
PCP	8	83.17[a]	0.02[b]	5.40[a]	0.19[c]	31.65[c]	3.74[c]
PCT	4	54.33[b]	0.02[b]	4.93[a]	0.13[c]	33.14[c]	3.44[c]
PCT	8	65.56[b]	0.02[b]	2.37[b]	0.14[b]	42.85[b]	5.31[b]
SEM		6.09	0.03	0.38	0.05	1.78	0.27

[a, b, c]: Means in same column with different superscripts are significantly ($p<0.05$) different

SEM= Standard Error of Mean; SP: Sole Panicum; PCP: *P. maximum* x *C. pascuorum*; PCT: *P. maximum* x *C. ternatea*; 4 WAP: 4 weeks after planting; 8WAP: 8 weeks after planting.

Maximum (13.43%) and minimum (5.20%) CP contents were obtained in sole *P. maximum* at 4 and 8 weeks after planting respectively. The ash content represents the inorganic (mineral matter) content in a feed. Its value is mainly in the contents of phosphorus, calcium, or potassium and large amounts of silica (Bogdan, 1977). The values of ash obtained for *P. maximum* falls within the range of 3 – 12% (Gillespie, 1998) and 8 – 12% (Bogdan, 1977). The maximum

CP of this study was very high compared with those reported for sole *P. maximum* and mixtures of *P. maximum* with *S. guianensis* or *A. histrix* (Ajayi, *et al*., 2007). The crude protein contents of *P. maximum* as affected by the intercrop of *C. pascuorum* or *C. ternatea* were within the acceptable range for ruminant performance (NRC, 1981), and were within the critical CP level of 7 % recommended by ARC (1980) and 8 % suggested by Norton (1994) for ruminal function. Highest (78.00%) CF was obtained in *P. maximum* intercrop with *C. pascuorum* at 8 weeks after planting while the least value (71.00%) was obtained in *P. maximum* intercrop with *C. ternatea* at 4 weeks after planting. The fibre contents (NDF, ADF, Lignin, cellulose and hemicellulose) have implication on the digestibility of plants. The neutral detergent fibre (NDF), which is a measure of the forage cell wall contents, is the chemical component of the feed that determines its rate of digestion (Odedire and Babayemi, 2008). NDF is inversely related to the plants' digestibility (McDonald *et al*., 1995; Gillespie, 1998). Highest (78.00%) NDF of this study was obtained in *P. maximum* intercrop with *C. pascuorum* at 8 weeks after planting while lowest value (68.00%) was obtained in sole *P. maximum* at 4 weeks after planting.

The roughage diets with NDF content of 45-65% and below 45% were generally considered as medium and high quality feeds, respectively (Singh and Oosting, 1992). Thus, the NDF contents of *P. maximum* in this study could be considered to be extremely fibrous and low in quality at 8 weeks after planting, since decrease in NDF content has been associated with increase in digestibility and hence feed intake (Van Soest, 1994; McDonald *et al*., 2002). Maximum (46.00%) ADF content was obtained in *P. maximum* intercrop with *C. ternatea* at 8 weeks after planting while least value (37.00%) was obtained in *P. maximum* intercrop with *C. pascuorum* at 4 weeks after planting. The digestibility of forage in the rumen is related to the proportion and extent of lignification (Van Soest, 1994). Highest (10.00%) ADL of this study was obtained in sole *P. maximum* and *P. maximum* intercrop with *C. ternatea* at 8 weeks after planting while the least value (4.00%) was obtained in *P. maximum* intercrop with *C. pascuorum* at 4 weeks after planting. Lignin content of a plant is the most indigestible component of the fibre fractions (Gillespie, 1998) and its amount will also influence the plant's digestibility. As such, the lower lignin content (4.0 %) of *P. maximum* as intercropped with *C. pascuorum* and harvested at weeks after planting of this study may likely predispose *P. maximum* intercrop with *C. pascuorum* at 4 weeks after planting to better digestibility by grazing animals than other treatments. Digestibility has been reported to be synonymous to *in vitro* gas production (Fievez *et al*., 2005) such that the higher the gas production the higher the digestibility of forage.

The sequential *in vitro* gas production of *Panicum maximum* as affected by legume species and age at harvest was presented on Table 2. Volume of gas produced after 24 hours of incubation of sole *P. maximum* was higher than those reported for the same grass by Ajayi and Babayemi (2008). Post incubation parameters of *P. maximum* as affected by legumes and age at harvest were significantly ($P<0.05$) different (Table 4). Highest OMD (51.59%) recorded in sole *P. maximum* at 4 weeks after planting was higher than the value (41.52%) reported for *Panicum* in stylo intercrop (Ajayi and Babayemi, 2008). SCFA contents ranged from 0.05µmol in *P. maximum* intercrop with *C. ternatea* at 4 weeks after planting to 0.63µmol in sole *P. maximum* at 4 weeks after planting. SCFA has obtained for sole *P. maximum* in this study was higher than 0.40% of *P. maximum* when intercropped with lablab (Ajayi and Babayemi, 2008). ME had highest value (6.33MJ/kg) in sole *P. maximum* at 4 weeks after planting while the least value (3.44MJ/kg) was obtained in *P. maximum* intercrop with *C. ternatea* at 4 weeks after planting. ME values of this study were within the range reported by Ajayi and Babayemi (2008) for sole *P. maximum* and Panicum-legume intercrops. The interaction effect of legume and age at harvest were significant (P<0.05) for the gas production kinetics. The insoluble but degradable fraction ranged between 15.67ml/200mg DM in *P. maximum* intercrop with *C. ternatea* and 84.69ml/200mg DM in sole *P. maximum* at 4 weeks after planting. The value for fractional rate of gas production ranged from 0.0lml/hour to 0.24ml/hour both in sole *P. maximum* at 8 weeks after planting. However, the lag time was higher (5.52 hours) and lower (1.88 hour) after 4 weeks after planting in *P. maximum* intercrop with *C. pascuorum* and in sole *P. maximum* respectively.

CONCLUSIONS

Although the Sole Panicum grew higher than others, *P. maximum* in *Clitoria* intercrop grew appreciably over the period of study. Efficient rumen fermentation can be achieved when *P. maximum* are fed at tender age (around four weeks old). Intercrop of Butterfly pea or Centro with *Panicum maximum* improved and maintained the proximate composition, organic matter digestibility and metabolizable energy compared to the sole grass. The reduction in the methane produced during gas fermentation for the sole grass is an indication of its usage as energy feed. The legumes were high in methane and so require energy supplement in order to sustain livestock production.

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Yield and nutrient uptake of white yam as affected by organo-mineral fertilizer in Ikenne, Southwestern Nigeria

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ABSTRACT

Information is scanty on the optimum level of fertilizer requirement for the production in yam production in relation to yield and nutrient uptake. This study was conducted to evaluate the effects of different levels of organic and mineral fertilizers, singly and in combination, on yield and nutrient uptake of white yam in 2004 and 2005 at Ikenne, Southwestern Nigeria. Four cultivars of white yam (Adaka, Amula, Danacha and Omiefun) were subjected to 10 fertilizer treatments comprising, sole organic fertilizer (OF), mineral (NPK 12-12-12) fertilizers combinations of the two (organo-mineral) and control, at the rate of 2.5 and 5.0 t/ha OF; 0.15, 0.3 and 0.45 t/ha NPK; 1.75 t/ha OF+0.15 t/ha NPK; 2.5 t/ha OF+0.15 t /ha NPK; 2.5 t/ha OF+0.3 t/ha NPK and 5.0 t/ha OF+0.3 t/ha NPK. The trials were conducted at Ikenne, Southwestern Nigeria. The experiment was a split-plot fitted into randomized complete block design with four replicates. White yam cultivars and fertilizer rates were main and sub-plot treatments respectively. Tuber yield and nutrient uptake were assessed. Data obtained over two years were pulled together and analyzed using analyses of variance and in the differences treatment means were separated using Duncan's multiple range test at 5% probability level. Four fertilizer treatments (5.0 t/ha OF, 0.45 t/ha NPK, 2.5 t/ha OF+0.3 t/ha NPK, 5.0 t/ha OF+0.3 t/ha NPK) significantly ($P < 0.05$) improved the growth and yield of white yam compared to the control. Fertilizer treatment at 5.0 t/ha OF + 0.15 t/ha NPK produced the highest tuber yield of 22.0 t/ha in 2004 and 17.9 t/ha in 2005. They were significantly ($P<0.05$) higher than the control plots in the two years. Similarly, the same fertilizer treatment had the highest N, P and K uptake of 48.4, 15.9 and 64.7 g/plant respectively in 2004. There were N, P and K uptakes of 42.9, 15.8 and 62.6 g/plant respectively in 2005 and were significantly ($P< 0.05$) higher than the control. Fertilizer treatment at 5.0 t/ha OF+0.3 t/ha NPK was the best with reference to tuber yield and nutrient uptake. Amula had the highest tuber yield of 21.5 and 10.7 t/ha in 2004 and 2005 respectively.

Keywords: *Dioscorea rotundata*, Fertilizers, Tuber- yield, Nutrient uptake.

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INTRODUCTION

Yams (*Dioscorea* spp.) are important staple food crops widely cultivated worldwide where, they constitute major source of calories and vitamin C in the diet of people (Obigbesan, 1981). Yams are cultivated in an area of about 2.5 million hectares in the world, producing about 23.5 million metric tonnes of tubers (FAO, 1999; 2004). Africa alone produces about 90% of yam tubers and covers about 95% of the area of production. Beside Africa, it is also grown on large scale in countries like China, Japan, Oceania and other Caribbean countries (Ghosh *et al*., 1988). Most of the yams are produced from the yam zone of West Africa (Cameroon, Nigeria, Benin, Togo, Ghana, and Cote d'Ivoire) and to a lesser extent, the neighbouring countries (Chad, Burkina Faso, Mali and Guinea). These areas account for about 92 percent of the total world production (FAO, 1999; Wilfried and Lutaladio, 1999; Chukwu and Ikwelle, 2000). In Nigeria about 2.5 million hectares of land is put into yam production annually, with the bulk production in the middle belt and southern part of Nigeria (Rai and Yadav, 2005).Yams are very important in local commerce in Africa and account for about 32% of farm income earned from crops. As a source of foreign exchange, they are exported from Caribbean countries to Europe and North America (FAO, 1999) primarily to meet the needs of Africans and African descendants in these regions.

Prior to the advent of shifting cultivation system of farming, tropical and subtropical soils could guarantee sustainable production of arable crops (such as yams, maize, cowpea etc.) without external input of nutrients. Presently there is problem of widespread nutrient deficiency that limit crop uptake, growth and yield due to land degradation and nutrient fixation in the soil (Akinrinde, 2006). Most of the plant essential nutrients especially nitrogen (N), phosphorus (P) and potassium (K) are not readily available to plants due to erosion, leaching and fixation. According to Akinrinde and Okeleye (2005), crops have become so expensive to produce that nutrient deficiency should not be allowed to limit their yields. However, this goal is far from reality. The use of mineral fertilizer (e.g. NPK) is beyond the reach of peasant farmers due to high cost and procurement difficulties especially in developing countries. Apart from this, continuous use of mineral fertilizer alone leads to soil acidity, nutrient imbalance and declining crop yield (Tendon, 1992).

In recent times, alternatives to the use of mineral fertilizers are being sought. This is because, apart from the ability of organic manure to neutralize soil acidity, it could also provide some essential macronutrients (N, P, K, Ca, Mg) and micro nutrient (Zn, B, Cu etc.) for crop production and lead to increased crop growth, nutrient uptake and yield (Brower and Powel, 1995). This is because organic manure holds in check (in-situ within the root zone) the movement of mineral nutrients due to leaching and erosion. In the case of low activity clay of most tropical soils, organic manure makes available cation exchange sites to augment the normal property of clay, which is lacking thereby enhancing nutrient uptake, and hence use efficiency. It also increases crop yield quality, which enhances shelf-life (Kpello *et al.*, 1981). Organic fertilizers also have long-term residual effects, which maintain soil fertility in continuous cropping. Studies carried out on the use of organic manure alone and in conjunction with mineral fertilizers on yam in humid forest zone of Nigeria produced excellent results (Agboola and Obigbesan, 1975; Adeoye *et al.*, 1991). Dearth of recent information exists on the nutrient uptake and tuber yield of white guinea yam from plants grown with organic with or without-mineral fertilizers. This study was conducted to evaluate the yield and NPK uptake of white yam grown with different fertilizer treatments in Ibadan.

MATERIALS AND METHODS

Field trials were conducted in Ibadan (Longitude 3^0 42'E and Latitude 6^0 54'N) on an alfisol (Oxic Kandiustalf), in the lowland forest zone of Nigeria in 2004 and 2005. The 2004 and 2005 sites were under natural and mucuna fallow for a year respectively before cropping. The composted organic fertilizer used in the experiment was analyzed for total N, P, K and exchangeable bases as in IITA (1981). In pre and post cropping soil analysis, total N was estimated by Micro Kjeldahl method of Black (1965). Available P was determined by first extracting with Bray- P1, and then read colorimetrically with spectrophotometer (Bray and Kurtz, 1945). Exchangeable K, Ca, Mg and Na were determined by extraction with IN ammonium acetate (Murphy and Riley, 1962). Soil pH was determined by pH meter with glass electrode. Organic carbon was determined by the wet oxidation method of Walkley and Black (1934) and particle size distribution was determined by method of Bouyoucos (1962). The experiment was laid down in a split plot arrangement in randomized complete block design replicated four times. Fifty to sixty grams sett sizes of four landrace cultivars of *Dioscorea rotundata* (CV. Adaka, Danacha, Omiefun and Amula) were planted in April each year on ridges at a spacing of 1 m X 0.5 m. Alleys 2 m wide separated the plots to prevent flow of fertilizer from one plot to another and tangling of vines between the adjacent plots. Six weeks after planting, 10 fertilizer treatments were applied, comprising: control (no fertilizer), 2.5 t/ha organic fertilizer (OF), 5.0 t/ha OF, 0.15 t/ha NPK 12-12-12(NPK), 0.3 t/ha NPK, 0.45 t/ha NPK, 1.75 t/ha OF+0.15 t/ha NPK,2.5 t/ha OF+0.15 t/ha NPK, 2.5 t /ha OF+0.3 t/ha NPK and 5.0 t/ha OF+0.3 t/ha NPK. The fertilizers were applied in a groove about 5 cm deep and 10 cm from the base of each plant. The yams were staked and weeded manually after initial pre-emergence application of herbicide. Sampling was done monthly for data collection from one month after fertilizer application till the start of senescence of yam plants. Harvesting was done in December each year. Three yam plants/plot were carefully uprooted, washed and separated into leaves (petiole plus lamina), vines, tuber and roots. They were weighed and dried in oven at 70 ^{0}C for 72 hours for dry matter determination and the nutrient uptakes were calculated by multiplying the dry matter weight by the plant's nutrient contents. Five plants were harvested in the net plot and weighed for tuber yield. Data obtained over the two years were pulled together and analyzed using analyses of variance and differences treatment means were separated using Duncan's multiple range test at 5% probability level. Statistical analysis software, SAS version 9.1 (2003) was used for the analysis.

RESULTS AND DISCUSSION

Physical and chemical properties of the study sites

The chemical and physical properties of the two experimental soils are presented in Table 1. The soils of the two sites were sandy loam. Soil pH was 5.7 in 2004 and 5.9 in 2005. The soils were slightly acidic. The organic carbon content ranged from 0.67 g/kg in 2004 and 0.62 g/kg in 2005 while total N content ranged from 1.58 g/kg in 2004 and 1.08 g/kg in 2005. The total N and organic carbon contents were high in 2004 but low in 2005 based on the critical value of 1.5-2.0g/kg, (Sobulo and Osiname, 1981). The available P was 15.70 mg/kg in 2004 and 8.43 mg/kg in 2005 representing sufficiency and marginal deficiency levels, considering the 10-16mg/kg as being critical for crop production (Sobulo and Osiname, 1981; Adeoye and Agboola, 1985). The exchangeable K was 0.38 cmol/kg in 2004 and 0.15 cmol/kg in 2005. The soils were generally rich in K, considering the 0.16-0.25cmol/kg critical level (Adeoye and Agboola, 1985). This indicates the need for additional nutrient supply to the soils. The soils silt, clay and sand contents of between 160-170, 100 and 730-740 g/kg respectively (Table 1) are optimal to retain adequate water for normal yam growth.

Table 1. Pre-cropping chemical and physical properties of soils of the experimental sites in 2004 and 2005

Soil Properties	**2004**	**2005**
pH (H_2O)(1:1)	5.7	5.9
pH (KCl) (1:1)	4.1	4.7
Total N (g kg^{-1})	1.58	1.08
Organic carbon (g kg^{-1})	0.67	0.62
Available P (mg kg^{-1})	15.7	8.43
Exchangeable cations (cmol kg^{-1})		
Ca^{2+}	1.47	4.81
Mg^{2+}	0.32	1.05
K^{+}	0.38	0.15
Na^{+}	0.34	0.08
Al^{3+} + H^{++}	4.30	4.10
ECEC (cmol kg^{-1})	6.86	10.18
Base saturation (%)	68.2	85.3
Extractible micronutrients mg kg^{-1}		
Iron	69.9	38.0
Zinc	0.83	3.48
Copper	0.89	1.89
Manganese	92.9	83.0
Soil texture (g kg^{-1})		
Sand	740	730
Silt	100	100
Clay	160	170
Classification (USDA 1994)	Typic Paleudalfs Sandy loam	

Table 2. Nutrient content of the fertilizer materials

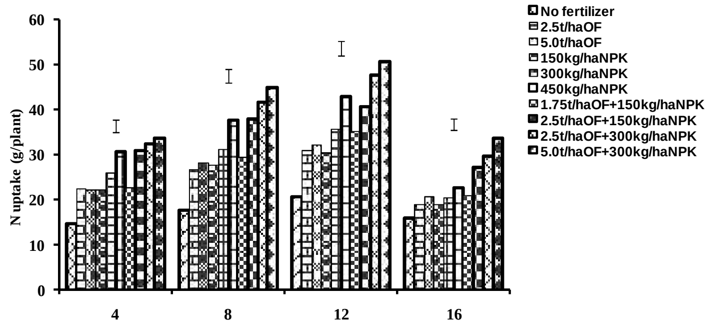
	Fertilizer materials			
Properties	OF*	Urea	TSP	MOP
N (%)	1.09	46	-	-
P ,,	0.70	-	60	-
K ,,	1.27	-	-	60
Ca ,,	1.48	-	-	-
Mg ,,	0.58	-	-	-
C/N ratio (g/kg)	8.97	-	-	-
Na (cmol kg^{-1})	2.75	-	-	-
Fe (mg kg^{-1})	95.0	-	-	-
Mn ,,	346	-	-	-
Cu ,,	48.3	-	-	-
Zn ,,	287	-	-	-

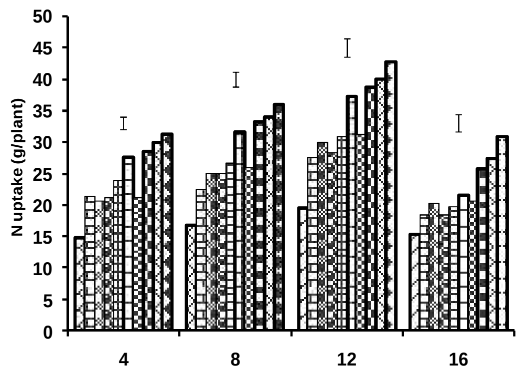
*OF = Organic fertilizer, TSP = triple super phosphate,MOP = Muriate of potash

Table 3: Effects of different fertilizer treatments on tuber yield of of white yam at Ikenne in 2004 and 2005 cropping season

	Tuber yields (t/ha)	
Fertilizer treatment	**2004**	**2005**
No fertilizer	18.46ab	8.08e
2.5tha^{-1}OF	19.88ab	9.36de
5.0tha^{-1} OF	22.60a	12.37bc
150$kgha^{-1}$NPK 12-12-12	20.69ab	11.88cd
300$kgha^{-1}$NPK 12-12-12	21.31a	12.53bc
450$kgha^{-1}$NPK12-12-12	19.20a	17.34a
1.75tha^{-1}OF+150$kgha^{-1}$NPK	19.14ab	14.24bc
2.5tha^{-1}OF+150$kgha^{-1}$NPK	20.58a	16.60b
2.5tha^{-1}OF+300$kgha^{-1}$NPK	21.65a	17.94a
5.0tha^{-1}OF+300$kgha^{-1}$NPK	21.98a	18.22a

Means in the column followed by the same letters are not significantly different by Duncan Multiple Range Test (DMRT).





Weeks after Fertilizer application

Figure 1: Effects of fertilizer treatment on nitrogen

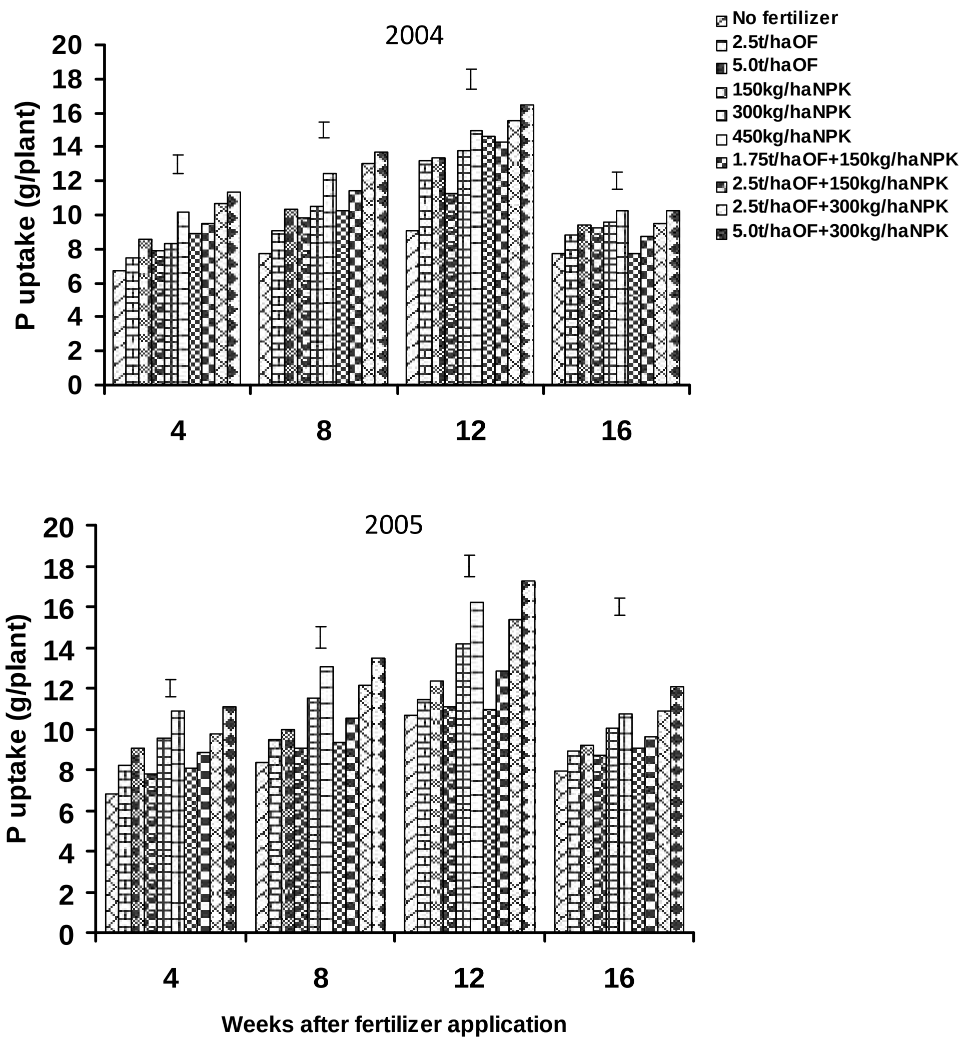


Figure 2: Effects of fertilizer treatment on phosphorus uptake of white yam at Ikenne in 2004 and 2005

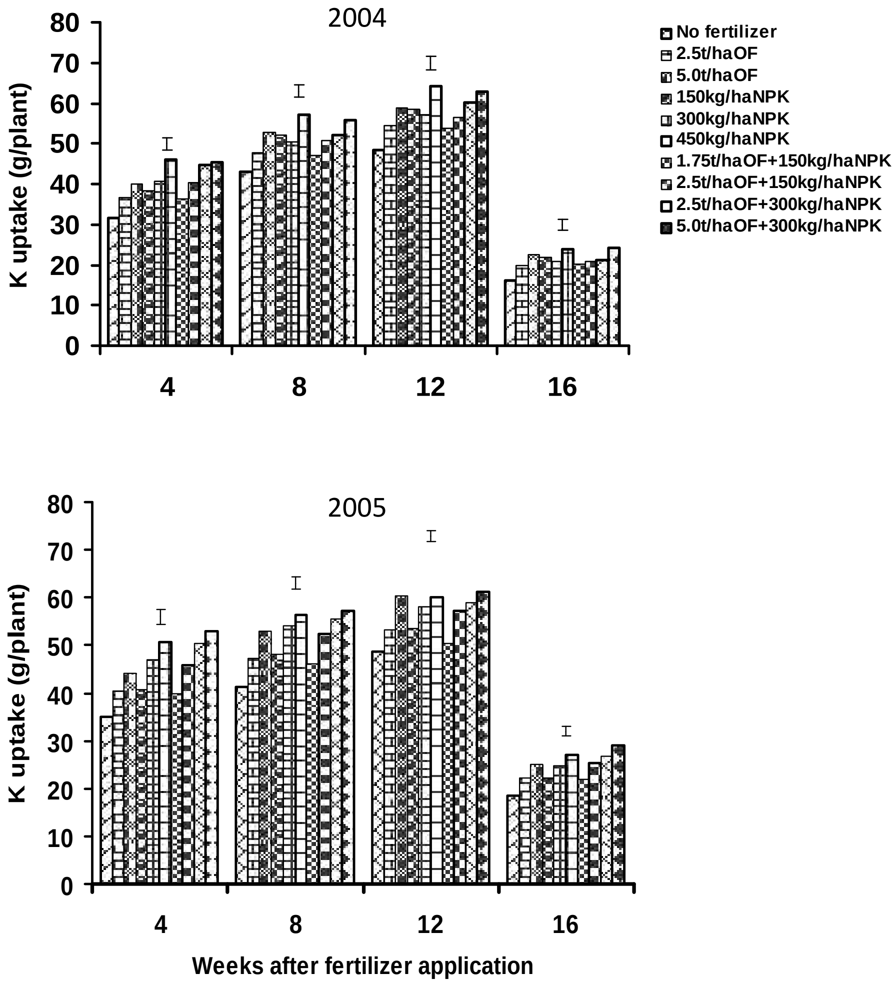


Figure 3: Effects of fertilizer treatment on Potassium uptake of white yam at Ikenne in 2004 and 2005

Organic fertilizer (Cowdung plus sorted city refuse) contained 1.09, 0.7, 1.27, 1.48 and 0.58% of N, P, K, Ca and Mg, respectively. Urea contained 46% N, TSP contained 60% P while MOP contained 60% K. The organic materials are rich in plant nutrients with C/N ratios of 8.97g/kg being adequate for quick nutrient release (Table 2).

Effect of different fertilizer treatments on nutrient uptake and tuber yield of white yam

The NPK uptake by the yam plants (Fig. 1 to 3) increases with increasing nutrient content of fertilizer materials. However, organo-mineral fertilizer enhanced better nutrient uptake compared to NPK fertilizer alone and the control. Fertilizer rate at 5.0 t/ha OF + 300 kg/ha NPK is superior to other fertilizer treatment in this study. The organic manure content of this fertilizer material must have enhanced appropriate release, availability and consumption of nutrient by the yam plants compared to the control. Also, the slow release of nutrients by organic manure coupled with the long period yam plants took to reach maturity made it easy for enhanced nutrient uptake by yam plants from the organic and organo-mineral fertilizer (Obigbesan, 1981) as compared to mineral fertilizer that releases its nutrients very fast or get leached out even before the plant could absorb it. Effects of different fertilizer treatments on tuber yield of white yam at in 2004 and 2005 is shown in Table 3. In 2004 and 2005, plots grown with 5.0 t ha^{-1} OF + 300 kg ha^{-1} NPK had significantly higher mean tuber yields of 18.46 t ha^{-1} and 8.08 t ha^{-1}), about 97.6% and 67% higher than tuber yield from the control plots (Table 3). There were significant ($P< 0.05$) differences in yields among the four white yam cultivars, with cv. 'Adaka' and 'Amula' having significantly higher mean yields of 16.58 t ha^{-1} and 16.89 t ha^{-1} relative to others only in 2005. There were no significant differences in tuber yields among the four yam cultivars in 2004 (Table 3).

The significant ($P<0.05$) increase in tuber yield and N, P, K uptakes with increasing nutrient content of fertilizer for both years indicated the important and positive effects of organic, inorganic and organo-mineral fertilizer on yam plants. This is expected because of the low native soil fertility status of the sites where the yam was grown. Many research findings on yam support the view that yams generally respond well to fertilizer application especially in an exhaustively cropped land (Agboola and Obigbesan, 1981; Adeoye *et al*., 1991). However among the fertilizer treatments those that received the combination of organic and inorganic fertilizers performed better. This observation is in accord with the findings of Agboola and Obigbesan (1975), Adeoye *et al*., (1991) and Adediran *et al.* (1999) on yams and other crops. They all asserted that combination of organic and inorganic fertilizer on crop production performed equally and in some cases even better than the use of either organic or inorganic fertilizer alone. The relatively poor performance of the control plots can be attributed to very low nutrient (NPK) status of the plots that can not sustain optimum yam production (Adeoye and Agboola, 1985; FFD/FMARD, 2002).

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Influence of poultry manure on the agronomic performances of okra and tomato under different cropping systems.

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ABSTRACT

Field experiment was conducted at the Teaching and Research Farms of the Federal University Technology Minna, Gidan Kwanu campus to determine the agronomic performances of okra and tomato under different cropping systems as influenced by poultry manure. The experiment was arranged in a randomized complete block design with three replicates. The treatments were four different cropping patterns: sole cropping with poultry manure, sole cropping without poultry manure, okra intercropped with tomato in ratio 2:1 with poultry manure application and okra intercropped with tomato in ratio 2:1 without application of poultry manure. There were significant ($p<0.05$) differences in the plant height among sole and inter cropped systems. Intercropped okra and tomato plots that were treated with poultry manure had significantly highest plant height, number of fruits and fruit weight than other treatments. In terms of land use efficiency, intercropped okra and tomato plots had highest land equivalent ratio (LER). The result showed that, the application of poultry manure produced the highest yield of okra and tomato under intercropping system when compared with sole cropping and could be recommended for farmers in guinea savannah agro-ecological zones of Nigeria.

Keywords: Poultry manure, okra, tomato, mixed cropping, sole cropping

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INTRODUCTION

Okra, *Abelmoschus esculentus* L. Moench, is of the family Malvaceae. It is widely cultivated fruit vegetable by subsistence farmers of Guinea and Sudan savanna zones of West Africa. The production of okra in Nigeria has rapidly increased in recent years. The seasonal supply of okra to a large extent determines how much of it is being consumed by the majority of the people. Okra contains proteins, carbohydrate and vitamin C (Lamont *et al.* 2004; Goplan *et al.,* 2007; Arapitas, 2008, Dilruba *et al.,* 2009). Okra plays a vital role in human diet (Kahlon *et al*., 2009). Consumption of young immature okra pods is important fresh fruits, and can be consumed in different forms (Ndunguru and Rajabu, 2004). Fruits can be boiled, fried or cooked (Akintoye *et al*., 2011).

Tomato consumption benefits the heart, amongst other body organs (Hosseini *et al.,* 2011). Tomato has medicinal properties because its consumption has been associated with decreased risk of breast cancer (Cheng *et al*., 2009). Tomato consumption is beneficial for reducing cardio-vascular risk associated with type diabetes (Hosseini *et al.,* 2011).

Research has shown that intercropping is an efficient soil conservation practice due to the increased ground cover that it provides as well as the exploitation of different soil layers due to the different depth of root systems of the two species being intercropped (Jarenyama *et al*., 2000).Through more effective use of water, nutrient and solar energy, intercropping can significantly enhance crop productivity compared with the growth of sole crops (Hussaini *et al*., 2001). Studies have shown the utility of intercropping as one of the crop contingency strategies against any sole cropping failure. Furthermore, intercropping has a great potential for pests, and diseases reduction (Baumann *et al*., 2000). It has been acclaimed globally that, intercropping is most reliable approach to safeguard the sustainability of crop production (Ayoola and Agboola, 2001). Manures provide a source of all necessary macro- and micro-nutrients in available forms, thereby improving the physical and biological properties of the soil (El-Magd *et al*., 2006).

Sustainability in agro-ecosystems involves environment-friendly techniques based on biological and non-chemical methods (Ridray and Bonato, 2007). Tomato is grown by using conventional and organic fertilizers. However, fertilizer sources can have a significant effect on tomato quality (Toor *et al*., 2006). Nonetheless, there is growing interest in using organic amendments and compost extracts to improve soil conditions and prevent crop diseases in tropical, arid and temperate climates (Litterick *et al*., 2004). They may also reduce the severity of diseases caused by foliar plant pathogens (Abbasi *et al*., 2002). Using organic fertilizers, composts and additions of rock minerals not only supplies plant nutrients but increases tolerance and resistance to insects and diseases; helps control weeds; retains soil moisture; and enhances fruit quality. The combination of animal and chicken manures provide an excellent sources desirable natural nitrogen (N), phosphorus (P), potassium (K) and sulfur (S) nutrient to the soil (Ghanbarian *et al*., 2008). The objective of the study is therefore to assess the influence of poultry manure on some agronomic characters of okra and tomato under different cropping systems.

MATERIALS AND METHODS

Field experiment was conducted during the 2012 cropping season at the Teaching and Research Farms of the Department of Crop Production, Federal University of Technology Minna, Gidan Kwanu campus located at Latitude 6^0 33 E and Longitude 9^0 37 N in the Southern Guinea Savannah Zone of Nigeria. The average rainfall ranges between 750 mm-1250 mm. The soil textural class of the experimental site was sandy loam. The experiment consisted of two sources of nutrients (poultry manure at 5.2 t/ha and no soil amendment) and three cropping patterns (sole cropping of tomato, sole cropping of okra and okra intercropped with tomato). Tomato variety (UC-82B) and okra variety (LD88-1) were used. The plastic buckets were filled with sandy loam top soil. The tomato seeds were sown into perforated plastic buckets by broadcasting method and watered daily. The seedlings were transplanted to the field 30 days after sowing at 50 cm × 75 cm inter row and 75 cm intra spacing. Okra seeds were sown directly to the field seven days after transplanting. Tomato plants were staked using wooden poles to provide support for the tomato plants. Weeding was done manually at 2, 4, 6 and 8 weeks after sowing. Five stands of okra and tomato were randomly selected and tagged from each plots for data collection. Data collected included days to 50% flowering, plant height, number of leaves, fruit diameter, number of fruit and fruit weight. All data collected were subjected to analysis of variance (ANOVA) and means were separated using least significant difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

The result presented on Table1 showed that there was no significant difference in plant height of sole okra and inter planted okra at 3, 6 and 9 weeks after sowing (WAS). However, application of poultry manure produced highest plant height in intercropped okra. Plants from the control plot in both sole and intercropped had similar heights. Significant differences were observed in plant height in the sole tomato and intercropped tomato at 3, 6 and 9 WAS after the application of poultry manure. The highest plant height was observed where poultry manure was applied, especially to tomato sole crop while the lowest plant height was recorded in both sole and intercropped where there was no soil amendment.

The result presented on Table 2 revealed that there was no significant difference in the number of days for both sole and intercropped okra to attain 50% days to flowering. However, plants supplied with poultry manure attained 50% flowering in lesser days. Significant differences were recorded in fruit length and fruit diameter of sole and intercropped tomato after the application of poultry manure. Highest fruit length and fruit diameter were recorded in plants supplied with poultry manure while the lowest fruit length and diameter were observed where there was no soil amendment.

Table1: Effects of poultry manure on plants height (cm) of okra and tomato under different cropping patterns

Treatments	Okra 3WAS (cm)	Okra 6WAS (cm)	Okra 9WAS (cm)	Tomato 3WAS (cm)	Tomato 6WAS (cm)	Tomato 9WAS (cm)
Sole + C	8.4	31.1	86.4	23.7	40.3	49.7
Sole + PD	8.1	33.8	85.7	23.2	43.9	58.5
Inter + C	8.5	30.4	88.6	17.7	27.5	46.2
Inter + PD	8.3	38.7	97.2	17.5	29.0	50.4
SE±	0.8	3.3	3.4	1.7	4.2	1.8
$LSD_{0.05}$	2.9	11.4	11.8	5.9	14.6	6.4

Foot note: C – control; PD - Poultry dropping at 5.2t/ha; Inter- Inter-planting.

Table 2 Effect of poultry dropping on 50% flowering, fruit length (cm) and diameter (cm) in okra and tomato under different cropping patterns.

Treatments	Okra 50% flowering (days)	Okra Fruit length (cm)	Okra fruit diameter (cm)	Tomato 50% flowering (days)	Tomato Fruit length (cm)	Tomato Fruit diameter (cm)
Sole +C	68.3	6.5	2.4	45.7	5.1	3.7
Sole + PD	69.3	7.5	2.7	44.3	5.3	3.9
Inter + C	66.0	6.7	2.7	44.7	4.7	3.1
Inter + PD	60.8	7.7	3.0	44.7	4.7	3.2
SE±	3.9	0.3	0.1	1.2	0.1	0.1
$LSD_{0.05}$	13.4	0.9	0.3	4.3	0.3	0.5

Foot note: C – control; PD - Poultry dropping at 5.2t/ha; Inter - Inter-planting.

Table 3. Effect of poultry dropping on the number of fruits and yield in okra and tomato (tha^{-1}) mixtures.

Treatments	Okra Number of fruit per plant	Okra Yield (t/ha)	Tomato Number of fruit per plant	Tomato Yield (t/ha)	LER
Sole + C	5.1	2.9	1.8	2.4	-
Sole + PD	6.8	3.1	2.4	3.5	-
Inter + C	5.2	3.2	1.5	2.2	2.02
Inter + PD	8.1	4.2	1.9	2.4	2.05
SE±	0.3	0.2	0.2	0.2	
$LSD_{0.05}$	1.1	0.8	0.8	0.7	

Foot note: C – control; PD - Poultry dropping at 5.2t/ha; Inter- Inter-planting.

There were significant differences in the number of fruits and fruit yield in sole and intercropped okra (Table 3). Number of fruits and yield from plants supplied with poultry manure in intercropped okra were significantly higher than those of sole okra. However, similar number of fruits were produced in intercropped where there was no soil amendment. Significant differences were recorded in number of fruits and yield in sole and intercropped tomato after the application of poultry manure.

Nutrient source is one of the most important inputs contributing to crop production because it increases productivity and improves yield and quality (Akande *et al.,* 2010). Plants that were treated with poultry manure had greater vegetative performance in okro intercropped over sole okro. This findings is in agreement with Akande *et al.,* (2010) who reported that application of organic base fertilizer, poultry dropping, enhanced plant growth and development. The fruit yield was higher in intercropped than in sole okra. This result agreed with the findings of Adeniyi and Omotunde (2011) who reported that best response was obtained in okra-tomato intercrop. It was also reported that application of poultry resulted in higher yield. The significant effect of poultry dropping on the number of fruits and yield could be attributed to the improvement of the soil fertility by poultry dropping through the addition of macro and micro nutrients (Adeniyan and Oyeniyi 2005). Their findings also corroborates the works of Akande, *et al* (2010) who attributed higher okra plant height to the application of organic manure. It had been reported that organic and soil nutrients increases with the application of poultry manure; and that poultry manure contains organic matter, N, P, Ca and Mg which are released into the soil (Adenawoola and

Adejoro, 2005). Depletion of organic matter under intensive cropping can be amended by proper addition of poultry manure into the soil. However, spacing of crop under intercropping and sole cropping systems significantly affected plant height and vegetative growth. The low performance of intercrop tomato could be traced to the presence of inter specific competition and okra being more competitive in terms of resource utilization than tomato (Tunku *et al.,* 2010)

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