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Soil chemical properties and okra yield as affected by sole and combined application of poultry manure and cow dung

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ABSTRACT

The use of animal manure to improve soil fertility and crop yield has been extensively studied, however, research work on animal manures applied in mixture is scanty. Soil application of poultry manure (PM), cow dung (CD) at 10 t/ha each, 7.5t PM + 2.5 t CD/ha, 5t PM + 5t CD/ha, 2.5t PM + 7.5t CD/ha and control were evaluated on soil chemical properties, and okra yield in a field experiment in 2011 and 2012 at the Federal University of Agriculture, Abeokuta, Nigeria. Soil was sampled and analyzed at 4, 8 and 12 weeks after manure application (WAMA). The test crop used was okra (NHAE 47 – 4). Application of sole PM at 10t/ha and 5t PM + 5t CD/ha resulted in highest available phosphorus content (38 mg/kg) while highest calcium (4.73 cmol/kg) and organic carbon (13.5 g/kg) concentrations were observed on plots treated with 2.5t PM + 7.5t CD/ha in 2011. In 2012, available potassium content was significantly increased above the control by the application of 10t PM/ha and 7.5t PM + 2.5 t CD/ha while highest organic carbon content (25.8 g/kg) resulted from 2.5t PM + 7.5t CD/ha application. Nitrogen, pH and calcium concentrations reduced with time while highest phosphorus, magnesium and organic carbon values (38 mg/kg, 0.41 cmol/kg and 20.6 g/kg respectively) were obtained at 12 WAMA in 2011, highest potassium concentration (0.16 cmol/kg) and pH (6.83) were observed at 4 and 12 WAMA respectively in 2012. The height of plants treated with 7.5t PM + 2.5 t CD/ha and 10t PM/ha was higher than the control by 22.07 % and 37.94 % in 2011 and 2012 respectively. Application of 10t CD/ha and 5t PM + 5t CD/ha resulted in highest number of okra leaves (5 and 12.80 respectively) in 2011 and 2012 respectively. Combined application of PM and CD at 5t/ha each increased okra fruit yield by 68.33 % and 70.89 % over the control in 2011 and 2012 respectively. Thus okra should be planted with sole PM at 10t/ha and the combination of poultry manure and cow dung for better soil quality, and higher fruit yield.

Keywords: Manure, Mixture, Poultry manure, Cow dung, Combination

INTRODUCTION

Soils in Africa were reported to be among the poorest in the world (IFDC, 2006), this is as a result of low activity clays and low organic matter content. The use of organic resources as soil amendment and animal manure generation have been reported to be on the increase (Lloyd and Anthony, 1999, Obi and Ebo, 1995). Manure utilization has been described as an integral part of sustainable agriculture (Anonymous, 2008). Animal manures have been reported to improve the physical, chemical and biological properties of the soil (Marere *et al.,* 2001; Kheyrodin and Antoun, 2007; Schjonning *et al.,* 1994). Adewumi *et al.,* (2011) reported that about 932.5 metric tons of poultry manure are produced yearly in Nigeria while cattle manure output of 1368 kg /DM/head/year was reported (Ifendy, 1977). The rate at which different types of the animal manures are generated varies with regions in some countries. The southern part of Nigeria was reported to have low cattle density while most of the cattle population is in the northern part (Rogger, 1999). An intensive commercial rearing of poultry was reported in the southern states (Bourn *et al.,* 1994). In a similar vein, cattle is reported to have been mostly reared in northern Ghana while poultry rearing is more concentrated in the rainforest region (Roland *et al.,* 2012). Thus huge amounts of cow dung will be generated in the northern regions with little poultry manure, the reverse will be the case in the southern part. The huge animal manures generated have been reported to cause disposal problems and environmental hazard. These could be incorporated into the soil for improved crop production (Adekiya *et al.,* 2012; Adeleye and Ayeni, 2010; Parker *et al.,* 2002).

There is the likelihood of shortage of one type of animal manure in some areas therefore, there is the need to look into how the use of these animal manures could be maximized. Many experiments have been conducted using sole animal manures, but there is little information on the use of the manure from different sources as mixture for crop production (Okpara and Mbagwu, 2003). When animal manures are combined, their effects on soil and crop yield are likely to be complementary. Therefore, this experiment was designed to evaluate the effects of sole application of poultry manure, cow dung and their combinations on soil chemical properties and yield of okra.

MATERIALS AND METHODS

Description of the experimental site and field experiment

The experiment was carried out at the organic research farm of the Federal University of Agriculture, Abeokuta, Ogun State Nigeria (latitude 7° 17´ N and longitude 3° 26´E). The average precipitation is 1187.36 mm with two peaks in July and September. Soil in the area is classified as Oxic Paleustal (FDALR, 1990). The treatments used were: 10t/ha PM, 10t/ha CD, 7.5t PM + 2.5 t CD/ha, 5t PM + 5t CD/ha, 2.5t PM + 7.5t CD/ha and control, the poultry manure was sourced from layer birds kept in battery cages in the poultry section of the College of Animal Science Farm of the Federal University of Agriculture, Abeokuta, Nigeria while the cow dung was from the cattle section of the same farm and University. The test crop was okra (variety – NHAE47-4), obtained from the National Horticultural Research Institute, Idi-Ishin, Ibadan, Oyo State, Nigeria. The experimental area measuring 754 m^2 was manually cleared on the 17^{th} of April, 2011. Plots measuring 5 m by 4 m were demarcated with pegs. Spaces of 1 and 2 m were left between plots and replicates respectively, the experiment was arranged in a Randomized Complete Block Design with four replicates. Treatments were applied by

broadcasting and thoroughly mixed with the top soil, three okra seeds were planted per hole at a spacing of 60 cm by 30 cm on the 7th of May, 2011 at two weeks after treatment application. The seedlings were thinned to one per stand a week after planting, weeding was done at four and eight weeks after planting.

In 2012 planting season, the plots used in the previous year were manually cleared, the weeds from each plot were allowed to decompose in situ. The treatments used in the previous year were also applied on the plots and left for two weeks. Okra was planted on the 22nd of May, 2012, thinning and weeding were done as in the previous year.

Data Collection

Ten plants were randomly selected at the middle of each plot, plant height, canopy cover, number of leaves and stem girth were measured by a ruler, physical counting and vernier caliper respectively at 3, 4 and 5 weeks after planting (WAP). Yield was taken by harvesting matured okra fruits at three days interval. These were weighed on a Mettler weighing balance.

Soil sampling

Top soil (0-15 cm) samples were taken randomly with the aid of a soil auger on the experimental plot before fertilizer application, these were composited and a representative sample was taken. Soil samples were also collected randomly on each plot at 4, 8 and 12 weeks after manure application (WAMA). All the soil samples were air dried, ground with mortar and pestle and sieved with 2 mm and 0.5 mm sieves for analyses.

Soil and Data Analyses

Processed soil samples (0.5 mm) were subjected to micro-Kjeldahl and titration methods for total nitrogen determination (Bremner, 1965), organic carbon was determined by Walkley Black wet oxidation method (Nelson and Sommers, 1996), available P in the soil sample (2.0 mm) was extracted with Bray 1 solution followed by molybdenum blue colorimetry method (Bray and Kurtz, 1945). Soil was extracted with 1 N ammonium acetate (pH 7.0), potassium and sodium were determined by flame photometry, while calcium and magnesium were determined with atomic absorption spectrometry (Jackson 1964). The pH was determined using 1:1 soil : water with a glass electrode pH meter (Mclean, 1982).

Data was analyzed by Analysis of variance using SAS 2003 package, significant means were separated using Duncan's Multiple Range Test at 5 % probability level.

RESULTS

Chemical properties of pre-planting soil and animal manures

Results of the pre-planting soil analysis shows that it is low in organic carbon (8.8 g/kg), total nitrogen (0.9 g/kg), available phosphorus (4.10 mg/kg) and potassium (0.24 cmol/kg). The soil is slightly acidic (Table 1). Nitrogen, phosphorus and potassium concentrations of the animal manures used for the experiment are shown in Table 2. Cow dung had higher nitrogen and carbon concentrations while the pH, phosphorus and potassium concentrations of poultry manure were higher.

Table 1: Selected chemical properties of pre-planting soil

Parameters	**Value**
pH (H_2O)	6.33
Organic carbon (gkg^{-1})	8.8
TN (gkg^{-1})	0.9
Avail. P (mg/kg)	4.10
K (cmol/kg)	0.24
Ca (cmol/kg)	4.41
Mg (cmol/kg)	0.86
Na (cmol/kg)	0.56

Table 2: Chemical Properties of poultry manure and cow dung

Amendment	pH (H_2O)	N (g/kg^{-1})	P (%)	K (%)	C (g/kg^{-1})	C:N
Cow dung	9.02	83.4	0.04	0.33	83.0	0.99
Poultry manure	9.86	76.0	0.05	0.54	77.0	1.01

SOIL CHEMICAL PROPERTIES

The effects of sole and combined applications of poultry manure and cow dung and time of soil sampling on pH, N, P, K, magnesium, calcium and organic carbon concentrations is shown in Table 3. In 2011 planting season, manure application and time of sampling significantly ($P<0.05$) affected soil N concentration, N values as a result of fertilizer application ranged from 1.1 g/kg to 1.6 g/kg. Application of 10 t PM/ha and 7.5t PM + 2.5t CD/ha significantly increased N more than the control. The value of N observed at 4 and 8 WAMA (1.8 g/kg) was higher than at 12 WAMA (0.5 g/kg). Potassium concentrations in the above year were similar, the range was from 0.09 cmol/kg – 0.19 cmol/kg, all fertilized plots had significantly ($P<0.05$) higher P concentrations when compared with the control, plots with the application of 10t PM/ha and 5t PM + 5t CD/ha had highest P concentration (38 mg/kg), while control plot had the lowest value (22.80 mg/kg). Time interval between manure application and soil sampling also affected P concentration, the highest value (38 mg/kg) was observed at 12 WAMA. Magnessium values were similar with manure application, while 0.41 cmol/kg which was the value obtained at 12 WAMA was significantly ($p<0.05$) higher than at 4 and 8 WAMA. Application of 2.5t PM + 7.5t CD/ha resulted in the highest soil pH (7.05), while the lowest (6.85) was from 5t PM + 5t CD/ha plot. These values were not significantly different from the control. Soil pH decreased with time, highest pH (7.23) was obtained at 4 WAMA while the lowest (6.40) was at 12 WAMA. Maximum calcium concentration (4.73 cmol/kg) was observed in plots where 2.5t PM + 7.5t CD/ha was applied, followed by this was 4.68 cmol/kg, being the value given by the plot with PM at 10t/ha while calcium concentration decreased with time. The lowest value (4.42 cmol/kg) was obtained at 12 WAMA. Increase in organic carbon concentration in relation to fertilizer application followed this order: 2.5t PM + 7.5t CD/ha, 10t CD/ha > 10t PM/ha > 5t PM + 5t CD/ha, 7.5 t PM + 2.5t CD/ha > Control. Organic carbon concentration increased with time, highest value (20.6g/kg) was recorded at 12 WAMA. In 2012, N, P, Mg, pH and Ca were not significantly affected by fertilizer application also, time of sampling had no

effect on N, P, Mg, Ca and O.C. Soil K concentration was promoted by the application of 10t PM/ha and 7.5 t PM + 2.5t CD/ha, the values ranged from 0.10 cmol/kg (Control) – 0.16 cmol/kg (10t PM/ha and 7.5 t PM + 2.5t CD/ha). Similarly, 10t CD/ha and 2.5 t PM + 7.5 t CD in addition to the above significantly ($P<0.05$) improved the carbon concentration compared to the control. Soil pH ranged from 5.96 – 6.83, the highest value was observed at 12 WAMA.

Agronomic and fruit yield of okra

In 2011 planting season, all the manure treatments significantly ($P<0.05$) increased the height of maize plants above the control at 3 weeks after planting (WAP). The heights of plants treated with 7.5t PM + 2.5t CD/ha increased by 24.65 % than control. Percentage increase in height as a result of the application of 2.5t PM + 7.5t CD/ha and 7.5t PM + 2.5t CD/ha at 4 and 5 WAP were 17.90 and 22.07 than the control respectively. However, no significant differences existed at 4 and 5 WAP. Number of leaves of plants with manure application were similar at 3 WAP, highest number (3.70) was from plants with the application of 5t/ha PM+5t/ha CD. At 4 and 5 WAP, highest values (4.35 and 5.00 respectively) which were significantly higher than control was as a result of 7.5t PM + 2.5t CD/ha and 10t/ha CD applications respectively, lowest values (3.60 and 4.10 leaves/plant respectively) were from the control. In 2012, plant height increased by 24.94 %, 29.74 % and 37.94 % than control at 3, 4 and 5 WAP respectively. Highest number of leaves (6.28 and 12.80) which were significantly higher in comparison with the control at 3 and 5 WAP respectively were from okra plants with the application of 10t PM/ha and 5t PM + 5t CD/ha. Number of okra leaves was not significantly affected by manure application at 4 WAP (Table 4).

Table 3: Effect of poultry manure, cow dung abd time on pH, nitrogen (N), phosphorus (P), potassium (K), Magnessium (Mg), Calcium (Ca) and organic carbon(O.C.) contents of soil planted into okra in 2011 and 2012

Treatment/ha	2011							2012						
	N (gkg^{-1})	P (mg/kg)	K (cmol/kg)	Mg (cmol/kg)	pH	Ca (cmol/kg)	O. C. (gkg^{-1})	N (gkg^{-1})	P (mg/kg)	K (cmol/kg)	Mg (cmol/kg)	pH	Ca (cmol/kg)	O.C. (gkg^{-1})
Control	1.1a	22.80c	0.11	0.33	7.01	4.58ab	10.1b	1.4	39.35	0.10b	3.16	5.90	3.72	17.4c
10t PM	1.6a	38.00a	0.13	0.39	7.04	4.68a	12.2ab	2.1	46.44	0.16a	4.06	6.68	4.11	24.9a
10t CD	1.4ab	30.40ab	0.09	0.37	6.98	4.64ab	12.8a	1.9	44.84	0.13ab	3.22	6.69	4.05	22.7ab
7.5t PM+2.5tCD	1.5a	30.40ab	0.19	0.39	6.89	4.63ab	12.1ab	2.1	42.25	0.16a	3.29	5.97	4.17	25.0a
5t PM+5t CD	1.4ab	38.00a	0.10	0.32	6.85	4.55b	12.1ab	4.0	41.50	0.14ab	3.45	6.55	4.05	19.1bc
2.5t PM+7.5tCD	1.4ab	30.40ab	0.12	0.39	7.05	4.73a	13.5a	2.1	49.73	0.15a	3.11	6.60	4.07	25.8a
			NS	NS	NS			NS	NS		NS	NS	NS	
TIME (WAMA)														
4	1.8a	22.80b	0.12	0.34b	7.23a	4.73a	8.0b	1.9	44.59	0.16a	3.35	5.96b	3.06	23.8
8	1.8a	22.80b	0.09	0.33b	7.20a	4.74a	7.8b	1.8	39.75	0.14ab	3.49	6.40b	3.57	22.1
12	0.5b	38.00a	0.16	0.41a	6.40b	4.42b	20.6a	3.0	47.72	0.12b	3.29	6.83a	4.40	21.5
			NS					NS	NS		NS		NS	NS

Means followed by the same alphabet(s) in a column are not significantly different from each other at $p < 0.05$.
PM- Poultry manure; CD – Cow dung; NS – Not Significant; WAMA – Weeks After Manure Application

Manure application had no significant effects on the canopy cover of okra at 3 WAP in 2011, the highest value (12.40 cm) was however observed on plants treated with 5t PM+5t CD/ha. At 4 and 5 WAP, the highest canopy covers (21.40 cm and 31.68 cm respectively) which were significantly ($P<0.05$) higher than that of control were given by plants with 5t PM+5t CD/ha treatment. Stem girth of okra plants were not significantly affected by manure application in 2011. Application of 5t PM+5t CD/ha and 2.5t PM + 7.5t CD/ha resulted in the highest stem girth at 3 WAP, while the plants treated with 7.5t PM+2.5t CD/ha and 5t PM+5t CD/ha had highest stem girth at 4 and 5 WAP respectively. In the year 2012, canopy cover was significantly ($P<0.05$) increased above that of control by the application of 10t PM/ha at 3 WAP and 5t PM + 5t CD/ha in addition to the above at 4 WAP, canopy cover increase followed this order of manure application: 10t PM/ha > 5t PM + 5t CD/ha > 7.5t PM + 2.5t CD/ha > 10t CD/ha > 2.5t PM + 7.5t CD/ha > control. Okra canopy cover was significantly ($p<0.05$) improved above the control by manure application with the exception of 10t CD/ha and 2.5t PM + 7.5t CD/ha at 5 WAP in the same year, the order of increase was: 5t PM + 5t CD/ha > 7.5t PM + 2.5t CD/ha > 10t PM/ha > 2.5t PM + 7.5t CD/ha > 10t CD/ha > Control. Maximum okra stem girth (0.42 cm, 0.65 cm and 0.99 cm) at 3, 4 and 5 WAP respectively were observed on plants with the application of 10t PM/ha, 10t CD/ha, and 7.5t PM + 2.5t CD/ha respectively. Lowest values were given by control plants. The stem girth of plants treated with 7.5t PM + 2.5t CD/ha were significantly higher than that of the control at 3, 4 and 5 WAP (Table 5).

Highest okra yield of 2.40 t/ha and 1.58 t/ha resulted from the application of 5t PM + 5t CD/ha in 2011 and 2012 respectively, followed by this was 7.5t PM + 2.5t CD/ha (2.36 t/ha) in 2011 and 10 PM (1.49 t/ha) in 2012, in addition to these was the yield of plants with the application of 7.5 t PM + 2.5 t CD (1.16 t/ha) in 2012 (Fig. 1). All these values are significantly ($P<0.05$) higher than that of the control.

Table4: Okra height and number of leaves as affected by poultry manure, cow dung and their combinations in 2011 and 2012

Treatment/ha	2011						2012					
	Height (cm)			Number of leaves			Height (cm)			Number of leaves		
	3 WAP	4WAP	5 WAP	3 WAP	4 WAP	5 WAP	3 WAP	4 WAP	5 WAP	3 WAP	4 WAP	5 WAP
Control	8.10 b	10.78	11.65	3.30	3.60b	4.10b	8.88c	11.15c	15.05c	5.00b	6.50	8.20c
10t PM	10.43a	11.90	13.88	3.45	4.25ab	4.73ab	11.99a	15.87a	24.25a	6.28a	8.25	12.10a
10t CD	10.28a	11.88	13.23	3.35	4.05ab	5.00a	9.44bc	13.13bc	17.61c	5.40b	7.50	8.98bc
7.5t PM+2.5t CD	10.75a	12.93	14.95	3.50	4.35a	4.55ab	11.03ab	14.28ab	20.92ab	5.65ab	8.00	12.15a
5t PM+5t CD	10.50a	12.95	14.43	3.70	3.75ab	4.45ab	11.03ab	14.40ab	19.93bc	5.75ab	7.85	12.80a
2.5t PM+7.5t CD	10.30a	13.13	14.23	3.45	3.75ab	4.70ab	10.43abc	14.36ab	18.53bc	5.39b	7.35	10.10b
		NS	NS	NS							NS	

Means followed by the same alphabet(s) in a column are not significantly different from each other at $p < 0.05$.

PM- Poultry manure
CD – Cow dung
NS – Not Significant

Table 5: Canopy cover and stem girth of okra as influenced by poultry manure, cow dung and their combinations in 2011 and 2012

Treatment/ha	2011						2012					
	Canopy cover (cm)			Stem girth (cm)			Canopy cover (cm)			Stem girth (cm)		
	3 WAP	4 WAP	5 WAP	3 WAP	4 WAP	5 WAP	3 WAP	4 WAP	5 WAP	3 WAP	4 WAP	5 WAP
Control	9.20	11.98b	18.05b	0.25	0.33	0.43	12.76bc	20.48b	30.55b	0.27b	0.44b	0.58c
10t PM	10.68	15.95ab	21.78ab	0.25	0.35	0.48	19.14a	30.40a	42.13a	0.42a	0.52ab	0.92ab
10t CD	11.33	17.10ab	25.48ab	0.25	0.40	0.48	15.40bc	25.58ab	34.03b	0.34ab	0.65a	0.72bc
7.5t PM+2.5t CD	11.03	18.48ab	24.63ab	0.28	0.45	0.48	16.74ab	27.25ab	43.23a	0.36a	0.60a	0.99a
5t PM+5t CD	12.40	21.40a	31.68a	0.35	0.43	0.53	16.85ab	30.10a	43.60a	0.37a	0.62a	0.85ab
2.5t PM+7.5t CD	10.98	16.15ab	21.13ab	0.35	0.35	0.48	14.52bc	24.31ab	37.70ab	0.35a	0.53ab	0.83abc
	NS			NS	NS	NS						

Means followed by the same alphabet(s) in a column are not significantly different from each other at $p < 0.05$.

PM- Poultry manure
CD – Cow dung
WAP – Weeks After Planting
NS – Not Significant

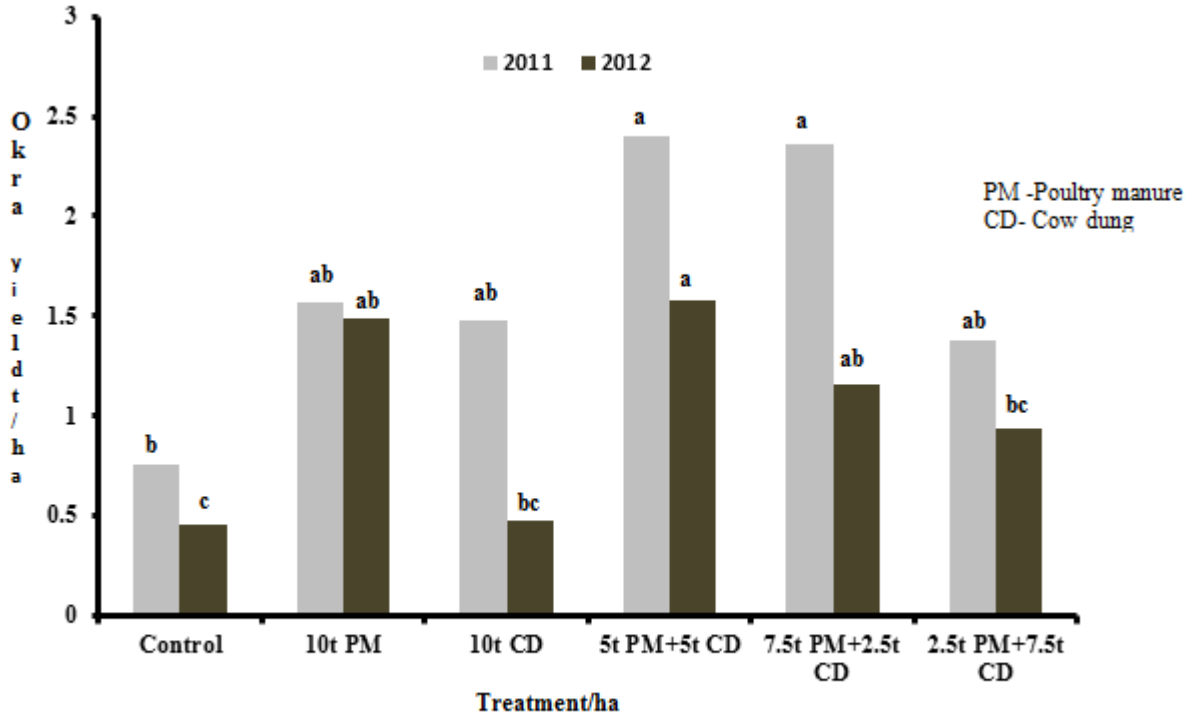

Figure 1: Effect of cow dung, poultry manure and their combination on okra yield

DISCUSSION

The low chemical properties of the pre-planting soil showed that response to manure application was expected. Higher values for N and organic carbon were observed in cow dung. This was similar to the findings of Ano and Agwu, (2005), Adekunle et. al. (2009) and Akande et. al, (2012) who reported higher N, and carbon concentrations in cow dung than poultry manure. Nutrient composition of animal manures is dependent on the quality of feed given to the animals, based on the source of the cow dung used for this study, they might have been fed with concentrates. Nitrogen in poultry manure has been reported to be

subject to loss as a result of different management or environmental conditions (Zublena *et al.,* 1993).

SOIL CHEMICAL PROPERTIES

Increase in soil P and O. C. obtained with PM and CD at 5t/ha each and PM at 10t/ha and 2.5 t PM/ha + 7.5t CD/ha respectively indicated that these could be the appropriate combination rates of these manures for improving the above nutrients, this was similar to the findings of Chioma and Okorie, (2011) who reported highest values of organic matter and available P from the combination of cow dung and PM at 5t/ha each. The decrease in soil N content with time could be that okra plants had made use of the major part of the element in the soil for vegetative growth within the first eight weeks. Soil pH was observed to decrease with time in 2011, while the reverse was the case in 2012, the manure might have undergone further decomposition after the first application while decomposition might have been completed and the rate of mineralization became higher in 2012. The highest P concentration was observed at 12 WAMA, soil pH at the time which was 6.4 could be the reason for this, P has been reported to be mostly available at pH between 6 and 7 (Lowell *et al.,* 2009). The same reason could be deduced for the decrease in calcium with time, calcium was reported to be mostly abundant at pH 7 and above (Soil phosphorus Reactions 2013).

AGRONOMIC PARAMETERS

Poultry manure application at 10t /ha increased the height of okra throughout the duration of the experiment in 2012. Nwachukwu *et al.,* 2012 reported that poultry manure increased the height of amaranthus, this could be due to the higher decomposition and faster release of nutrients in poultry manure which is as a result of low C: N ratio. Highest number of okra leaves was as a result of 10t/ha CD application in 2011, this is in agreement with the findings of Gudugi (2013) who reported that cow dung increased the number of okra leaves and Ewulo *et al.,* (2007) who also reported increase in the number of pepper leaves as a result of cow dung application. Combination of poultry manure and cow dung (5t PM + 5t CD/ha, 7.5t PM + 2.5t CD/ha) was observed to increase the number of okra leaves in 2012, this may be due to the complementary effect of the animal manures. Application of sole PM also increased the number of okra leaves, this is similar to the report given by Michael *et al.,* (2012) that chicken manure application increased the number of leaves of lettuce. It could be observed that significantly higher values than control in canopy cover and stem girth of okra were observed in combined manure application in both 2011 and 2012 while this observation was in 2012 for sole manure application, this showed that the effects of the different manure were complementary. This could have led to earlier release of nutrients in sufficient quantity to improve the canopy cover and stem girth of okra in the first year of application.

YIELD

Application of 5t PM + 5t CD/ha, 7.5t PM + 2.5t CD/ha significantly improved okra yield in 2011 while PM at 10t/ha in addition to the above did so in 2012. The above combination rates appeared to be the rates at which adequate nutrients are released into the soil to improve okra yield. This agreed with the findings of Chioma and Okorie (2011) who reported that the combination of poultry manure and pig manure at the rate of 5t/ha + 5t/ha and 2.5t/ha + 2.5t/ha resulted in higher grain weight, number of pods and grains of soybean, Kekong *et al.,* (2010) also recommended the combination of 20t/ha CD and 15t/ha PM for maximum yield of garden egg. It could also be observed that the yield from sole PM application at 10t/ha was only significantly higher than control in the second year, this might have resulted from the non availability of the nutrients in PM in

quantities large enough to increase yield in the first year (Eddie, 2013).

CONCLUSION

This study showed that sole application of poultry manure and poultry manure and cow dung applied in various mixtures improved the growth and yield of okra. Application of 7.5t PM + 2.5t CD/ha improved the height and stem girth of okra. Highest number of okra leaves was by 5t PM + 5t CD/ha application. Since the yield of okra was similar with sole PM application and combination with CD, where there is shortage of PM, it could be combined with CD for okra production. Soil N, P, Ca and O. C. were increased by the application of sole PM at 10t/ha, 5t PM + 5t CD/ha and 2.5t PM + 7.5 CD/ha. The longer the fertilizers stayed in the soil considering the duration of this experiment, the higher the O. C. content while N, and Ca reduced with time. The time between manure application and planting should not be too long so that the crop could benefit maximally from the above nutrients. Okra should be planted with sole PM, combination of PM and CD at the rate of 5t/ha each and 7.5t PM + 2.5t CD/ha for higher yield, sole PM at 10t/ha and PM 5t/ha + CD at 5t/ha for better crop quality and PM 10t/ha 7.5t/ha PM + 2.5t/ha CD and 2.5 t/ha PM + 7.5 t/ha CD for improved soil quality on the type of soil used for this experiment.

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