Standard Scientific Research and Essays Vol 3(10): 290-297, October 2015 (ISSN: 2310-7502)
http://www.standresjournals.org/journals/SSRE

Research Article

Effects of sawdust, poultry manure and NPK fertilizer amendment materials on the growth and leaf yield of fluted pumpkin in southeastern Nigeria

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Accepted 26 October 2015

Abstract

The comparative effects of sawdust ash (SDA), poultry manure (PM) and NPK (20:10:10) fertilizer on the growth and foliar yield of fluted pumpkin (*Telfairia occidentalis)* were examined in a two-year study, 2010 and 2011, at Onne, near Port Harcourt, southeastern Nigeria. Eight treatments used in the study included: 6 t/ha SDA, 3 t/ha SDA, 4 t/ha PM , 300 kg/ha NPK (20:10:10), 3 t/ha SDA + 2 t/ha PM, 3 t/ha SDA + 150 kg/ha NPK, 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK and Control (no sawdust ash, no poultry manure, no NPK) laid in a Randomized Complete Block Design (RCBD) and replicated three times. Results obtained showed that the application of either of the soil improvement inputs significantly increased growth and leaf yield of fluted pumpkin in relation to the control plot. Similarly, application of either PM or NPK fertilizer alone significantly increased yield in relation to application of SDA and the control. Above all, application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK, (a combination of reduced quantities of SDA, PM and NPK fertilizer) gave a significantly higher foliar yield than all the other treatments in the second year. The incorporation of the organic sources of manure with inorganic fertilizer perhaps elevated the organic matter content of the soil, increased soil pH and improved the nutrient exchange capacity of the soil, thereby resulting in higher yield of fluted pumpkin.

Keywords: sawdust ash, poultry manure, NPK (20:10:10), *Telfairia occidentalis*

INTRODUCTION

Vegetable products are of great importance in human nutrition in developing countries as they are a primary source of energy, lipids, and carbohydrates, including fibres, minerals and vitamins (Lima *et al.,* 2009). Fluted pumpkin (*Telfairia occidentals* Hook L.) is the most popular vegetable cultivated for its edible succulent shoots and leaves and seeds in southern Nigeria, particularly, in the Southeast and South-south states (Akoroda, 1990). It is mildly consumed to an appreciable degree in other parts of the country (Okoli and Mgbeogu, 1982). The crop is principally dioecious in nature and produces luxuriant edible green leaves on vines which run on the soil surface and climb any available support by means of coiled tendrils. Predominantly, 78% of its cultivation is carried out by female farmers. The crop goes in association with other food crops around the compound in villages and towns on subsistence levels but of recent, sole cropping with some commercial intent is being practiced (Ojeifo *et al.,* 2006). Fluted pumpkin cultivation provides an appreciable cash income to the farm families (Akoroda, 1990)

The usefulness of fluted pumpkin can never be over emphasized among the people of southern Nigeria. The tender leaves and shoots are consumed by human beings in different forms. The crop also makes a good fodder for livestock such as goats, sheep and pigs. The leaves and edible succulent shoots together contain 85% moisture, 11-39% crude protein (it increases with age of leaf), 25% carbohydrates, 3.0% fat, 0.58% phosphorus, 4.32% potassium, 0.57% magnesium, 0.47% calcium and 700ppm iron (Akwaowo *et al.,* 2000). There has always been an increasing demand for the crop in area of human health and nutrition. The young leaves of fluted pumpkin if sliced and mixed with coconut water and salt, makes a useful concoction for the treatment of convulsion (Alegbejo, 2012). The fresh leaf extract alone is used in the management of hypertension, liver problems and impaired immune system (Eseyin *et al.,* 2005; Adaramoye *et al.,* 2007). It is also used as a tonic for women that have just given birth due to its high iron content (Alada, 2000). The seed is high in crude protein and fat recording 27 and 53%, respectively (Tailor*, et al*., 1980). Generally, malnutrition is rarely found among dwellers consuming large daily proportion of fluted pumpkin (Dike, 2010). The roots contain high amount of sapoin, a poisonous substance and are used to kill rats and mice as rodenticide and ordeal poison (Gill, 1992). The plant produces fruits known as gourds which range between 16 and 105 centimeters in length, 9-27 cm in diameter, 2-6 kg weight and contains 30-196 seeds gourd^{-1}. The seed measures between 2.4 and 4.9 cm in length (Okoli and Mgbeogwu, 1983). The seeds are of high demand as they do not only serve as planting materials but eaten either roasted or boiled and ground to make a sauce as soup thickener, eaten with boiled yam, plantain and cocoyam. It is also a source of oil for making margarine. The crop could be described as a “wonder crop” and a blessing to the people of southern Nigeria.

Despite these numerous usefulness of the crop, there is dearth of information on means of solving the soil nutrients constraints, to enhance production of the crop in Onne, a high rainfall zone (annual rainfall of 3500mm) in southeastern Nigeria. These constraints are principally caused by high nutrients leaching due to high rainfall, low N and organic matter content of the soils, low pH (4.9) and high weed and pest infestation (IITA, 1984). Research has shown that about 30 kg N/ha, 100 kg/ha of K_2O and 22 kg/ha P will be needed to sustain the leaf yield production of the crop either through organic manure or inorganic fertilizers (Obiagwu and Odiaka, 1995). Sawdust ash (SDA), Palm bunch ash, Kitchen Residues ash and Oyster Shell ash have been used to improve the organic matter content as well as reducing the acidity of soils (Olayinka and Adebayo, 1989; Onwuka *et al.,* 2009; Abdulraheem *et al.,* 2012). The application of SDA increased the yield of cowpea, okra, tomato and uptake of P, K, Ca and Mg by the crop (Owolabi *et al.*, 2003). Similarly, growth and yield of sorghum was significantly increased by combining reduced levels of urea fertilizer and SDA (Abdulraheem *et al.,* 2012). Such technology needs to be imported to the zone to enhance the production of the crop. The integration of SDA in combination with poultry manure (PM) and or inorganic fertilizer with high N content is expected to reduce the C/N ratio of SDA, which ranges between 300 and 500 (Olayinka and Adebayo, 1989), through microbial action to quicken the release and sustenance of nutrients in the compounds applied.

Since fluted pumpkin, as a vegetable, has become so popular and important in the lives of the people, there is the need to advance the production strategies to sustain its availability at all times; hence this study which aims at examining the effects of organic inputs such as sawdust ash, poultry manure and in combination with inorganic fertilizer on the vegetative growth and yield of this very important vegetable, *Telfairia occidentalis,* in Onne, southeastern Nigeria.

MATERIALS AND METHODS

The experiment was conducted in the 2010 and 2011 main cropping seasons at the Rivers State University of Science and Technology, Institute of Agricultural Research and Training (RIART) Farm, Onne, near Port Harcourt, Rivers State, Nigeria. Onne is located in the south-south geopolitical zone of Nigeria. The site is located on latitude 4^{o} 46^{l} N and longitude 7^{o} 10^{l} E and has a humid tropical condition with temperature range of 28-32^{o}C. It is a high rainfall zone in South-south Nigeria, with mean annual rainfall of 3500mm. The soil is an Ultisol, with low pH (H_2O) (4.8) and poor soil fertility due to low nitrogen and organic matter status. A randomized complete block design with eight treatments replicated three times was used. The different treatments were: : 6 t/ha sawdust ash (SDA), 3 t/ha SDA, 4 t/ha Poultry manure (PM), 300 kg/ha NPK (20:10:10), 3 t/ha SDA + 2 t/ha PM, 3 t/ha SDA + 150 kg/ha NPK, 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK and Control (no sawdust ash, no poultry manure, no NPK). The plots measured 8 x 4m each.

Prior to the commencement of the experiments, Sawdust ash (SDA) was collected from the saw mills at timber market, Marine base, Port Harcourt, where heaps of sawdust are incinerated to ash on a daily basis, to reduce bulk. Poultry manure (PM) (cured for 3 months) was obtained from the University poultry farm. Chemical compositions of the sawdust ash and poultry manure are shown in Table 1. Before the soil was tilled for planting, forty core soil samples were randomly collected from the entire experimental area at a depth of 0-15 cm, bulked to form a composite sample for analysis of both physical and chemical properties (Table 2). Also, at 24 weeks after commencement of the experiment in the second year, soil samples were collected from individual plots and analyzed for chemical properties. In each case, the soil was air dried for 21days, ground and sieved using a 2-mm mesh sieve for the determination of pH, Organic carbon (OC), Nitrogen (N), Phosphorus (P), Calcium (Ca) and Magnesium (Mg), according to procedures described by Tel and Rao (1982).

The field used for the study was dominated principally by *Chromoleana odorata* with traces of *Aspilia africana, Panicum maximum, Anthonatha mycrophylla* and *Alchonea cordifolia* (in decreasing order of dominance) as the main vegetation spp. The land was previously cultivated to maize and cassava and had fallowed for one year. It was slashed, ploughed and harrowed. The second year trial was repeated on the same site and land preparation involved only clearing of the field of weeds without ploughing and harrowing. In each season, the specific quantity of Poultry Manure (PM) and Sawdust Ash (SDA) were applied manually (depending on the treatment), and worked into the soil surface using garden fork and shovel, two weeks before planting. *Telfairia occidentalis* seeds were extracted from the fruits, cleaned up of the pulp and allowed to dry in an open aerated shade for two days prior to planting. Seeds were planted on the 9th and 8th of April 2000 and 2011 respectively, at a spacing of 1 x 1m at one seed per stand, giving a population of 10,000 plants/ha. Inorganic fertilizer (NPK 20:10:110) was applied according to the design of the study 10 days after planting. Weeds were controlled manually using the weeding hoes. First and second weeding were done one and two months after planting, respectively. Subsequent weeding were done selectively as the vines spread and cover the plots making weeding extremely difficult. Harvesting of fluted pumpkin vines commenced from 8 weeks after planting (WAP) when the crop was fully established with a reasonable number of vines and leaves.

Table 1. Chemical composition (%) of Poultry Manure (PM) and Sawdust Ash (SDA) used in 2010 and 2011 at Onne, Port Harcourt, Nigeria

Chemical properties (%)	Year 2010		Year 2011	
	PM	SDA	PM	SDA
C	45.90	23.70	43.60	32.19
N	4.14	2.70	3.94	2.59
P	0.48	2.72	0.52	2.94
K	4.95	2.91	5.35	3.71
Ca	5.52	2.80	6.12	3.60
Mg	0.45	0.80	0.51	0.92

PM = poultry manure; SDA = sawdust ash.

Table 2. Soil properties at Onne, the study site, prior to commencement of experiments in 2010

Soil properties @ 0-15 cm depth	Values/ classification
Texture	**Sandy loam**
Physical properties	
Sand (%)	77.0
Silt (%)	15.3
Clay (%)	17.7
Chemical properties	
pH (H_2O)	4.8
Total N (%)	0.08
OC (%)	1.08
Avail. P (g/kg)	62.3
K *(Cmol/kg)*	0.14
Ca *(Cmol/kg)*	1.22
Mg *(Cmol/kg))*	0.24

Harvest was done manually by pruning with a sharp kitchen knife. Subsequent harvests were done at 3 weeks interval (Odiaka *et al.,* 2008). First pruning of the vines was done immediately after a few old and unacceptable leaves (coarse and not good for consumption) at bout 25cm from the base of the vine. Subsequently, offshoots were cut at the base close to the point of attachment to the main stem but immediately after a few new shoots on the vine to allow such offshoots to develop for subsequent harvests. Ten middle plants within each plot were included in the harvests, discarding the boarder plants. Data collected included length of main vines, number of branches, number of leaves per vine at 8 WAP; quantity of biomass at 8, 11, 14, 17 and 21 WAP; cumulative fresh leaf yield per season and soil nutrient status at the end of the study in the second season. The data collected were subjected to analysis of variance using the procedure GLM of SAS (SAS Institute, 2010). Where there was significant F-test, means were compared using F-LSD at 5% probability level.

RESULTS

Analysis of sawdust ash (SDA) and poultry manure (PM) used in 2010 and 2011 showed a C:N ratio of 8:1 and 11:1 for SDA and 12:1 and 11:1, for PM, respectively (Table 1). Calcium, a prospective liming agent, ranged between 2.80 and 6.12% in PM. Calcium is a good liming agent for increased soil pH values. Results of initial soil analysis carried out before the commencement of the experiment (Table 2.) revealed that the soil had good physical properties but was deficient in most essential elements for plant growth. Apart from P and K that showed appreciable values, soil pH value was 4.8, indicating high acidity. Values for OC, N and Ca were grossly low indicating that the soil was not only very acidic but low in fertility (IITA, 1994).

Vine length

There was a significant (P=0.05) treatment effect on primary vine length of fluted pumpkin harvested at 8 WAP (Table 3.). Application of 300 kg of NPK (20:10:10) fertilizer produced the longest vine in 2010 cropping season while application of a combination of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK (at reduced rates of each fertility material) gave the longest vine in 2011 cropping season. On the contrary, the control treatment produced vines that were significantly (p=0.05) shorter by 39 and 41% in relation to the application of 300 kg/ha NPK (20:10:10) in 2010 and 2011, respectively. Application of 6 t/ha of SDA increased vine length by 10 and 32%, 3 t/ha SDA by 10 and 23%, application of 4 t/ha PM by 39 and 59% and application of 3 t/ha SDA + 2 t/ha PM by 31 and 47% in relation to the control in 2010 and 2011, respectively. Generally, all plots receiving external soil amendments produced longer vines than the control, indicating an improvement in soil fertility and subsequent nutrient uptake. An overview of the means of the two years show that treatments performances were in the decreasing order of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK < 300 kg/ha NPK (20:10:10) < 3 t/ha SDA + 150 kg/ha NPK < 4 t/ha PM < 3 t/ha SDA + 2 t/ha PM < 6 t/ha SDA < 3 t/ha SDA < control. The Typic Paleudult at Onne is said to have good physical properties but deficient in most essential elements for plant growth (IITA, 1994)

Number of branches per main vine

Results of the first and second cropping years taken at 8 WAP in each year (Table 4) showed that, the control treatment recorded the lowest number of branches of 2.42 in relation to all other treatments receiving external inputs with number of branches ranging between 2.76 with application of 3 t/ha SDA and 3.24 with 300 kg/ha NPK (20:10:10). Even though there were variations among the number of branches on the vines in all treatments, they did not differ significantly in their performances in the first cropping year. Application of 300 kg/ha of NPK gave the highest number of branches of 3.24 in 2010 while application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK gave the highest number (4.08) in 2011. There were generally, more branches on the vine as well as a reverse in the trend of performance of the second cropping year over the first year. Application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK gave the highest number of branches in the second cropping year and did not differ significantly from application of 4 t/ha PM, 3 t/ha SDA + 2 t/ha PM, 3 t/ha SDA + 150 kg/ha NPK, and 300 kg/ha NPK with branch number decreased by 2, 21, 8 and 11%, respectively. Number of branches was significantly lower in the control treatment in relation to all other treatments that received external inputs. Application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK significantly increased the number of branches over application of 6 t/ha SDA, 3 t/ha SDA and 3 t/ha SDA + 2 t/ha PM by 25, 30 and 16%, respectively.

Table 3. Effects of sawdust ash, poultry manure and NPK (20:10:10) applications on vine length of fluted pumpkin at 6 WAP in the years 2010 and 2011 at Onne, Port Harcourt

.	Vine length (cm)	
Treatment	**Year 2010**	**Year 2011**
6 t/ha SDA	68.72	73.01
3 t/ha SDA	66.16	68.36
4 t/ha PM	83.53	87.80
3 t/ha SDA + 2 t/ha PM	78.46	81.30
3 t/ha SDA + 150 kg/ha NPK	84.82	89.01
3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK	86.66	97.17
300 kg/ha NPK (20:10:10)	98.95	94.06
Control	60.12	55.27
LSD(0.05)	10.253	9.692

SDA = sawdust ash; PM = Poultry manure; NPK = 20:10:10 fertilizer.

Table 4. Effects of sawdust ash, poultry manure and NPK (20:10:10) applications on number of branches per vine of fluted pumpkin at 6 WAP in the years 2010 and 2011 at Onne, Port Harcourt

Treatment	Vine branches	
	Year 2010	Year 2011
6 t/ha SDA	2.81	3.02
3 t/ha SDA	2.76	2.84
4 t/ha PM	3.01	3.98
3 t/ha SDA + 2 t/ha PM	2.85	3.24
3 t/ha SDA + 150 kg/ha NPK	3.23	3.76
3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK	3.21	4.08
300 kg/ha NPK (20:10:10)	3.24	3.62
Control	2.42	2.25
LSD(0.05)	0.968	0.852

Number of leaves per main vine

Number of leaves per primary vine recorded at 8WAP (Table 5) shows significant treatment effect. Application of 300 kg/ha of NPK and 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK gave the highest number of leaves per vine in the first and second cropping years, respectively. In the first cropping year application of 3 t/ha SDA + 150 kg/ha NPK, 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK and 300 kg/ha NPK significantly increased number of leaves per vine by 25, 29 and 33%, respectively, in relation to the control treatment. Although other treatments also showed some variations in the number of leaves on the primary vines, such did not differ significantly compared to the control treatment. More significant differences occurred in the second cropping year where application of 4 t/ha PM, 3 t/ha SDA + 2 t/ha PM, 3 t/ha SDA + 150 kg/ha NPK, 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK and 300 kg/ha NPK significantly increased the number of leaves per vine in relation to the control treatment by 8.15 (34%), 6.6 (29%), 8.16 (34%), 11.27 (48%) and 10.39 (44%), respectively, in 2011.

Table 5. Effects of sawdust ash, poultry manure and NPK (20:10:10) applications on number of leaves per primary vine of fluted pumpkin at 6 WAP in the years 2010 and 2011 at Onne, Port Harcourt

Treatment	Number of leaves per vine	
	Year 2010	Year 2011
6 t/ha SDA	26.65	27.91
3 t/ha SDA	25.96	27.52
4 t/ha PM	27.36	31.81
3 t/ha SDA + 2 t/ha PM	27.08	30.26
3 t/ha SDA + 150 kg/ha NPK	30.78	31.82
3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK	31.65	34.93
300 kg/ha NPK (20:10:10)	32.71	34.05
Control	24.61	23.66
LSD(0.05)	5.570	4.244

Leaf yield

The mean yield of fluted pumpkin leaf (for 2010 and 2011cropping years) as obtained at each harvest period (Table 6) showed that at 8 WAP application of 300 kg/ha of NPK produced a significant high yield of 3.57 kg/plot in relation to the control treatment and applications of 6 t/ha SDA, 3 t/ha SDA, and 3 t/ha SDA + 2 t/ha PM with yield reduction of 35, 37 and 23%, respectively. All other treatments, except the control, were not significantly different from application of 300 kg/ha of NPK. At 11 WAP, application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK produced the highest yield that was only significantly (p=0.05) higher application of 6 t/ha SDA, 3 t/ha SDA, and the control. Application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK sustained the highest yield throughout successive harvest periods. At 14 WAP, application of 4 t/ha PM significantly increased yield over 3 t/ha SDA, 6 t/ha SDA and control. At 17 WAP application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK gave a significant high leaf yield than all the other treatments except 4 t/ha PM and 300 kg/ha NPK. Application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK showed significant superiority over all other treatments from 20 to 23 WAP.

Table 6. Mean yield (kg/plot) of fluted pumpkin leaves as influenced by application of sawdust ash, poultry manure and NPK (20:10:10) at each harvest, in 2010 and 2011

Treatment	8WAP	11WAP	14WAP	17WAP	20WAP	23WAP
T1	2.32	3.24	4.15	6.84	7.32	8.15
T2	2.25	3.14	3.92	6.01	7.00	7.75
T3	2.97	4.74	7.03	8.97	10.72	11.40
T4	2.75	3.66	5.86	8.75	9.63	11.01
T5	2.86	4.25	5.90	9.69	9.37	9.56
T6	3.04	5.10	6.85	11.79	12.64	13.49
T7	3.57	5.83	6.54	9.93	10.51	11.23
T8	2.28	3.33	3.42	4.27	4.49	4.87
LSD (0.05)	0.764	1.695	1.757	1.895	1.752	1.902

T1 = 6 t/ha SDA; T2 = 3 t/ha SDA; T3 = 4 t/ha PM; T4 = 3 t/ha SDA + 2 t/ha PM; T5 = 3 t/ha SDA + 150 kg/ha NPK; T6 = 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK; T7 = 300 kg/ha NPK (20:10:10); T8 Control

The cumulative annual leaf yield for the years 2010 and 2011 stood at 17.09 and 20.26 t/ha respectively, indicating a yield increase of 3.17 t/ha (19%) in 2011. All the treatments, except the control, showed appreciable yield increases in the second year (Table 7). Although the control treatment produced the lowest yield in the first and second years of the experiment, it did not differ significantly from the performances of the two levels of SDA applied in the first year only. Similarly, application of 300 kg/ha NPK gave the highest yield in the first year and was not significantly higher than the yield obtained by application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK. In the second year, application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK gave a leaf yield that was significantly higher than all other treatments and was 94% higher than the control. Similarly, application of 300 kg/ha NPK was higher by 76%, while 4 t/ha PM, 3 t/ha SDA + 2 t/ha PM, and 3 t/ha SDA + 150 kg/ha NPK increased by 4.26, 3.48 and 2.91%, respectively.

Table 7. Effects of sawdust ash, poultry manure and NPK (20:10:10) fertilizer application on cumulative leaf yield (t/ha) of fluted pumpkin in the years 2010 and 2011 at Onne

Treatment	Leaf yield (t/ha) per season	
	Year 2010	Year 2011
6 t/ha SDA	6.92	7.58
3 t/ha SDA	6.56	7.19
4 t/ha PM	8.91	10.44
3 t/ha SDA + 2 t/ha PM	7.85	9.66
3 t/ha SDA + 150 kg/ha NPK	7.65	9.09
3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK	9.04	11.96
300 kg/ha NPK (20:10:10)	9.62	10.85
Control	6.39	6.18
LSD(0.05)	0.594	0.638

Soil chemical properties

Results of soil analysis after two years of soil amendments application are presented in Table 8. With the exception of application of 300 kg/ha of inorganic fertilizer that lowered the pH by 0.06 (1.25%) as compared to the value at the start of the experiments in 2010 (Table 2), pH values appreciated with application of all other treatments between 0.1 and 0.49, representing a range of 2 to 10%. The highest increase was by the application of 4 t/ha of PM followed by 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK with values of 0.45 and 0.44 in relation to the control. Similarly, highest values for OC and N was by application of 4 t/ha of PM followed by 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK. Treatment with 6 t/ha of SDA gave the highest values for P and Mg while K and Ca levels were enhanced by the application of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK and 4 t/ha of PM, respectively, as compared to other treatments.

Table 8. Mean effects of SDA, PM and NPK on soil nutrients status at Onne at the the end of the study in the years 2011

Treatment		%		g/kg		Cmol/kg	
	pH	**OC**	**N**	**P**	**K**	**Ca**	**Mg**
6 t/ha SDA	5.12	1.88	0.10	63.34	0.13	1.67	0.35
3 t/ha SDA	5.10	1.82	0.09	63.19	0.12	1.59	0.31
4 t/ha PM	5.29	2.04	0.15	57.30	0.16	2.52	0.28
3 t/ha SDA + 2 t/ha PM	5.19	1.93	0.13	55.14	0.16	2.32	0.29
3 t/ha SDA + 150 kg/ha NPK	5.18	1.84	0.12	58.14	0.17	2.22	0.31
3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK	5.24	2.02	0.15	56.94	0.15	1.32	0.25
300 kg/ha NPK (20:10:10)	4.74	1.04	0.15	55.21	0.16	1.32	0.28
Control	4.80	0.92	0.09	44.84	0.13	1.12	0.18
LSD(0.05)	ns	0.110	0.036	6.418	0.019	0.316	0.021

DISCUSSION

All external inputs application enhanced vine elongation and number of branches on primary vine at 8 WAP in relation to the control treatment. Although application of different levels of sawdust ash (6 t/ha SDA and 3 t/ha SDA) gave long vines, higher number of branches and leaf yields than the control treatment, their performances were low among the external amendment plots. Poultry manure (PM), another source of organic nutrients gave excellent performance almost comparable to application of NPK, especially later in the seasons. The higher yield performances of plots receiving combinations of SDA and PM relative to plots receiving full doses of SDA alone or the control plots may be attributed to a possible release of their inherent nutrients such as Ca and N into the soil medium (Table1). Appreciable amount of calcium was present in the SDA and PM used in the study. Calcium is a good liming agent for increased pH values of soils while N present in appreciable amount in PM and NPK enhances photosynthesis and thereby contribute significantly to the high foliage yield. Application of 300 kg/ha NPK alone significantly (p=0.05) enhanced leaf yield in the first year of the experiment in relation to other treatments. The primary advantage of inorganic fertilizer usage is that the nutrients are easily available to the plants than the case of organic fertilizers that require longer time for mineralization (Kang and Okeke, 1991). In the second cropping year, yield from plots receiving a combination of 3 t/ha SDA + 2 t/ha PM + 150 kg/ha NPK was significantly (p=0.05) higher than all other treatments. The treatment, a combination of both inorganic fertilizer and organic manures increased the soil pH by 8% in relation to application of 300 kg/ha NPK alone. This action tends to portray that the incorporation of organic manure with inorganic fertilizer would augment soil organic matter content of the soil, raise soil pH and improve the nutrient exchange and water holding capacity of the soil. This finding agrees with observation of Bationo *et al*. (1989) that when manure is used in combination with inorganic fertilizers, particularly nitrogenous fertilizers, it reduces the negative effects of fertilizers particularly acidification by providing organic surfaces. The SDA and PM used in the study contained much organic material that may have produced some levels of mulching, decomposing further to create conducive environment for micro and macro-organisms to survive. Such situation would increase soil macro-pores, improves soil moisture relations, possibly modifies soil temperature and enhance nutrients availability thereby increasing leaf yield.

CONCLUSION

The presence of organic matter (OM) is therefore a good phenomenon for the soil since it is the nutrient store-house of the soil (Weber, 1996). The integration of sawdust ash, poultry manure and inorganic fertilizer (NPK 20:10:10) is a deserving technology that increases the pH and improves the OM and N content of the soil of the zone, which are the major deficiencies for crop production in the zone (IITA, 1994).

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