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ORGANIC MANURING ON FRUITS AND VEGETABLE PRODUCTION AND SOIL PROPERTIES IN LANDMARK UNIVERSITY, OMU-ARAN, SOUTH-WEST NIGERIA

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ABSTRACT

Three experiments were established in the field within Landmark University Teaching and Research Farm during 2013 and 2014 cropping seasons (August – November each year). One experiment tested the response of tomatoes to Urea (at 40 kg/ha rate), NPK (40 kg/ha), Cowdung (5t/ha) and Poultry manure + NPK. The second trial tested the effect of varying levels of poultry manure + NPK. The second trial tested the effect of varying levels of poultry manure on Amaranth Vegetable applied at six levels including Control (0, 2, 4, 8, 10 and 15 tones ha^{-1}). While the third trial investigated the effect of green manure incorporation (4 legumes and control) on soil properties and the performance of *Amaranthus hybridus*. The legumes incorporated were cowpea (*Vigna unguiculata*), Soybean (*Glycine max*), Mucuna (*Mucuna pruriens*) and Groundut (*Arachis hypogaea*). Although all the green manures incorporated increased agronomic traits and yield of amaranthus, mucuna incorporated plots gave the best yield. This trend was also reflected in the slight increase of soil N, P, K, Ca, Mg and CECof green manured plots compared to the control.Tomato performed best under poultry manure application. The difference in tomato agronomic and yield data due to treatments were significant. The value of significance was in the order of poultry manure >NPK>Cowdung> Mixture of Poultry manure + NPK> Urea > Control. In addition to the higher nitrogen content of poultry manure, it was likely that its mineralization process and therefore the release of nutrients coincided with the feeding rate of tomato. Height and girth (studdiness) of amaranthus were significantly improved with poultry manure application. The poultry manure provides macro and micro-nutrients such as Fe, Mg, Cu, B, and Zn and other growth factors not normally supplied by inorganic fertilizers.

Keywords: Green manures, Poultry manure, amaranth, tomato.

INTRODUCTION

Organic manures are materials that come from plant or animal waste or by-product such as poultry manure, cow dung, composted plant materials or other crop residues, sewage sludge, green manures and legume clippings.

Manure from different animals has different qualities and required different application rates when used as fertilizer. Animal manure such as chicken manure and cow dung has been used for centuries as a fertilizer for framing (Bullock and Burton , 1996).

Green manure are usually leguminous crops such as cowpea (*Vigna unguiculata*), soya been (*Glycine max*), mucuna (*Mucuna pruriens*) and groundnut (*Arachis hypogaea*) grown for the express purpose of incorporating them into the top soil to increase the soil fertility and improve the soil physical properties. These green manu-

rial crops are able to fix nitrogen using Rhizobia bacterial in specialized nodules in the roots.

For routine application of manure for crop production, laboratory nutrient analysis should be carried out especially for total nitrogen (N), ammonium NH_4, phosphate (P_2O_5) and potassium (K_2O). When green manure is incorporated directly after application, 45-75% of the total N (Organic-N + Ammonium NH_4) is available in the first year (Rosen and Bierman, 2015). In essence, just adequate amount of manure should be applied so as to avoid excessive vegetative growth of some crops, nitrate leaching, phosphorus runoff and accelerated eutrophication of lakes.

Among many important kinds of vegetable crops, Amarant*h (Amaranthus hybridus*) and tomatoes have significant role in supplying nutritive value to human daily diets with a dual purpose of edible leaves and seeds (Olufolaji and Dimakin, 1988). These crops when cooked without oil contribute about 45 % of vitamin A requirement and vitamin C is present in significant levels.

Most tropical soils are highly weathered and leached resulting from high rainfall and continuous cropping using slash and burn method of land clearing which removes vegetable wastes (Onweremadu *et al.,* 2008). Specifically low crop yield in the savannah zone of West Africa are attributed to nitrogen and phosphorus deficiencies which usually results from depletion of soil N through intensive cropping (Ojeniyi, S.O. 2010). The situation is further worsened with ever increasing population and alternative land use types (Onweremadu *et al.,* 2008). The low fertility status of the soil necessitated the need for external fertilizer input. The use of fertilizer (organic or inorganic) supplement the soil with nutrients especially nitrogen for succulent green leafy growth (Olufolaji and Dimakin, 1988).

Synthetic fertilizers are usually not available and are always expensive for the resource-poor farmers. Thus the need for green manure input as it improves physical, chemical and biological properties of the soil (Linger and Critchdey, 2007). Apart from increasing soil Nitrogen, the soil organic matter is maintained and renewed and the physical and chemical characteristics of soil are improved. The potentials of using legumes crops such as Cowpea (*Vigna unguiculata*), soybean (*Glycine max*), mucuna (*Mucuna pruriens*) and groundnut (*Arachis hypogaea*) as green manures for amaranth (*Amaranthus hybridus*) production has not been fully utilized, researched and worked on, so there is scarcity of research data on it especially in Omu-Aran area of Kwara State, Nigeria. The effect of each green manure on soil properties and crop yields depends upon its chemical composition.

Tomatoes and Amaranth are chosen as test crops due to their nutritional importance in most parts of Nigeria. Therefore, this work studied the comparative effects of different green manure incorporation, poultry manure, urea and NPK application on soil chemical properties and crop yields. Specific objectives of this study are 1. to find out which green manure crop can be effective and suitable in enhancing and improving soil properties and 2. the production of *Amaranthus hybridus* and tomatoes under similar field conditions and to be able to come up with some appropriate manuring practices for recommendations to farmers.

MATERIALS AND METHODS

Study Location

The field experiments were conducted at Landmark University Teaching and Research Farm Omu-Aran, Kwara State, South-West, Nigeria in 2013 and 2014 cropping seasons to test

Tomato and Amaranth production under inorganic fertilizers (Urea and N:P:K – 15:15:15), Poultry manure and green manures; Mucuna (*Mucuna pruriens*), Cowpea (*Vigna unguilata*), Soybean (*Glycine max*), Groundnut (*Arachis hypogea*).

Landmark University lies on Latitude 8.133^0 N and longitude 5.100^0 S with altitude of 506 m above sea level and located in the Derived Savannah of Nigeria, The rainy season is from April to October and the dry season from November to March in an average year. The mean annual rainfall is between 1300 – 1500 mm falling under the Ustic moisture regime. The mean annual temperature varies between 32^0C and 35^0C with average of about 60 % relative humidity and 8 to 10 hours sunshine.

Field Operation

Three experiments were established in the field within Landmark University. One experiment tested the response of tomatoes to Urea (at 40 kg/ha rate), NPK (40 kg/ha), Cowdung (5 t/ha) and Poultry manure + NPK. The second trial tested the effect of varying levels of poultry manure on Amaranth vegetable applied at six levels including Control, (0, 2, 4, 8, 10 and 15 tones ha^{-1}).While the third trial investigated the effect of green manure incorporation (4 legumes and control) on soil properties and the performance of *Amaranthus hybridus.*

All experiments had plot sizes of 4m X 3m with 1.0 m between replicates and 0.5m between treatments. The experiments were arranged in Randomized Complete Block Design (RCBD) in three replicates.

The inorganic fertilizers (Urea and NPK) were applied to tomato seedlings ten days after planting by band placement while the manure application was done two weeks before planting through incorporation into the top soil. Previously grown green manures were harvested, chopped and incorporated into the top soil two weeks before sowing amaranthus. Manual weeding was done regularly to keep the plots clean.

Agronomic data such as plant height, number of branches, number of leaves, stem girth, tap root length were collected at two weeks interval till crop maturity. Yield data such as fresh shoot weight, dry shoot weight, number of fruits, weight of mature fruits were taken. All the data were statistically analyzed using GENSTAT and SAS. The analysis of variance (ANOVA) was performed to find out the significance of variation among treatments. The treatments were compared using the Duncan's Multiple Range Test (DMRT) at 5% level of probability.

Soil Sampling and Analysis

Before the commencement of the experiments in 2013, surface soil samples (0-15 cm depth) were taken randomly from the experimental sites. The samples were bulked, air dried and sieved using a 2 mm sieve and analyzed for particle size, soil organic matter, total N, P, K Ca, Mg and pH. Soil samples (0-15 cm depth) were also collected at the end of the experiments and were subjected to routine physical and chemical analyses. Particle size analysis was done using hydrometer method (Bouyoucos, 1962) while organic matter was determined by the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson and Sommers, 1982). Total N was determined by Micro-Kjeldahl digestion method (Bremner, 1965) and available P was by Bray P – 1 extraction followed by molybdenum blue colorimetry (Bray and Kurtz, 1945) and determine using the spectronic 20 at 882 mm. Exchangeable K, Ca and Mg were extracted by EDTA titration method (Jackson,

1962). Soil pH was determined in 1:2 soils – water ratio using digital electronic pH meter.

RESULT AND DISCUSSION

The Physical and Chemical properties of the surface soil samples (0-15 cm depth) are presented in Table 1 (before treatments) and Table 3

TABLE 1: Physico-chemical characteristic of soil in experimental area before sowing

SOIL PROPERTIES	SITE 1	SITE 2
Sand %	74.4	76.12
Silt %	17.3	12
Clay %	9.3	11.88
Texture class	Sandy loam	Sandy loam
pH H_20	5.79	5.25
Organic Carbon%	1.22	1.88
Organic Matter%	2.11	3.24
Total N%	0.20	0.16
Available P ($mgkg^{-1}$)	41.0	21.12
Calcium (cmol/kg)	1.98	3.97
Potassium (cmol/kg)	0.12	0.23
Magnesium (cmol/kg)	1.4	1.32
Sodium (cmol/kg)	0.41	0.66
EA	1.1	0.07
ECEC	4.95	6.20
BS%	75.50	81.2

TABLE 2: Appropriate nutrient composition of various types of green manure and animal manure (all value is on a fresh weight basic)

Plants	C/N	Source
Mucuna	14.35	Matheus et al., (2013)
Cowpea	16.88	Usman et al., (2013)
Soybean	12.2	Thonninsen et al., (2000)
Groundnut	14.5	Mohammed et al., (2013)

Manure Type	Dry Matter	Ammonium –N	Total –N	P_2O_5	K_2o
	%	<.....gkg-1.....>			
Cow dung	50-52	7-8	20-22	14-20	23-28
Poultry manure	45-75	26-36	33-56	45-48	30-35
Urea	-	-	460	-	-
Mucuna	-	-	17-28	1.0-2.0	14-19
Cowpea	-	-	20-50	16-20	4.0-6.0
Soybean					
Groundnut					

Source: M.A Bell and v. Balasubramamen, 2015.

(after manure incorporation). Comparison with the established critical levels for soils in Southwestern Nigeria, the soil was acidic and low in organic matter (Agboola and Corey 1973, Agbede 1984). Both the total N (>0.15 %) and available P (>10ppm) are considered adequate for crop production (Sobulo and Osiname, 1981). This might be due to previous fertilization programme in the Teaching and Research Farm of the University. However, K, Mg, Ca contents of the soils were of marginal fertility level.

Green Manure incorporation on Soil Properties

Green manure incorporation did not significantly increase soil parameters relative to control but there were slight increases in N, P, K, Ca, Mg and cation exchange capacity (CEC) as presented in Table 3. It was likely that only partial decomposition and mineralization of the incorporated green manures took place during the growth and maturity period of the Amaranthus test Crop.

The incorporation of plant as green manure improved soil organic matter (SOM), N, P, K, Ca, Mg, Na, and ECEC of the soil compared to the control. The increases in SOM and nutrients attributed to green manure affirmed that these nutrients were released into the soil as the plant residues were decomposed. The decomposition of green manures added to the soil improved soil conditions by increasing organic matter, soil organic carbon concentration, humus and polysaccharides as reported by MacRae and Mehuys (1985). In this study, though treatments were not significantly different, Mucuna increased the SOM, organic carbon, N, Ca, Mg, K, ECEC, and available P over the other green manures; this might be attributed to its slow C/N ratio and probably high nutrient content compared with other plants used as green manure (Table 2). It has been reported that *Mucuna pruriens* (velvet bean) increased the availability of phosphorous in soil (Vanlauwe *et al.,* 2000). Higher N in soil treated with Mucuna than with the other green manure crops might also be due to higher N contents which initially decomposed rapidly, resulting in faster mineralization of nitrogen. A positive effect of such green manures has also been reported by Nayyar and Chibba (2000).

Effect of Incorporation of Green Manure on Performance and Yield of *Amaranthus hybridus*

Table 4 revealed that green manure improved plant height, taproot length, fresh shoot and root weight, and dry shoot and root weight compared with the control and this might be attributed to the nutrients released into the soil during decomposition of the green manures, Mucuna increased the performance of amaranthus compared to other green manures. This could be due

Table 3: Effect of incorporation of green manure on soil chemical properties

Trt.	pH H_20	OC%	OM%	Total N%	Cacmol/kg	K cmol/kg	Mg cmol/kg	Na cmol/kg	Al+Hcmol/kg	ECECcmol/kg	Av.P mg/kg
M	5.45	3.69	6.36	0.24	4.56	0.48	2.31	0.79	0.09	8.23	36.32
Co	5.05	3.54	6.11	0.21	3.90	0.44	1.72	0.69	0.10	6.85	29.28
S	5.12	3.59	6.18	0.22	4.29	0.44	2.04	0.76	0.10	7.63	32.40
G	5.40	3.55	6.12	0.24	4.57	0.45	2.11	0.74	0.08	7.95	30.40
Con	5.33	3.53	6.09	0.20	3.68	0.40	1.68	0.63	0.08	6.47	25.18
LSD	ns	Ns	ns	Ns	Ns	Ns	ns	Ns	ns	Ns	Ns

M = MUCUNA, Co=COWPEA, S=SOYBEAN, G = GROUNDNUT, Con=CONTROL, ns= Not Significant, Trt. = TREATMENT

to the higher nutrient content and composition in terms of carbon, phosphorus, nitrogen, and potassium in the Mucuna residue and the soil chemical properties of the mucuna incorporated plots (Table 3) that were involved in plant growth and rapid shoot growth. This observation agrees with Blay *et al.* (2001), who reported that the application of organic fertilizers to the soil supply plant nutrients for increased plant height and more leaves.

On the average, the mean fresh shoot weight of amaranthus on the incorporated plots were significantly (P<0.0.1) higher than the control plot (Table 4). The significant differences in fresh shoot weight of amaranthus in incorporated plots compared to the control might be due to difference in soil chemical properties – the N, P, K, Ca and Mg and presence of micro nutrients in *Mucuna pruriens* green manure provided some advantage (Ewulo *et al.,* 2008).

The tap root length and plant height of amaranthus improved significantly with the application of the green manure (Table 5), which followed the pattern of the changes in the nutrient levels in the soil after treatment application, similar findings were obtained by Agyarko *et al.* (2006)

Poultry Manure versus Other Manures

TABLE 4: Effect of incorporation of green manures on *Amaranthushybridus* performance and yield

TRT	TL (cm)	FSW (kg)	FRW (kg)	PH (cm)	DSW (kg)	DRW (kg)
MUCUNA	18.21^{a}	4924.33^{a}	1334.00^{a}	41.30^{a}	623.63^{a}	187.70^{a}
COWPEA	14.25^{c}	1971.67^{d}	533.00^{d}	25.80^{d}	218.93^{d}	87.27^{d}
SOYBEAN	12.38^{d}	2009.33^{c}	757.33^{c}	35.77^{c}	269.50^{c}	108.80^{c}
GROUDNUT	7.55^{b}	3077.00^{b}	850.67^{b}	29.53^{c}	332.77^{b}	123.23^{b}
CONTROL	10.84^{e}	1361.67^{e}	475.00^{e}	23.60^{e}	187.10^{e}	76.93^{e}
LSD (0.01)	0.49	95.45	13.35	2.11	15.39	8.83

TRT = TREATMENT, TL = TAPROOT LENGTH, FSW = FRESH SHOOT WEIGHT, FRW = FRESH ROOT WEIGHT, PH = PLANT HEIGHT, DSW = DRY SHOOT WEIGHT, DRW = DRY ROOT WEIGHT

In each section means followed by the different letter within columns are significantly different (p<0.01) according to Duncan's Multiple range Test (DMRT)

Table 5: Organic and inorganic manure on tomato production

Treatment	No of Branches	Plant height	No of Leaves	No of Fruits	Weight of mature fruits
Control	16.80^{de}	27.40^{c}	109.73^{d}	1.8^{a}	12.23
Urea	15.60^{e}	25.40^{d}	110.37^{d}	1.6^{a}	16.03
NPK	17.93^{cd}	32.30^{a}	124.10^{b}	1.8^{a}	21.53
Cow dung	19.43^{c}	29.60^{b}	115.46^{c}	1.8^{a}	19.98
Poultry manure	28.83^{a}	32.27^{a}	136.57^{a}	2.3^{a}	35.87
Pm + NPK	23.93^{b}	29.80^{b}	120.53^{bc}	1.8^{a}	28.59

In each section mean followed by different letters with columns are significantly different (P<0.0.1) according to Duncan's Multiple range Test (DMRT)

TABLE 6: Effect of varying poultry rates on growth and yield of amranthushybridus

TREATMENT	PARAMETERS			
	Plant Stand	Plant Height (cm)	Leaf Count	Stem Girth
A	9	5.7	9.0	4.33
B	23.3	26.7	11.0	5.70
C	26.7	32.7	12.33	7.50
D	28.7	35.3	13.33	8.17
E	29.7	37.7	14.7	9.33
F	30.7	41.0	15.33	13.70
LSD	2.95	10.6	1.40	3.22

A = 0 tonne/ha, B=2.0tonnes/ha, C=4.0tonnes/ha, D=8.0tonnes/ha, E=10.0tonnes/ha, F=15.0tonnes/ha.

Table 5 revealed the superiority of poultry manure over the other manures and even inorganic fertilizers in this study. Tomatoes performed best under poultry manure application. The differences in tomato agronomic and yield data due to treatments were significant. The value of significance was in the order of poultry manure>NPK>Cowdung> Mixture of Poultry manure + NPK> Urea > Control. In addition to the higher nitrogen content of poultry manure, it was likely that its mineralization process and therefore the release of nutrients coincided with the feeding rate of tomato.

On the other hand the mineralization of N in cowdung might have been slow, while N-release from Urea might have been too fast for tomato utilization resulting in substantial leaching losses. As a fast growing annual crop, whether or not tomato would derive maximum benefit from urea-N depended on time of application vis-à-vis maximum root development and nutrient absorption.

Table 6 revealed that all poultry rates (from 2 to 10 t/ha) increased the growth and yield of Amaranthus Vegetable crop. Height and girth (studdiness) of amaranthus were significantly improved with poultry manure application. The poultry manure provides macro-nutrients and micro nutrients such as Fe, Mg, Cu, B and Zn and other growth factors not normally supplied by inorganic fertilizers. The organic matter component in the poultry manure decomposes to release and increase soil organic matter, N, P, K, Ca, Mg and plant agronomic traits and yield. This is consistent with the findings of Kingery *et al* (1993) and Adeniyan and Ojeniyi (2005).

CONCLUSION

Organic manures from both plant and animal sources have been found to be a good and viable replacement to chemical fertilizers in the production of tomato and amaranthus in this study. Soil quality was also improved in terms of increased organic matter, N, P, K, Ca, Mg, Na and ECEC. In addition to increased crop growth the manure has added afvantage of improving the soil quality over the use of chemical fertilizers.

Poultry manure was the best animal manure while mucuna incorporated as green manure improved the soil and gave the highest yield of tomato and amaranthus.

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