International Journal of Organic agricultural Research & Development
Volume 19 (2024)

COMPARATIVE EFFECT OF ORGANIC MANURES AND METHODS OF APPLICATION ON YIELD OF MAIZE AND SOIL NUTRIENTS DYNAMICS

BELLO, W.B.
Department of Soil Science Technology, Oyo State College of Agriculture and Technology, Igboora, Oyo State, Nigeria
Corresponding Author: waswarith@gmail.com

ABSTRACT

Field study was conducted on the effect of Organic manures and methods of application on yield of maize and Soil nutrients dynamics during the cropping seasons of 2022 and 2023. Two organic amendments (poultry manure (PM) and compost manure (CM) with two methods of application Surface (S) and Incorporated (I) and no amendment (Co). The treatments thus includes; Co, CI, CS, PI and PS which were arranged in a Randomized Complete Block Design with four replications. Soil nutrient statuses of the site were evaluated before and after cultivation to reveal the nutrients content and yields of maize taken at harvest. Data obtained were subjected to analysis of variance and means separated using Duncan Multiple Range Test. Manure application improved soil fertility status, especially soil organic C, CEC, available P, exchangeable K, Ca, and Mg and increased nutrient uptake and yields of maize. Nutrient of Soils treated with CM gave the highest potential for carbon sequestration and the incorporated had nutrients compared to the surface. The highest grain yield was obtained in the rainy season for CMI, followed by PMI, CMS and PMS, respectively while the control gave the least. Soil nutrient responses after the first cropping, following one time manure application indicated residual effects of manure application. Hence, the study shows that CM >PM and Incorporated application is better than surface method. Therefore, the application of CMI at 5t/ha should be considered for optimum maize production in the region of investigation.

Keywords: Compost incorporated, Soil nutrients, poultry manure surface application, maize yield

INTRODUCTION

Maize, a major source of carbohydrate is used as food, in livestock diet, in the textile industry and also in pharmaceutical industry. Thus, the crop has an immense potential in the tropics and at times can produced up to 7.5t/ha when properly managed. Unfortunately, yields are still generally below 5t/ha (FAO, 2007) and this had cause inadequacy of maize for its numerous purposes. The crop responds well to high soil fertility and maximum yield potentials is possible with high fertility. Hence, adequate soil fertility is one of the requirements for profitable maize production (Davies and Westfall, 2009).

Organic manure helps to improve the physical condition of soil and provide adequate amount of necessary nutrients for soil productivity (Qhureshi, 2007). Also, other workers have reported beneficial effects of organic manure on soil properties such as bulk density; soil moisture content; water–holding capacity and other soil physical properties (Adeleye *et al.,* 2010). Findings have shown that the soil could be sustained with the addition of poultry manure, its application in the soil may contribute to combat soil organic matter decline and soil erosion (Adeleye *et al.,* 2010). The utilization of organic resources in agriculture for maintaining soil fertility and crop yields is increasingly gaining importance among small scale farmers. Such resources within farm include crop residues, green manure, compost and farmyard manure. It is also of note that livestock industry is expanding in Nigeria resulting in the discharge of huge amounts of manures that pollutes the environment (Bello and Adejuyigbe, 2012).

Similarly, Bello *et al. ,* 2019 study confirmed that farmyard manure and their compost are valuable amendments for improving soil fertility for sustaining maize production in the sandy loam soils of Oyo state in the derived savanna zone of south west Nigeria. Although poultry manure application produced higher maize yields, in term of maintaining soil organic C on a long term basis, application of their compost appear more promising. These organic amendments also had residual values in terms of sustainability of soil fertility and maize.

Information is presently insufficient on the alternative use of different manure sources such as poultry and compost as organic manures on the production of Maize in derived savannah, the northern part of Oyo state. Therefore, this study was conducted to determine the comparative effect of Organic manures and methods of application on yield of maize and Soil nutrients dynamics

MATERIALS AND METHODS

Experimental layout and cultural practices

The land was ploughed and harrowed was carried out in June, 2023. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates having plot size 3 x 3 m with treatments: No fertilizer (control), Compost Incorporated application (CM I), Compost surface application (CMS), Poultry manure incorporated (PMI), Poultry manure surface application (PM S) with all manures application rate of 5 t/ha. All the treatments were five with their replication adding up to fifteen plots. The Poultry manure (PM) was the droppings from broilers raised by deep litter system that had been left to decompose for about five months on College farm and deposited outside.

Treatments (compost and poultry manure) were applied on the 1st of July by working them into the soil with hoes by surface and incorporated method while the maize seeds were planted a week after (8th of July,2023) and the NPK was applied two weeks after planting (22nd July, 2023). The maize variety ACR.91 SWAN1.SRCI was planted, at a spacing of 75 cm x 25 cm, and thinned to one plant/stand a week after emergence.

The organic manures were analyzed before for addition and presented in Table 3. Two seeds were planted per hole and thinned two weeks to one given 48 plants per plot with 75 x 25 cm, spacing given about 533 plants / ha. All the manures were applied a week before planting. The plots were weeded manually two times before harvesting (three and seven weeks after planting). Maize was harvested at 14 WAP and was sun-dried to 14 % moisture content. The moisture content was determined with the use of moisture thermometer.

Before the application of the treatments, a soil auger was used to take random soil samples at (0 -30cm) top soil horizon from 10 different location on the experimental site. (Table 2). The soil samples were bulked, air-dried and sieved through 2.0 mm mesh for particle size analyses. The pH was measured in a 1: 2 soil: water ratio and in IM KCL solution. Texture of the soil was determined by the pipette method.

Soil samples were fractionated according to the method described by Vanlauwe et al. , (1998). This method is based on particle size separation after dispersion. Hundred ml of hexametaphosphate $Na_2 CO_3$ solution (35.7 g of sodium hexametaphosphate L^{-1} and 7.9 g of $Na^2CO^3L^{-1}$) and 400ml – distilled water were mixed with 100g of dry soil and shaken for 16hours at 144 rPm. Fractions > 2000-250 um and 53 um were separated by wet- sieving (Octagon 200, Endecotts, London, UK). All the fractions were dried in an oven at 650C for 24 hours.

Olsen-P was measured to determine the plant available phosphorus. The method can be used for a wide range of soil types and pH values. Percentage total nitrogen was measured by the Kjeldahl digestion method. The Amato method was used to measure the percentage total soil carbon (Amato, 1983).

COMPOST PREPARATION

Maize based compost was prepared on farm April, 2023, in pile form of 1.5 m by 1 M size. The pile was made in ratio 3:1 of Animal manure (cow dung, swine faeces and poultry manure mixture) and plant material (maize left over).The temperature was monitored using thermometer to confirm temperature levels and turning was carried when the temperature became constant. The compost was prepared near the experimental site.

Heap method of compost preparation was used and the layers in pile form. A portion of the land was demarcated and measured out with tape rule in a dimension of 1.5 m x1 m x 1 m that is 1.5 m in length, 1m in breadth and 1 m in height.

The measured area was cleared and maize stover waste which were chopped into about 5 cm in size were laid down and followed by the manure, wood ash was then spread all over it to aid mineralization and water was sprinkled to accelerate decomposition. This was then repeated with plant waste as the first layer and other manures were added in an alternative manner until the desire height was reached (1 m). The compost heap was then covered with banana leaves to create a warm medium to increase the activities of microbes. Composting was completed in two and half months of about 75 days.

Measurements and field data collection
Harvesting
The experiment was terminated at the end of 13weeks at physiological maturity and the following yield parameters were evaluated: weight of grain, length of cob, length of grain filled, number of seeds per cob, number of cob per plot, nodes number, cob diameter, root biomass weight, cob +husk weight and dehusk cob weight were recorded.
The maize cob length after and before de-husk was measured using meter rule, covering all the length of grain filled on cob and the length were noted. The diameter was determined using micrometer screw gauge on the center of the maize grains on the cob. This was applicable to all samples in each treatment. The maize was then shelled. This was done manually and after shelling, it was counted to determine the number per cob for every sample in each treatment. The length of grain filled was measured from the base to the brim of the cob for areas covered by grains.

RESULTS AND DISCUSSION
The nutrient status of the soil was below the critical levels for N, P and K with slight acidity and sandy loam textural class (Table 1). Result from Table 2, revealed the chemical properties of the manures (Compost and poultry manure), the result showed that compost manure is richer than poultry manure and this may definitely influence the result of the experiment. Compost manure should be expected to provide the soil and plant with higher quantity of nutrients especially N, than poultry manure treatments.
All the yield parameters considered were significantly ($P > 0.05$) influenced by the treatments (Table 3). Highest grain yield (3. 3t/ha) were recorded from application CI followed by CS (3.08t/ha), PMI (2.83t/ha) and PMS (2.75t/ha), while the lowest yield of (2.13t/ha) were recorded from the control. The highest yield from CI plots may be due to the better response of compost incorporated manure compared with the poultry manure surface application. It also shows that CI >CS and PMI > PMS, Compost had higher advantage over poultry manure while nutrient incorporation method is better than the surface application. Similar pattern of observation were shown by cob yield t/ha and number of seeds per cob.
Also, maximum weight of cob (1.43kg) was recorded from CI treatment while the minimum weight of cob (1.07kg) was recorded from the control. Similarly, maximum number of cob (10.67) was recorded with CI while the minimum number of cob (10.00) was recorded with control and PMS. The composts (CI and CS) gave better cob dry weight compared with the poultry manures (PMI and PMS) with similar quantities. Maximum length of grain filled cob (11.90cm) was recorded with CI followed by CS and PMI with same value (10.93cm) while minimum length of grain filled cob (10.73 cm) was recorded with control.
From table 4, all the soil characters evaluated after the cropping were significant ($P > 0.05$) with treatments considered. The highest organic –carbon (1.49%) were recorded from CI treatment while the lowest OC (0.081%) was recorded with control. Maximum total N% (0.22%) were recorded with CI followed by PMI and CS with equal amount (0.21%) followed by PMS (0.16%), while minimum TN % (0.11%) with control. Also, from table 4, significant ($P > 0.05$) treatment effects were obtain on C/N, P, Ca, Mg and K content after maize cropping in 2022 and 2023 cropping season. The result from other characters considered from table 4 followed similar trend when compared with observation from both manures (CM and PM) and application methods (I and S) respectively. For all the yield and nutrients characters examined, the highest value of response was obtained from plots treated with CM followed by PM while control gave the least.
From the result compost is expected to provide the soil and plant with higher quantity of N compared with PM treatments, because it contains higher N than PM. The observed performance of compost is similar to the findings of Achieng *et al. ,* (2010) who reported that farmyard manure prepared by improve method (using mixtures of manures, lime and covered with banana and black sheet was better in terms of maturity and quality (nutrient composition) when compared to using each manure separately. The potentials of maize manure mixtures confirmed the results of Bello and Adejuyigbe, 2012 who investigated the combination effect of Cow-dung, poultry manure, and swine manure on soil chemical properties of tomato and maize yields.

The authors found the positive responses of the crops compared with their respective sole application.

The response of CM manure over PM application may be due to variation in the nutrient contents. Result also indicated that the nutrient incorporation is better than surface method of application.

Thus, the order of response by the treatments is CI >CS> PMI > PMS ascertained the findings of Bello and Salami, (2018) who concluded that the richer the organic manure, the better the response. Similarly, the findings imply that both sources of manures (farm yard and crop residues) had significant influence on the performance of pepper (*Capsicum annum*).

The positive response of soil and maize to manure application in this study was consistent with previous reports in other tropical regions (Yamato *et al.,* 2006).

The result clearly indicated that the application of manure by incorporated method performed remarkably better than the surface application method. This observed result ascertain the findings of Oke *et al. , (*2012), in their work on the response of organo-mineral fertilizer grade A, organo-mineral fertilizer grade B and NPK 15-15-15 with buried method of application irrespective of the rate in maize growth and yield parameters were better than surface method of application than either at full dose or half dose. They then suggested that buried method might minimize soil erosion and leaching of nutrients.

CONCLUSION

Findings from this study confirmed that poultry manure and their compost are valuable amendments for improving soil fertility for sustaining maize production in the sandy loam soils of Oyo state in the he derived savanna zone of south west Nigeria. Although poultry manure application produced higher maize yields, in term of maintaining soil organic C on a long term basis, application of their compost appear more promising. Also, the incorporation of manures gave a better yield compared to the use of surface application. These organic amendments also had residual values in terms of sustainability of soil fertility and maize. Hence, the application of compost or poultry manure at 5t/ha using incorporation method is therefore recommended.

ACKNOWLEDGEMENT

The author will like to thank the TETFUND for sponsored the project through the Institutional Base Research (IBR) as well as the College Management for allowing me to use the Institution Research project site.

REFERENCES

Achieng, J.O. ; Ouma, G.; Odhiambo, G.and Muyekho, F. (2010). Effect of farmyard manure and inorganic fertilizers on Maize production on Alfisols and Ultisols in Kakamega, Western Kenya. *Agriculture and Biology Journal of North America* 430 – 439.

Adeleye, E.O. and Ayeni, L.S. (2010). Effect of cocoa pod ash and poultry manure combinations on soil and plant nutrient contents and performance of maize screen house experiment. *The Researcher*, 2: 75 – 80

Amato, O. (1983). Determination of Carbon 12c and 14c in plant and Soil. *Soil Biology and Biochemistry* 5, 611-612.

Bello, W.B. and Adejuyigbe, C.O. (2012). Effect of mixed manure Compost and farmyard manures on growth and yield of maize. *International Journal of Organic Agriculture Research and Developmen*t(IJOARD). 6 pp. 82-89

Bello, W. B; Fawole, T.O.; Kareem, I.; Salami, T.B.; and Akanni, S.O. (2019). Response of NPK, farm yard manures and crop residues on growth, yield and yield components of pepper (Capsicum annum). *Nigerian Journal of horticultural society of Nigeria*. Vol. 24(2). Pp 90-95.

Bello, W.B. and Salami, T.B. (2018).Effect of poultry manure and kitchen wastes on soil, plant nutrient dynamics and performance of tomato. The proceedings of the 14th National Conference of Organic Agriculture Project in Tertiary Institutions in Nigeria (OAPTIN), scheduled to take place from 25th to 29th November, 2018, at Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

Davies, J.G. and D.G. Westfall, (2009) Fertilizing Corn, Soil. Crop series no. 0.538. FAO.(2007). Food and Agriculture Organization year book: volume 60

Oke, O. O., **Bello, W. B**. and Adeoye, G.O. (2012). Effect of Mineral and Organo Mineral fertilizer under different methods of application on Maize (Zea mays L.) production. *Journal of Environtropica* Special issue 8 pp.11-21.

Qhureshi, Z. (2007). Breeding Investigation in Bhendi Abelmoschus esculentus (L.) Moench). Master Thesis, University of Agriculture Sciences, GKVK, Bangalore.

Vanlauwe, B. Diels, J. , Sanyinga, N. And Metrax, R. (1998). Residue Quality and Decomposition. An Unsteady Relationship,? In Driven by Nature : Plant litter Quality and Decomposition . Aeds. G. Cadish and K.Giller, CAB International , Wallingford, U.K, 157 166

Yamato,M., Okimori, Y. , Wibowo, I. F. , Anshiori, S. and Ogawa, M. (2006). Effects of application of charred bark of Acacia mangium on the yield of maize, cowpea and peanut, and soil chemical properties in South Sumatra, Indonesia. Soil science. Plant Nutrition, 52: 489- 495.

Table 1: Physico-chemical properties of soil used for the experiment

Element	Value
pH (H_20) 1:2	6.30
Total Organic C (%)	0.90
Total Nitrogen (%)	0.09
C/N ratio	10
Available P (mg kg^{-1})	3.53
Exchangeable base ($cmolkg^{-1}$)	
Ca (cmol/kg)	5.34
Mg (cmol/kg)	1.20
K (cmol/kg)	0.30
Na (cmol/kg)	0.37
Exchangeable Acidity ($cmolkg^{-1}$)	
H^+	0.4
(ECEC)	7.33
Mn (mg/kg)	69.70
Fe	10.05
Cu (mg/kg)	0.60
Zn (mg/kg)	6. 90
Particle Size	
Sand(%)	91.20
Silt (%)	4.60
Clay (%)	4.20
Textural class	Sandy loam

Table 2: Chemical properties of organic materials used for experiment 1

Nutrient element (Units)	Compost	Poultry manure
Total N (%)	2.65	1.67
Available P (g/kg)	0.24	0.35
K (g/kg)	0.05	0.07
Ca (g/kg)	0.06	0.07
Na (g/kg)	0.03	0.05
Mg (g/kg)	0.32	0.34
pH	8.29	9.32
Temperature°(C)	27.2	27.1

Table 3: Effect of different methods of compost and poultry manure application on maize yield

Treatment	Husk with Wt.cob (kg)	Weight of cob (kg)	Number of cob	Cob dry weight	Cob length (cm)	Length of grain filled cob (cm)	Percentage grain filled (%)	Cob diameter (cm)	Number of Seed per cob	Cob yield t/ha	Grain yield t/ha
Control	3.07i	1.07h	10.00a	0.46f	11.63f	10.70e	92.13ab	3.52g	256.30h	2.68h	2.13h
CI	4.50c	1.43c	10.67e	0.62de	13.10e	11.90d	90.81ab	4.07cde	430.00e	3.58e	3.33e
CS	4.17f	1.37ef	10.34a	0.62de	12.07f	10.93de	90.62ab	4.13cd	402.00e	3.43ef	3.08ef
PMI	4.00fg	1.23fg	10.33a	0.59e	11.90f	10.93de	91.89ab	3.93def	362.00f	3.08fg	2.83f
PMS	3.83g	1.20gh	10.00a	0.53ef	11.83f	10.83e	91.49ab	4.82a	327.31fg	300gh	2.75fg

Where: CO = control, NP K = NPK 15:15:15 fertilizer, CI = Compost Incorporated method, CS = Compost surface application, PMI = Poultry manure Incorporated method. PMS = Poultry manure surface application
Means with the same letters in the column are not significantly different at 5%

Table 4: Chemical properties of s oil after maize cropping in 2022 and 2023 cropping season as influenced by different manures incorporation methods

Treatment	pH (H_20)	Organic - carbon (%)	Total N%	C/N Ratio	P (mgkg-1)	Exchangeable cations Ca	Mg	K
						(CmolKg-1)		
CO	5.45c	0.81d	0.11g	7.19d	7.63c	0.10b	0.10c	0.77c
PMS	6.15ab	1.24abc	0.16	8.43c	17.23bc	0.20ab	0.20abc	1.20abc
CS	6.21ab	1.36ab	0.21b	8.06c	23.63ab	0.30a	0.27ab	1.27ab
PMI	6.17ab	1.29abc	0.21c	7.96c	21.20abc	0.27a	0.30a	1.23ab
CI	6.79a	1.49a	0.22a	10.12a	31.93a	0.23a	0.30a	1.47a

Where: CO = control, NP K = NPK 15:15:15 fertilizer, CI = Compost Incorporated method, CS = Compost surface application, PMI = Poultry manure Incorporated method. PMS = Poultry manure surface application
Means with the same letters in the column are not significantly different at 5%