INFLUENCE OF SOME ANIMAL MANURES ON GROWTH AND YIELD OF MAIZE (*Zea mays* L.) UNDER A HUMID ULTISOLS ENVIRONMENT

LAW-OGBOMO, K.E[+]., OSAIGBOVO, A.U AND KADIRI, I.H.
Department of Crop Science, Faculty of Agriculture, University of Benin,
PMB 1154, Benin City, Nigeria
[+]Corresponding author's e-mail: edomwonyi.law-ogbomo@uniben.edu

Abstract

Maize crop is a key source of food and livelihood for millions of people in many countries of the world. However, its productivity is highly constrained in the humid ultisols environment owing to low soil fertility status among other factors. This experiment was conducted at the Experimental Farm, Faculty of Agriculture, University of Benin, Benin City, Nigeria between the period of May and August, 2014 and repeated during the period in 2015 to evaluate the effect of different animal manures on the growth and yield of maize (*Zea mays* L.). The trial involved five treatments (control, rabbit manure, goat manure, poultry manure and cattle manure) laid out in randomized complete block design and replicated three times. All manures were applied at 300 kg N ha^{-1}.Data were collected on plant height, stem girth, number of leaves, leaf area index and total dry matter at 50 % tasseling day. Data were also collected on yield and yield components of maize. Results showed The application of animal manures significantly ($P<0.5$) increase plant height, leaf area index, number of leaves, total dry matter, ear length and grain yield Over control. The highest ear yield (11.61 t ha^{-1}) and grain yield (5.77 t ha^{-1}) was observed in plots treated with rabbit manure compared to the lowest ear and grain yields (7.05 and 3.66 t ha^{-1} respectively) from control. However, rabbit manure treated plants were not significantly superior to other manures. It is suggested that poultry manure adopted by maize growers for high productivity of maize under intense and continuous cropping of humid ultisols location due to ease of availability, collection and high nutrient composition.

Keywords: Dry weight, grain yield, leaf area index, nitrogen application rate, plant height.

Introduction

Maize (*Zea mays* L.) is cultivated worldwide and represents a staple food for a significant proportion of the world's population (International Food Biotechnology Council, 1990). Maize crop is a key source of food and livelihood for millions of people in many countries of the world. It is produced extensively in Nigeria where it is consumed roasted, baked, fried, pounded or fermented (Agbato, 2003). In the developed countries, it is an important source of many industrial products such as popcorn, sugars, corn oil, corn flour, starch, syrup, brewer's grit, and alcohol (Dutt, 2005). Corn oil is used in salad, soap making and lubrication. Maize is a major component of livestock feed and it is highly palatable to poultry, cattle and pigs as it supplies them energy (Iken *et al.,* 2001).

Maize has potential in the tropics and yield up to 7.5 t ha^{-1} can be obtained if the crop is properly managed. Unfortunately, yield is still generally below 5 t ha^{-1} and this had cause inadequacy of maize for its numerous usages. This low maize productivity is caused by low nutrient status of the soil among other constrains occasioned by such factors as erosion, crop harvesting and prevailing environmental conditions. This constraint can be resolved through the use of external fertilizer input to amend and raised the soil fertility status. Most farmers use chemical fertilizer because it gives quick response and nutrient is readily available to crops. However, due to the high cost and scarcity of chemical fertilizers, most farmers cannot afford the use as it is often associated with soil acidity and nutrient imbalance among other factors under intensive cultivation (Ojeniyi, 2000). Organic fertilizer is relatively cheap, readily available and environmentally friendly and can be used as an alternative to chemical fertilizer to maintain sustainable crop yield and soil fertility. Its application has been shown to sustain crop yield, improve nutrient recycling and enhance crop productivity (Belay *et.al*; 2001*;* El-Shakweer *et al*., 1998). Organic fertilizer safeguards the health of the soil and the seed. Published works on the animal manure use in Nigeria is rather scanty. The need to use renewable forms of energy and reduce costs of conventional fertilizer input method in crop production has revived the use of organic fertilizers worldwide. Improvement of environmental conditions and public health are important reasons for advocating increased use of organic materials (Seifritz, 1992). Hence the essence of this study was to investigate the effect of animal manures on the growth and yield of maize in the humid ultisols location.

Materials and Methods

This experiment was conducted between May and August, 2014 and repeated during the period in 2015 at the Experimental Farm of the Faculty of Agriculture, University of Benin, Benin City (06^0 20' 50" N, 05^0 37' 23" E 162 masl), Edo State, Nigeria. The location lies between latitude 6^0 14' N and 7^0 34' N and longitude 5^0 40' E and 6^0 43'E with altitude range of 500 m above sea level. The maize "Oba 98" variety used was an open pollinated, streak resistant (hybrid seed) obtained from ADP (Agricultural Development Programme) Benin City. Cattle, Rabbit, Poultry, Goat manures were obtained from the animal farm unit of the Experimental Farm, Faculty of Agriculture University of Benin. The field experiment was laid out in randomized complete block design involving five treatments (poultry manure, cattle manure, goat manure, rabbit manure and control) and replicated three times. Animal manures were cured for eight weeks after which composite samples were collected from each manure type for analysis. Field was prepared and organic fertilizer was applied at 300 kg N ha^{-1} to designated ridges at four weeks before sowing for equilibration. Composite soil sample was collected from top soil on different locations of the site depth (0 – 15 cm) before cropping with maize for physical and chemical analysis using standard laboratory procedures (Mylaravapus and kennelley, 2002).

The field was cleared of existing vegetation manually with hoes and cutlasses and field layout followed by land preparation and ridge making. Maize was sowed on April 24 each at a spacing of 75 x 25 cm and three seed were sown per hole. Resupplying of missing stands was done one week after sowing (WAS). Thinning was done at two WAS and weeding subsequently as at when due. Harvesting was done when maize ear were fully matured, turned brown and dry, it was done manually. Five plants were randomly tagged from the quadrant of 1.5 m^2 inside net plot in each of the trials for measurement of various parameters which include, plant height; stem girth, number of leaves, leaf area index and total dry matter at 50 % tasseling day. Also, data collected on yield included ear weight, ear yield, cob weight, cob yield, grain yield, shelling percentage (%) and 1000- grain weight. Plant height (cm) was measured using a meter rule from the base to the last leaf before the tassel. Stem girth (cm) was taken at 5 cm above ground level on each tasseled plant by the use of a venire caliper and then averaged to obtain mean value per plant per plot. Leaf area (cm^2) was obtained by measuring the length and width of the sampled leaves using a meter rule calibrated in cm and multiplied with a factor of 0.75 and the number of leaves to obtain the leaf area of plant. (Remison 1997). The number of leaves was done by the counting of fully expanded leaves of all sampled plants and the average computed. From the leaf area, the leaf area index (LAI) was computed as

LAI =

Table 1: Physical and chemical properties of the experimental site prior to cropping with maize

Parameter	Value	Fertility class*
Sand	872.60	N/A
Silt	17.60	N?A
Clay	109.80	N/A
Textural class	Sandy loam	N/A
pH	5.38	N/A
Organic carbon (g kg^{-1})	11.97	
Organic matter (g kg^{-1})	20.64	20.00
Total Nitrogen (g kg^{-1})	0.90	1.50
Available phosphorus (mg kg^{-1})	11.88	12.00
Exchangeable cations (cmol kg^{-1})		
Calcium	0.72	1.50
Magnesium	0.12	0.28
Potassium	0.76	0.16
Sodium	0.69	0.20
Al^{3+}	0.36	N/A
H^{2+}	0.24	N/A
Effective cation exchange capacity	2.93	10.00
Cation exchangeable capacity	2.33	N/A

*Ibude *et al* (1988)

Table 2: Chemical properties of animal manures applied before cropping with maize

Parameter	Animal manures			
	Cattle	Goat	Rabbit	Poultry
pH	6.00	6.50	5.60	7.70
Organic carbon (%)	38.00	21.00	20.00	26.20
Total Nitrogen (%)	2.30	1.37	1.30	3.00
Phosphorus (%)	0.84	0.84	2.18	1.28
Magnesium (%)	0.54	0.48	1.88	1.06
Potassium (%)	0.38	0.30	0.28	0.68

There were significantly ($P<0.05$) more leaves observed for the manure treated plants compared to control. The number of leaves varied from 7 – 10 leaves for control plants and manure treated plants, respectively. Except for the rabbit manure, there were significant differences observed for LAI values of manure treated plants compared to control. Nonetheless, highest LAI (3.09) were observed in plants treated with poultry manure. The dry weight ranged from 68.90 – 144.40 g plant^{-1} for control and rabbit manure, respectively. All treated plants were not significantly different among themselves.

Maize yield and its components as influenced by animal manure application

The fertilizer application had positive significant influence on ear weight (Table 4). Only the rabbit manure (217.30 g) and poultry manure (204.30 g) treated plants had ear weights that were significantly heavier than control. Although the heaviest ears were observed in rabbit manure plants. Nonetheless, they were not significantly different from those observed in poultry manure.

Table 3: Growth of maize as influenced by different animal manures

Animal manure	Plant height (cm)	Stem girth (cm)	No. of leaves	Leaf area index	Dry weight (g plant^{-1})
Control	46.40	4.53	7	1.66	68.90
Rabbit manure	69.10	4.91	10	2.45	144.40
Goat manure	69.40	4.99	10	2.72	126.70
Poultry manure	77.20	5.27	10	3.05	140.60
Cattle manure	68.80	5.10	10	2.86	134.90
$LSD_{C0.05)}$	4.530	0.619	1.9	0.853	51.010

The ear yield ranged from 7.05 and 11.61 t ha^{-1} for control and rabbit manure, respectively. The distribution trend exhibited by ear weight was also repeated for ear yield. The significantly heaviest cob (205.30 g) was observed on plants treated with rabbit manure and the lightest cob (121.50 g) was observed on untreated control. However, cobs observed on plants treated with goat (161.00 g) and cattle (136.00 g) manures were not significantly heavier than control. Cob yield was least with control (6.47 t ha^{-1}) and highest with rabbit manure (10.96 t ha^{-1}). Poultry manure (7.97 t ha^{-1}) and cattle manure (7.26 t ha^{-1}) were not significantly difference from control (6.47 t ha^{-1}). Cattle manure had the highest shelling percentage (62.30 %) and was only significantly different from control (47.00 %). There was not significant difference among treatments in 1000-grain weight. There was significant effect of manure application on grain yield where the grain yield was highest (5.77 t ha^{-1}) in rabbit manure but not higher than poultry (5.52 t ha^{-1}), goat (5.57 t ha^{-1}) and cattle (5.13 t ha^{-1}) manures. The least grain yield of 3.60 t ha^{-1} was observed on plants without manure treatment. There was positive correlation between stem girth and plant height ($r = 0.974$) at 50 % tasseling (Table 5). The number of leaves at 50 % tasseling was positively correlated with plant height ($r = 0.706$) and stem girth ($r = 0.645$) at 50 % tasseling (Table 5). The result of the correlation matrix indicated that LAI is significantly correlated with plant height, stem girth and number of leaves (0.852, 0.807 and 0.864, respectively) at 50 % tasseling (Table 5).

Table 4: Yield and yield components of maize as influenced by different animal manures

Animal manure	Ear weight (g)	Ear yield (t ha-1)	Cob weight (g)	Cob yield (t ha^{-1})	Shelling (%)	1000-grain weight (g)	Grain yield (t ha^{-1})
Control	132.00	7.05	121.30	6.47	47.00	316.90	3.66
Rabbit manure	217.30	11.61	205.30	10.96	61.70	359.60	5.77
Goat manure	162.00	8.63	161.00	8.57	61.70	366.90	5.57
Poultry manure	204.30	10.9	149.70	7.97	58.70	370.30	5.52
Cattle manure	186.90	9.95	136.00	7.26	62.30	355.80	5.13
$LSD_{C0.05)}$	55.620	2.978	37.370	2.001	10.170	ns	0.964

ns - not significant at 0.05 level of probability

Results of the correlation matrix indicated that dry weight was correlated with plant height; stem girth, number of leaves and LAI (0.673, 0.645, 0.753 and 0.697, respectively) at 50 % tasseling (Table 5). There was a positive correlation between LAI and 50 % tasseling day (r = 0.525) (Table 5). Ear weight was positively correlated with number of leaves, LAI and dry weight at 50 % tasseling day with values of 0.607, 0.475 and 0.640, respectively (Table 5). The result of the correlation matrix indicated that ear yield was significantly correlated with number of leaves, LAI, total dry matter and ear weight (0.473, 0.605, 0.639 and 1.000, respectively) (Table 5).There were positive correlations of cob weight with number of leaves, dry weight and ear yield (r = 0.554, 0.570 and 0.653, respectively) (Table 5). The result of correlation matrix indicated that cob yield was significantly correlated with number of leaves, dry weight, ear weight, ear yield and cob weight (0.554, 0.569, 0.655, 0.654 and 1.000, respectively) (Table 5). Grain yield was positively correlated with all the dependent variables (Table 5).

Discussion

Low maize productivity in Nigeria is attributable to low native soil fertility, very low plant density, complex intercropping practices and poor yielding varieties. The experimental site had low fertility status, exhibiting deficiencies in some plant essential nutrients. This observation confirmed the report of Akanbi and Togun (2002) that stated most of our agricultural soils are impoverished due to weathering, leaching and intensive cultivation. The resultant effect of this is poor yield, reasonable crop yield cannot be achieved except through the use of soil amendments. There is need to augment the soil nutrient with fertilizer input in the form of environmental friendly organic manures. The chemical composition of the organic manure used showed that they contain nutrients that can be used by crops. The high organic carbon content of the animal manures is an indication of abundant organic matter which plays an important role as reservoir of soil nutrients, buffer the soil reaction, binding the soil particles to form good soil tilth and stimulating the activity of soil organisms (Asgharipour, 2012). All these enhance and sustain the fertility of soil for good crop production.

The relatively low yield performance of the control plants compare to manure treated plants may be related to insufficient nutrient uptake as the plants had to rely on the native fertility of the soil which has been shown in this study to be deficient in total N, available P exchangeable Ca and exchangeable Mg. The significant grain yield increase obtained by the application of fertilizer clearly demonstrated the benefit of the application of the soil with rabbit, goat, poultry or

Table 5: Correlation matrix of different dependent variables of maize

	Cob yield	Ear yield	LAI	Number of Leaves	Plant height	Stem girth	Total dry matter	Cob weight	Ear weight	Grain yield
Cob yield	1.000									
Ear yield	0.654*	1.000								
Leaf area index	0.285	0.473*	1.000							
Number of leaves	0..554*	0.605*	0.864*	1.000						
Plant height	0.301	0.318	0.852*	0.706*	1.000					
stem girth	0.171	0.351	0.807*	0.645*	0.947*	1.000				
Dry weight	0.569*	0.639*	0.697*	0.753*	0.673*	0.645*	1.000			
Cob weight	1.000*	0.653*	0.286	0.554*	0.303	0.173	0.570*	1.000		
Ear weight	0.653*	1.000*	0.475*	0.607*	0.319	0.352	0.640*	0.652*	1.000	
Grain yield	0.602*	0.514*	0.686*	0.664*	0.698*	0.643*	0.598*	0.604*	0.515*	1.000

LAI - Leaf area index

cattle manure. Fertilizer application enhanced plant height, stem girth, number of leaves, grain yield, leaf area index, dry weight. This confirmed the role of organic fertilizer in promoting vigorous vegetative growth and yield (Tisdale and Nelson, 1990). Increase in plant height was most effective and noticeable in plants treated with poultry manure due probably to adequacy of N (Sa-nguansak, 2004). The shorter plants response in untreated plots could be probably be related to insufficient N uptake as the plant had to rely on the native fertility of soil which was shown to be deficient in total N. This finding indicated that plant height is sensitive to adequate nutrient supply (Sharma, 1997). Plant height is an important growth character linked to the yield potential of a plant (Saeed *et al.,* 2001). At 50 % tasseling day, only poultry manure treated plants had the thicker stem compared to untreated plants. This observation is in agreement with previous report of Ayoola and Adeniran (2006) that variation in nutrients source among treatments will result in a significant variation on stem girth per plant.

Increase in the number of leaves per plant occasioned by fertilizer application is bound to affect the plant growth and vigour positively. This is because leaves are the major organs of photosynthesis on plants. Number of leaves had strong and positive correlation with LAI (r = 0.864) and grain yield (r = 0.664). This association infers that higher number of leaves will resulted in higher LAI. Higher LAI signify greater leaf production rates, leaf area expansion and leaf area duration and could signify the relative amount of light intercept by plant. Increase in the number of leaves was a precursor to greater amount of assimilates and this allowing more translocation to the grain as there was a significant correlation between number of leaves and LAI. This was in harmony with the outcomes previously reported by Linehan (1995), Kodama *et al.* (1988). The LAI of any plant is a measure of the capacity of the photosynthetic system of translocation. The increase in LAI resulting from fertilizer application led to higher dry weight accumulation.

Fertilizer application influenced ear weight positively. The heaviest ears were observed in rabbit treated plants. However, they were not significantly different from those observed in poultry manure. The distribution trend exhibited by ear weight was reflected in ear yield. The obtained results are in harmony with those reported by Tara *et al.* (1996) who found that the addition of different organic fertilizers to the soil caused remarkable improvement in the different growth characters and yield of peppermint.

Conclusion and Recommendation

The study showed that the yield of maize can be increased with animal manure application to ensure food sustainability. The different manure types at equal applied rates provided equivalent amount of nutrients to plants. Based on ease of availability, collection and nutrient composition and nutrient composition, poultry manure is thereby suggested for maize growers for higher yield per hectare in the humid ultisols environment.

Reference

Agbato, S.O. (2003), *Principles and Practices of Crop Production.* Odumatt Press Publishers, Oyo, pp 57 - 62.

Akanbi, W.B. and Togun, A.O (2002). The influence of maize Stover compost and nitrogen fertilizer on growth, yield and nutrient uptake of Amaranth. *Scientia Horticulturae,* 93: 1 -9

Ayoola, O.T. and Adeniyan, O.N. (2006). Influence of poultry on yield and yield components of crops under different cropping systems in South west Nigeria. *African Journal of Biotechnology,* 5: 1386-1392.

Asgharipour, M.R. (2012). Effects of vermicompost produced from municipal solid waste on the growth and yield of Bobgol (*Plantago ovate* Forsk) and *Cuminum cyminum*. *Journal of Medicinal Plant Research*. 6 (9): 1612–1618.

Belay, A., Classens A.S., Wehner, F.C. and DE Beer, J.M. (2001). Influence of residual manure on selected nutrient elements and microbial composition of soil under long-term crop rotation. *South African Journal of Plant and Soil*, 18: 1-6

Dutt, S. (2005). *A handbook of Agriculture*, ABD Publishers, India, pp. 116 - 118

El-Shakweer M.H.A., El-sayad E.A. and Ewees, M.S. (1998). Soil and plant analysis as a guide for interpretation of the improvement of efficiency of organic conditioners added to different soils in Egypt. *Communication Soil Science and Plant Analysis.* 29:2067- 2088.

Ibedu, M.A., Unambra, R.P.A. and Udealor, A. (1988). Soil management strategies in relation to farming system development in the south eastern agricultural zone of Nigeria. Paper presented at the National Farming system Research Workshop, Jos, Plateau State, Nigeria. pp. 26-29.

Iken , J.E., Anusa, A. and Obaloju, V.O. (2001) Nutrients composition and weight of some newly developed maize varieties in Nigeria, *Journal of Food Technology,* 7: 25-28.

International Food Biotechnology Council (1990). Biotechnologies and food: Assuring the safety of foods produced by genetic modification. *Regulatory Toxicology and Pharmacology* 12: S1-S196.

Kodama, H., Schnitzer, M., Murad, E. (1988). An investigation of iron (III)-fulvic acids complexes by Mo Sbauer spectroscopy and chemical methods. *Soil Science Society of America Journal*, 52: 994-998.

Linehan, D.J., (1985). Organic matter and trace elements,. In: Vaughan D, Malcolm RE (eds) soil organic matter and biological activity. Nijhoff Junk. The Hague, pp: 403 -421

Mylaravarapus, R.S. and Kennelley, D.E. (2002). UF/IFAS extension soil testing laboratory (ESTL): Analytical procedures and training manual. Institute of Food and Agricultural Science, University of Florida, Gainsville, USA. 28 p.

Ojeniyi, S.O. (2000). Effect of goat manure on soil nutrient and okra yield in a rain forest area of Nigeria. *Applied Tropical Agriculture,* 5: 20-23.

Remison, S. U. (1997). *Basic Principles of Crop Physiology.* Sadoh Press (Nig.), Benin City. 197P.

Sa-nguansak, D.A (2004). Effect of nitrogen fertilizer on nitrogen assimilation and seed quality of Amaranth (*Amaranthus* spp.) and Quinoa (*Chenopodium quinoa* Wild). Dissertation for the Degree of Doctor of Agricultural Science, University of Gottingen. 135 p.

Saeed, I.M., Abbasi, R. and Kazim, M. (2001). Response of maize (*Zea mays*) to nitrogen and phosphorus fertilization under agro-climatic condition of Rawalokol, Azad Jammu and Kaslim and Kashmir, *Pakistan Journal of Biological Science*, 4: 949-952.

Seifritz, W. (1982). Alternative and renewable sources of energy in optimizing yield: The role of fertilizers in proceedings of 12^{th} IPI Congress. 1982: 153-163.

Sharma, A.R. and Mittra, B.N. (1991). Effect of different rates of application of organic and nitrogen fertilizers in a rice-based cropping system. *Journal of Agricultural Science,* 117: 313-318

Tara, A., Brien, O. and Allen, V.B. (1996). Growth of peppermint in compost. *Journal of Herbs, Spices and Medicinal Plants*, 4: 19-27

Tisdale, S.L. and Nelson, W.L. (1990). Soil fertility and effect of magnesium sources on the yield and chemical composition of crops. *Michigan Agricultural Experimental Station Bulletin*, 19: 29-31.