Nigerian Journal of Soil Science

Journal homepage:www.soilsjournalnigeria.com

EFFECT OF NPK AND POULTRY MANURE ON COWPEA AND SOIL NUTRIENT COMPOSITION

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ABSTRACT

Field experiment was conducted at University of Agriculture, Makurdi in the Southern Guinea Savanna ecology of Nigeria to test effect of NPK fertilizer and Poultry manure on performance of cowpea and soil nutrient composition. The study conducted in 2008 and 2009 had a control, NPK 20 – 10 – 10 (48 $kgha^{-1}$) and poultry manure (PM) with or without NPK fertilizer. The test soil was deficient in N and P. The PM, NPK and their combinations increased plant height, number of branches, leaves, dry matter yield (DMY), number of peduncles, pods, seeds and seed yield. The effect on plant height, DMY, number of pods and grain yield was significant. The 4 t ha^{-1} PM and 4 t ha^{-1} PM + NPK gave highest and similar seed yield. The PM alone or with NPK increased soil pH, N, P, K, Ca, Mg, CEC and O.M. The parameters increased with level of PM. Addition of NPK to PM increased soil N, P, K, Ca, ECEC, OM while NPK reduced pH. Application of PM at 4 t ha^{-1} is recommended.

INTRODUCTION

Cowpea is a tropical food grain legume for human and livestock. However, low soil fertility limits its yield. Although, the crop fixes nitrogen in symbiotic relationship with rhizobium bacteria, it suffers from temporary N deficiency during seedling growth once the cotyledon reserve is exhausted. Hence starter dose of N fertilizer is recommended to enhance early growth of cowpea plant (Dart *et al.,*1997). Also application of P is known to stimulate performance and grain yield of cowpea (Kolawole *et al.,* 2003). Because of problems associated with total dependence on inorganic or organic fertilizer alone (Adeniyan and Ojeniyi, 2003, 2005) the concept of integrated nutrient supply i.e combined use of inorganic and organic fertilizer is advocated to enable sustainable crop production (Ojeniyi, *et al., 2003*).

Integrated nutrient management ensures balanced nutrient supply, control of acidity, extended residual effect and improvement on soil physical conditions compared with use of inorganic fertilizer alone. Unlike its application in maize and vegetable production (Adeniyan and Ojeniyi, 2003, 2005; Adeoye, *et al., 2008;* Ayeni, *et al., 2009, 2010*; Ewulo, *et al., 2009*; Ojeniyi *et al., 2009a, 2009b*) studies are scarce on combined application of the two types of fertilizer in cowpea production.

Also, because of the old impression that cowpea can tolerate low soil fertility being a N-fixer, attention has not been given to enhancing performance of the crop using organic manure. The need to improve yield of cowpea in peri-urban soils of southeast Nigeria has been met by application of inorganic fertilizers which worsened acidic problem of soil. Organic fertilizers have so far served as a formidable alternative. Nnabude, *et al., (2006*) found that compost at 4t ha^{-1} gave highest cowpea grain yield, showing that compost was beneficial to cowpea. In cowpea production organic fertilizer has proved to be effective in combating nematodes without the usual side effects of nematicides. Abubakar and Majeed (2000) obtained greater than 50% reduction in nematode population with poultry droppings.

This study was therefore designed to evaluate the effect of poultry manure and its combined use with NPK fertilizer on soil nutrients composition, growth and yield components of cowpea in Makurdi in the humid savanna ecology of Nigeria.

MATERIALS AND METHODS.

Field Experiment:

The study based on NPK 20-10-10 fertilizer and poultry manure (PM) in the 2008 and 2009 cropping seasons was conducted at the University of Agriculture, Makurdi (7^0 41^0N, 8^0 35^0E) in the southern Guinea Savanna agro ecological zone of Nigeria. The soil is classified as typical Ustropept.

The experiments were laid out in a Completely Randomized Block Design with three replications. The plot size was 4m x 3m. The six treatments were as follow:

T_1- No poultry manure, No NPK 20-10-10 (control)

T_2- 48kg ha^{-1} NPK20-10-10

T_3- 2t ha^{-1} poultry manure

T_4- 2t ha^{-1} poultry manure with 48kgha^{-1} NPK 20-10-10

T_5- 4t ha^{-1} poultry manure

T_6- 4t ha^{-1} poultry manure with 48kgha^{-1} NPK 20-10-10

Sites were cleared manually using cutlass and later ridged with hoe. Poultry manure (PM) and the NPK 20-10-10 combined with poultry manure were uniformly spread on the top of the ridge and incorporated with hoe 2 weeks before planting. Planting was done in August for the two years at a spacing of 0.50m plant to plant with two seedlings per stand after thinning. Plots were weeded manually at frequency they required. Plant data collected included plant height, number of branches, number of leaves, nodule production and dry matter yield all taken at 50% to flowering. At pod maturity, yield components including peduncles per plant and number of pods per plant, number of seeds per pods were taken.

Soil sampling and Analysis.

Before planting in 2008, surface (0-15cm) soil samples were collected from 8 points and bulked. The soil sample and the poultry manure were analyzed. Post cropping composite soil sample was collected per plot at the end of the second cropping year. The soil samples and the poultry manure sample were air dried, crushed and allowed to pass through 2mm sieve. Particle size distribution was carried out by Hydrometer method, while soil pH was measured with the glass electrode pH meter in soil solution ratio 1: 2 in 0.01M $CaCl_2$. Soil organic carbon (OC) was determined by the Walkey Black method and the total N by the micro-Kjeldahl digestion method (Bremner and Mulraney, 1982) after digestion of samples with concentrated H_2S0_4. Availabile P was determined by Bray and Kurtz (1995) extraction method.

Exchangeable cations were extracted using NH_4OAc solution, K and Na were read using flame photometer, while Ca and Mg were determined on the atomic absorption spectrophotometer. Effective cation exchange capacity (ECEC) was established as the summation of the exchangeable cations (K, Na, Ca, and Mg).

Data Analysis

The statistical analysis was performed using SPSS statistical package for the analysis of variance (ANOVA). Means were separated using fisher's least significant difference F.L.S.D at 5% level of probability when F ratio was significant

RESULT AND DISCUSSION

Table 1 shows properties of the soil used for the experiment. The soil is sandy loam and very low in N and available P, their values were below critical values. It is expected that the test soil and cowpea would benefit from added fertilizers since the N and P limit cowpea performance.

The NPK fertilizer at 48kg ha^{-1}, PM and their combinations increased growth parameters of cowpea such as plant height, number of branches, leaves and dry matter yield (DMY) in 2008 (Table 2) and 2009 (Table 3). The effect on plant height and DMY was significant. The number of nodules was significantly reduced relative to control. Rhodes (1981) and Ofori (1973), also observed that nodulation in cowpea was inhibited by application of N fertilizer. Graham and Scott (1984) reported that N fertilizer at more than 30 kg ha^{-1} inhibited nodulation. Eriksen and Whitney (1984) reported that application of N at flowering promoted vegetative dry weight but reduced nodule dry weight. It is implied that enhanced growth of cowpea associated with application of NPK and PM was due to improved and direct availability of nutrients from the fertilizers rather than N from nodulations. Effect of treatments on plant height and DMY was significant. In both years the 4t ha^{-1} PM + NPK increased plant height and DMY significantly. Also, the growth parameters increased between 2 and 4 tha^{-1} PM indicating that nutrients release from PM had direct influence on growth of cowpea. Also, PM should have had nematicidal effect on cowpea (Nnabude, *et al., 2006),* Abubakar and Majeed, 2000.

In 2008 and 2009, the PM, NPK and their combinations increased number of penduncles, pods, seeds, seed weight and seed yield per plant. The effect on number of pods and grain was significant in both years. In 2008, the 4t ha^{-1} PM and 4t ha^{-1} PM + NPK increased grain yield equally and significantly, in 2009, 2t ha^{-1} PM, + NPK, 4t ha^{-1} PM and 4t ha^{-1} NPK increased grain yield significantly. They gave similar values. In both years, 4t ha^{-1} PM and 4tha^{-1}+ NPK had the highest and similar grain yield. The yield components increased between 2 and 4t ha^{-1} PM indicating that nutrients released from PM increased cowpea performance.

Table 6 indicates that PM alone, or with NPK fertilizer increased soil pH, N, P, K, Ca, Mg, CEC and OM compared to control or NPK alone. The parameters increased with increased in PM from 2 to 4t ha^{-1}. Thus it is ascertained that PM is a liming material in addition to being a source of the nutrients. Similar observations were made by other Workers. (Adeniyan and Ojeniyi, 2003; Ewulo, *et al., 2008*). The NPK reduced soil pH and slightly increased N and P, thus it is acid producing unlike the PM. It is observed that addition of NPK to PM tended to increase soil N, P, K, Ca, Mg, CEC and OM. This could be due to enhanced release and mineralisation of nutrients from native and added OM due to synergistic effect of the NPK on OM, (Adeniyan and Ojeniyi, 2005). Therefore nutrients released to the soil from NPK and PM led to enhanced growth and yield of cowpea. Some studies reported that application of N and P enhanced yield in Cowpea. (Kolawole *et al., 2005*) and other legumes. Also the increased OM should have had nematicidal effect on cowpea.. This effect should have obliterated effect of NPK on yield.

In conclusion there was no significant effect of addition of NPK added to PM on performance of cowpea. Hence, application of PM at 4t ha^{-1} is recommended for cowpea. Relative to control, 2t ha^{-1} + NPK, 4t ha^{-1} and 4t ha^{-1} + NPK increased mean grain yield (for 2008 and 2009) by 20, 24 and 27% respectively.

Table 1: Soil physical and chemical properties before planting.

Properties	Values
pH (H_20)	6.20
pH ($CaCl_2$)	5.90
% Sand	75.60
% silt	17.20
% Clay	7.20
Textural class	Sand loam
Nitrogen (g $100g^{-1}$)	0.09
Phosphorus ($mgkg^{-1}$	4.60
Potassium ($cmolkg^{-1}$)	0.22
Calcium ($cmolkg^{-1}$)	3.44
Magnesium ($cmolkg^{-1}$)	2.48
Sodium ($cmolkg^{-1}$)	0.31
ECEC ($cmolkg^{-1}$)	6.48
Organic Carbon (g $100g^{-1}$)	1.25
Organic matter (g $100g^{-1}$)	1.45

Table 2: Effects of poultry manure and NPK 20-10-10 on growth parameters of cowpea at 50% flowering stage in 2008

Treatments	Plant height (cm)	Branches/Plant (No.)	Leaves/Plant (No.)	Nodules/Plant (No.)	Dry matter ($gplant^{-1}$)
Control	12.18	4.80	28.50	14.50	26.80
NPK 48 Kg/ha	18.27	5.20	30.20	6.40	32.60
2t/ha PM	15.20	5.10	29.00	10.80	30.90
2t/ha PM+NPK	19.25	5.20	31.50	8.60	34.20
4t/ha PM	17.80	5.40	31.40	12.50	32.80
4t/ha PM+NPK	23.50	6.01	33.40	11.30	38.90
Mean	17.70	5.25	30.67	10.68	32.70
F-LSD (0.05)	9.45	NS	NS	5.92	9.68

Table 3: Effects of poultry manure and NPK 20-10-10 on growth parameters of cowpea at 50% flowering stage in 2009

Treatments	Plant height (cm)	Branches/Plant (No.)	Leaves/Plant (No.)	Nodules/Plant (No.)	Dry matter ($gplant^{-1}$)
Control	13.40	6.10	27.4	21.80	25.50
NPK 48 Kg/ha	23.80	8.20	32.50	10.30	38.50
2t/ha PM	20.40	8.20	28.50	15.50	37.50
2t/ha PM+NPK	26.50	9.40	34.90	14.80	42.80
4t/ha PM	23.50	9.70	35.20	17.50	40.20
4t/ha PM+NPK	38.60	9.80	36.60	17.20	46.70
Mean	24.32	8.57	32.52	16.18	31.50
F-LSD (0.05)	15.20	NS	NS	9.25	18.75

Table 4: Effects of poultry manure and NPK 20-10-10 on growth parameters of grain yield of cowpea at 50% flowering stage in 2008

Treatments	Peduncle Plant (No.)	Pods/Plant	Seeds/Pods (No.)	100 Seeds (g)	Grain Yield (tha^{-1})
Control	12.20	17.90	8.10	17.30	1.10
NPK 48 Kg/ha	12.80	19.50	9.40	22.40	1.18
2t/ha PM	13.20	19.20	9.60	20.50	1.22
2t/ha PM+NPK	15.20	22.80	11.20	26.10	1.28
4t/ha PM	16.80	20.60	11.00	24.50	1.32
4t/ha PM+NPK	17.50	24.50	11.60	25.80	1.31
Mean	14.67	20.75	8.48	22.76	1.23
F-LSD (0.05)	NS	5.60	NS	6.20	0.20

Table 5: Effects of poultry manure and NPK 20-10-10 on yield parameters of grain yield of cowpea at 50% flowering stage in 2009

Treatments	Peduncle Plant (No.)	Pods/Plant	Seeds/Pods (No.)	100 Seeds (g)	Grain Yield (tha^{-1})
Control	12.60	17.80	8.00	16.80	1.05
NPK 48 Kg/ha	13.10	20.10	9.50	23.50	1.20
2t/ha PM	14.20	19.20	10.10	22.10	1.26
2t/ha PM+NPK	16.50	23.50	11.20	27.60	1.32
4t/ha PM	17.20	21.50	11.40	26.70	1.35
4t/ha PM+NPK	18.20	24.84	11.80	28.50	1.42
Mean	15.30	21.15	10.33	24.20	1.27
F-LSD (0.05)	NS	5.98	NS	NS	0.22

Table 6: Effects of poultry manure and NPK 20-10-10 fertilizer on chemical properties of Soil after two seasons of cultivation

Soil Properties	Contol	NPK 84 t/ha	2t/ha PM+NPK	2t/ha PM	4t/ha PM	4t/ha PM+NPK
pH ($CaCl_2$)	5.90	5.45	6.36	6.48	6.40	6.50
Nitrogen (g $100g^{-1}$) (N)	0.12	0.15	0.16	0.19	0.18	0.22
Phosphorus ($Mgkg^{-1}$) (P)	4.40	4.60	4.80	5.10	5.70	5.80
Potassium ($cmol/kg^{-1}$) (K)	0.20	0.18	0.18	0.40	0.43	0.45
Calcium ($cmol/kg^{-1}$) (Ca)	3.65	3.55	3.62	4.40	4.40	4.51
Magnesium ($cmol/kg^{-1}$) (Mg)	2.50	2.61	2.65	3.02	3.02	3.02
Sodium ($cmol/kg^{-1}$) (Na)	0.35	0.33	0.45	0.75	0.82	0.82
ECEC ($cmol/kg^{-1}$)	7.25	7.55	7.60	8.85	9.90	10.85
Organic Carbon (g $100g^{-1}$)	1.35	1.38	1.50	1.55	1.60	1.62
Organic Matter (g $100g^{-1}$)	1.48	1.52	1.63	1.72	1.85	1.88

REFERENCES

Abubakar, U and Majeed, Q. (2000). Use of animal manure for the control of root-knot nematodes of cowpea. *Journal of Agriculture and Environment* 1: 23-33

Adeniyan, O.N and Ojeniyi, S.O. (2005). Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. *Nigerian Journal of Soil Science*. 15: Pp 34-41

Adeniyan, O.N and Ojeniyi, S.O. (2003). Comparative effectiveness of different levels of poultry manure with NPK fertilizer on residual soil fertility, nutrient uptake and yield of maize. *Moor Journal of Agricultural Research* 4(2). 191-197.

Adeoye, G.O., Adeoluwa, O.O., Oyekunle, M. Shridhar, M.K.C., Makinde, E.A. and Olowoake, A.P. (2008). Comparative evaluation of Organomineral fertilizer

(OMF) and mineral fertilizer on yield and quality of maize. *Nigerian Journal of soil science.* 18:132-137.

Ayeni, L.S., Adetunji, M.T and Ojeniyi, S.O. (2009). Integrated Application of NPK fertilizer Cocoa pod ash and poultry manure: Effect on maize performance plant and soil nutrient content. *International Journal of Pure and Applied Sciences* 2(2):34-41.

Ayeni, L.S., Omole, T., Adeleye, E.O. and Ojeniyi, S.O. (2010). Integrated application of poultry and NPK fertilizer on performance of Tomato in Derived Savanna Transition zone of Southwest Nigeria. *Science and Nature* 8(2):50-54.

Bray, R.H and L.T. Kurtz (1995). Determination of Total Organic and available forms of phosphorus in soils. *Soil Science*. 59:39-45.

Bremner, J.M and Mulvaney, C.S. (1982). *Nitrogen Total In: Methods of Soil Analysis* 2nd ed. A.L. Page *et al.,* (Eds) Pp. 595-624 ASA, SSSA Medison Winsconsin.

Dart, P.J., Day, R.A., Islam and J. Dobereiner. (1997). Some Effects of Temperature and Composition of the rooting medium in symbiotic nitrogen fixation in plants synthesis In: *Tropical Grain Legume,* Nutman, R.S (Ed.) Cambridge Univ. Press. Pp 361-383.

Ericksen, F.I. and A. Whitney. (1984). Effects of solar radiation requirements on growth and nitrogen fixation of soybean, cowpea and bush bean. *Agron. J.*, 76: 529-534.

Ewulo, B.S., Babadele, O.O. and Ojeniyi, S.O. (2009). Sawdust Ash and Urea Effect on soil and plant nutrient content and yield of Tomato. *American-Eurasian Journal of Sustainable Agriculture* 3 (1) 88-92.

Graham, A and R. Scott (1984). Response of cowpea (*Vigna unguiculata* (L) Walp) to nitrogen and inoculation. *Trinidad Trop. Agric*. 6:56-58.

Kolawole, G.O., G. Tian and B.B Singh (2003). Differential Response of cowpea lines to application of phosphorus fertilizer. In: *Challenges and opportunities of enhancing sustainable cowpea production*. Fatokun, O.A., S.A. Tarawali, B.B. Singh, P.M. Karmawa and M. Tama (Eds.) International Institute for Tropical Agriculture (IITA), Ibadan pp:319-328.

Nnabude, P.C., Obi, C.O. and Onuoha, E. (2006). Tillage and Kitchen wastes on peri-urban soil properties and vegetable cowpea (*Vigna unguiculata* (L) Walp) production in Southeastern Nigeria. *Nigerian Journal of Soil Science*. 16:140-144

Ofori, C.S. (1973). The Importance of fertilizer Nitrogen in Grain Legume production soils of gigantic origin in the upper region of Ghana. In: *Proceedings of first IITA grain legume improvement workshop*. pp: 155-161.

Ojeniyi, S.O., Owolabi, O., Akinola, O.M and Odedina, S.A. (2009a). Field study of effect of organomineral fertilizer on maize growth yield soil and plant nutrient composition in Ilesa, Southwest Nigeria. *Nigerian Journal of Soil Science.* 19(1):11-16.

Ojeniyi, S.O., Makinde, E.A., Odedina, S.A and Odedina, S.N. (2009b). Effect of organic organomineral and NPK fertilizer on Nutritional Quality of Amaranthus in Lagos Nigeria. *Nigerian Journal of Soil Science* 19(2): 129-134.

Rhodes, E.R. (1981). The economic of fertilizing cowpea (*Vigna unguiculata* (L) Walp) with basic slag on an oxisol in Njala and the effect of the fertilizer on leaf lamina N, P, Zn contents and nodulation. *Trop. Grain Legume Bull*. 22: 6-10