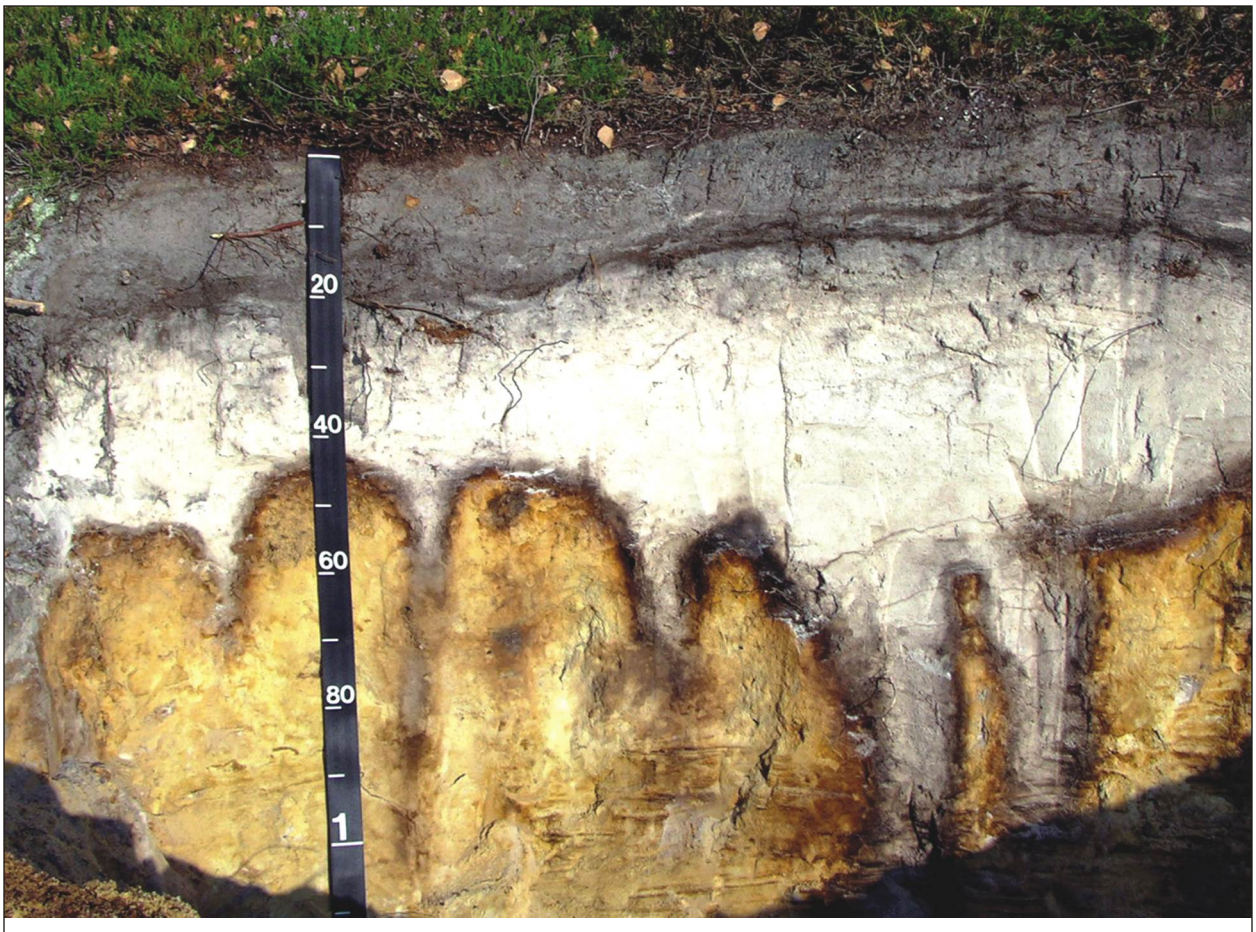

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Effect of Goat Dung and NPK Fertilizer on Soil and Leaf Nutrient Content, Growth and Yield of Pepper

M.A. Awodun, L.I. Omonijo and S.O. Ojeniyi
Department of Crop, Soil and Pest Management, Federal University of Technology, P.M.B. 704, Akure, Nigeria

Abstract: This study investigated effect of goat manure treatments and NPK fertilizer on soil nutrient, content leaf nutrient, content growth and yield components of pepper (*Capsicum annum*) grown at Akure soil in the rainforest zone of Nigeria. The treatments applied to soil and replicated three times were 0. 2.5, 5.0, 7.5, 10.0 t ha^{-1} goat manure and 250 kg ha^{-1} NPK 15-15-15 fertilizer. The trial was conducted twice. Chemical analysis of goat manure used was done in addition to initial soil analysis. The soil was slightly acidic and marginal in organic matter (OM) and available P. The goat manure was relatively high in organic matter, N and P compared with K, Ca and Mg. Goat manure treatments increased soil …. N, P, K, Ca, Mg and pH and leaf N, P, K, Ca and Mg of pepper. Growth and yield parameters such as number of leaves and branches, plant height, stem girth, number and weight of fruits were significantly ($p>0.05$) increased by goat manure treatments. However NPK fertilizer increased soil N, P and K status leaf N status and growth and yield parameters compared with manure treatments. Relative to control, 2.5, 5.0, 7.5 and 10.0 t ha^{-1} goat manure and NPK fertilizer increased number of fruits by 36, 82, 108, 141 and 195%, respectively. The increases in fruit weight were 6, 18, 39, 65 and 111%. The 10.0 t ha^{-1} manure is recommended.

Key words: Goat dung, biofertilizers, organic matter, acidic, number of fruits and fruit weight

INTRODUCTION

Sustainable crop production demands the use of fertilizers because of loss of soil fertility. However the use of chemical fertilizers has declined drastically in sub-sahara Africa and other tropical countries. For example about 70% of farmers engaged in dry season vegetable farming in Sokoto state of Nigeria have no access to chemical fertilizers due to their high cost and scarcity. Also although farmers know that fertilizers are important for maximizing crop yield, they are still reluctant to use these fertilizers for vegetables (Olasantan, 1994). Hence for the planting of pepper at household levels, the use of chicken droppings, cow dungs, wood ash and other plant residues is adopted particularly in Southeastern Nigeria (Ogbalu, 1999).

Irrespective of the enormous manure production in livestock farming and processing, very little of available manure is utilized in crop production. Kunbi *et al*. (1992) ciyed by Macrere *et al*. (2001) in Tanzania had observed that only one percent of farmers in Tanzania apply animal manures and this was attributed to lack of scientific basis for advising farmers on application rates. Also most studies on utilization of animal manure largely focused on crop yield with very little effort to relate the yield to availability of nutrients in soil and plant. It is also observed that research is scarce on response of pepper (*Capsicum annum*) to different types of anima manure. In Nigeria the use if goat manure has received research attention, whereas in many Asian countries notably Pakistan, India and Bangladesh,

Corresponding Author: M.A. Awodun, Department of Crop, Soil and Pest Management, Federal University of Technology, P.M.B. 704, Akure, Nigeria

goat manure fetches good price. In Rwanda, goat manure composts are prepared (Drechsel and Beck, 1998). Odiete *et al*. (1999) and Ojeniyi and Adegboyeaga (2003) had found that goat manure significantly improved growth and yield of okra, amaranthus, celosia and maize in southwest Nigeria. In southeast Nigeria, Samuel *et al*. (2003) found that goat manure increased soil pH, N and yield of plantain. In vies of these observations and the need to promote utilization of goat manure for vegetable production, this work investigated effect of different rates of goat dung (manure) and NPK fertilizer on soil and leaf nutrient concentration, growth and fruit yield of pepper in southwest Nigeria. Opara-Nadi *et al*. (1987) had observed that further studies were required to evaluate comparative effects of organic manures and inorganic fertilizers under field conditions and different agroecological zones.

MATERIALS AND METHODS

Field Trials

Field trials were conducted at Akure (7°5'N, 5°10'E) in rainforest zone of southwest Nigeria in 2003 and 2004 between July and October. Different sites were used and the land was initially manually cleared. Six treatments applied on soil to transplanted pepper plants were the control (no manure, no fertilizer), 2.5, 5.0, 7.5, 10.0 t ha^{-1} goat manure and NPK 15-15-15 fertilizer at 250 kg ha^{-1}. The treatments were replicated three times using a randomized complete block design.

Pepper seedlings (6 weeks old) were transplanted at 60 x 60 cm, each of the 8 plots being 8 m^2, given 24 plants per plot. Air-dried ground goat manure and NPK fertilizers were applied separately by ring method to each plant two weeks after transplanting. Eight plants were selected per plot for determination of number of leaves, branches, plant height and stem girth 10 weeks after treatment application. As from 11 weeks after treatment application, number and weight of fruits were taken at 5 days interval and accumulated.

Soil Analysis

Surface (0-15 cm) soil samples were collected over each site before commencement of trials. Also samples were collected in treatment plots 16 weeks after treatment application in 2003 and 2004 (i.e., after field experiment). Samples were air-dries and passed through 2 mm sieve. Particle size analysis was done using hydrometer method, soil Organic Matter (OM) was determined by wet dichromate oxidation method, total N by micro-kjeldahl approach and available P by molybdenum blue colorimetry after Bravay-1 extraction. Exchangeable calions were extracted with ammonium acetate; K was determined on flame photometer and Ca and Mg by EDTA titration. Soil pH in 1:1 soil-water suspension was determined (Tel and Hagarty, 1984).

Leaf and Goat Dung Analysis

At 10 weeks after treatment application, leaf samples were collected, oven-dried at 700°C for 24 h and milled. Nitrogen was determined using micro-kjeldahl method. Samples were dry ashed using nitric-perchloric-sulphuric acid mixture for determination of P, K Ca and Mg. Phosphorus was determined using vanadolmolbdate colormetry, K by flame photometer and Ca and Mg by EDTA titration (Tel and Hagarty, 1984). Samples of air-dried goat dung used was analysed as for leaf.

Statistical Analysis

Data on soil and leaf analysis, growth and fruit yield were subjected to analysis of variance and means were compared using the Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Table 1 presents initial soil analysis data for sites 1 and 2 and goat manure used for the experiment. The sandy loam soils were low in Organic Matter (OM), available P, marginal in

exchangeable K, adequate in total N, exchangeable Ca and Mg and slightly acidic (Akinrinde and Obigbesan, 2000). The goat dung was quite high in OM and had more N than K, Ca and Mg. The low OM and available P and acidic nature of soils is expected to benefit from application of goat dung.

Application of GD at 2.5, 5.0, 7.5, 10.0 t ha^{-1} and NPK fertilizer increased soil OM, N, P, K, Ca and MG content compared with the control (Table 2 and 3). The increases were significant as from 2.5 or 5.0 t ha^{-1} dung as the case may be and the effect of the fertilizer was also significant ($p>0.05$). The increases in soil nutrients due to GD application is consistent with the OM and nutrients content of the dung as shown in Table 1. The GD decomposed to release organic matter, N, P, K, Ca and Mg. Hence soil OM, N, P, K, Ca and Mg tended to increase with level of GD. The increased availability of cations in soil can be related to increases in soil pH recorded for GD treatments (Table 1). Earlier studies by Ojeniyi *et al.* (1999) Smith and Ayenigbara (2001), Akinola and Ojeniyi (2000), showed that GD improved N, P, K, Ca and Mg statics of soil. Olayinka (1990) indicated that organic manures have limiting effect and that poultry manure would be beneficial to plants on acidic soil. Increased availability of Ca and Mg and pH associated with NPK fertilizer could be due to improved soil OM contents, the latter being due to improved microbial activity associated with improved nutrient (NPK) availability (Olayinka, 1990).

Goat dung and NPK fertilizer increased leaf N, P, K, Ca and Mg content of pepper in 2003 (Table 4) and 2004 (Table 5). Leaf nutrient content tended to increase with level of GD. Thus as in case of soil nutrient content, the 10:0 t ha^{-1} GD have highest values of leaf N, P, K, Ca and Mg among the GD treatments. The GD on leaf nutrient content was significant ($p>0.05$) depending on nutrient.

Compared with GD treatment, NPK fertilizer gave higher N and K content in 2003 and 2004 and higher leaf P content in 2003.

Table 1: Analysis of soils at experimental sites and goat manure

	Site soil		
Property	1	2	Goat manure
OM (%)	2.30	2.40	69.2
Total N (%)	0.30	0.32	4.9
P (mg kg^{-1})	7.10	7.00	4.1%
K (cmol kg^{-1})	0.21	0.13	1.9% (total)
Ca (cmol kg^{-1})	1.60	1.40	1.0% (total)
Mg (cmol kg^{-1})	1.30	1.10	0.9% (total)
pH	6.60	6.50	-
Sand	66.50	70.20	-
Silt	14.30	13.40	-
Clay	19.20	16.40	-

Table 2: Effect of goat manure and NPK fertilizer on soil nutrient composition (First trial)

Treatments	SOM (%)	N (%)	P mg kg^{-1}	K cmol kg^{-1}	Ca cmol kg^{-1}	Mg cmol kg^{-1}	pH
0	2.3	3.00	7.1	0.21	1.60	1.30	6/52
2.5 t ha^{-1} cm	3.5	3.50	7.5	0.21	2.40	2.10	6.58
5.0 t ha^{-1} cm	3.5	3.60	8.3	0.24	2.80	2.60	6.70
7.5 t ha^{-1} cm	4.0	3.90	9.2	0.31	3.00	2.90	6.80
10.0 t ha^{-1} cm	4.2	4.20	10.6	0.33	3.20	3.80	7.20
250 ha^{-1} NPK	4.2	4.30	10.8	0.36	3.10	3.60	7.20
LSD (0.05)	0.6	0.04	1.1	0.04	0.18	0.49	NS

GM = Goat Manure

Table 3: Effect of goat manure and NPK fertilizer on soil nutrient composition (Second trial)

Treatments	SOM %	N %	P mg kg^{-1}	K cmol kg^{-1}	Ca cmol kg^{-1}	Mg cmol kg^{-1}	pH
0 t ha^{-1} GM	2.40	0.32	7.00	0.13	1.40	1.10	6.50
2.5 t ha^{-1}	3.40	3.30	7.50	0.18	2.20	2.00	6.63
6.0 t ha^{-1}	3.40	3.70	7.30	0.28	2.80	2.40	6.73
7.6 t ha^{-1}	3.70	3.90	8.00	0.30	2.80	2.60	6.90
11.0 t ha^{-1}	4.00	4.00	8.80	0.33	3.10	3.40	7.23
250 ha^{-1} NPK	4.20	4.10	9.60	0.36	3.00	3.20	7.30
LSD (0.05)	0.36	0.18	0.27	0.06	0.31	0.58	0.04

GM = Goat Manure

Table 4: Effect of goat manure and NPK fertilizer on leaf nutrient content of *Capsicum annuum* (First trial)

Treatments	N %	P %	K %	Ca %	Mg %
0 t ha^{-1} GM	2.30	0.02	0.17	0.40	0.09
2.5 t ha^{-1}	2.40	0.03	0.19	0.42	0.12
7.0 t ha^{-1}	2.90	0.04	0.23	0.43	0.11
7.7 t ha^{-1}	3.20	0.07	0.25	0.45	0.14
12.0 t ha^{-1}	3.40	0.09	0.26	0.45	0.15
250 ha^{-1} NPK	3.60	0.12	0.27	0.44	0.13
LSD (0.05)	0.22	0.02	0.06	0.03	0.04

GM = Goat Manure

Table 5: Effect of goat manure and NPK fertilizer on leaf nutrient content of *Capsicum annuum* (Second trial)

Treatments	N %	P %	K %	Ca %	Mg %
0 t ha^{-1} GM	2.5	0.23	0.13	0.42	0.10
2.5 t ha^{-1}	2.6	0.24	0.14	0.44	0.11
8.0 t ha^{-1}	2.8	0.29	0.16	0.47	0.12
7.8 t ha^{-1}	3.0	0.35	0.27	0.48	0.13
13.0 t ha^{-1}	3.2	0.38	0.29	0.49	0.14
250 ha^{-1} NPK	3.8	0.36	0.30	0.49	0.13
LSD (0.05)	0.18	0.12	0.03	0.02	0.01

GM = Goat Manure

Table 6: Effect of goat manure and NPK fertilizer on growth parameter of *C. annuum* (First trial)

Treatments	No. of leaves	No. of branches	Plant height (cm)	Stem girth (cm)
0 t ha^{-1} GM	150	4.0	34.3	2.4
2.5 t ha^{-1}	195	5.4	34.6	2.6
9.0 t ha^{-1}	230	6.0	34.9	3.2
7.9 t ha^{-1}	280	8.2	56.0	3.3
14.0 t ha^{-1}	299	10.5	63.0	3.5
250 ha^{-1} NPK	315	12.0	70.0	3.6
LSD (0.05)	71	3.1	3.4	0.6

GM = Goat Manure

Table 7: Effect of goat manure and NPK fertilizer on growth parameter of *C. annuum* (Second trial)

Treatments	No. of leaves	No. of branches	Plant height (cm)	Stem girth (cm)
0 t ha^{-1} GM	30	4.80	44.1	2.30
2.5 t ha^{-1}	175	5.20	47.2	2.40
5.0 t ha^{-1}	200	6.40	48.2	3.20
7.5 t ha^{-1}	250	8.70	59.0	3.40
10.0 t ha^{-1}	305	10.10	65.7	3.60
250 kg ha^{-1} NPK1	320	12.40	72.7	3.80
LSD	73	2.23	13.0	0.11

GM = Goat Manure

The increased availability of nutrient in soil observed for GD treatments led to increased uptake of N, P, K, Ca and Mg as indicated by leaf analysis. Earlier, Ojeniyi and Adegboyega (2003) found that GD increased leaf N, P, K, Ca and Mg contents of Celosia. Also Smith and Ayenigbara (2001) found that GD increased leaf N, K and Ca status of Indian Spinach.

Goat dung and NPK fertilizer increase growth and yield parameters of pepper as indicated by number of leaves, branches, plant height, stem girth (Table 6 and 7), number and weight of fruits (Table 8). In fact the parameters increased with level of applied GD, hence the 10 t ha^{-1} GD had highest values of these parameters among GD treatments. The effects of GD at 5.0, 7.5 and 10.0 t ha^{-1} were significant ($p>0.05$) depending on parameter. Therefore improved nutrient availability adduced to GD led to significant enhancement of growth and fruits yield of pepper Odiete *et al.* (1999) recorded that GD increased yield of okra, amaranthus and maize in southwest Nigeria, Ojeniyi and Adegboyega (2003) found that GD increased growth of Celosia.

However it was found in the present study that NPK fertilizer increased growth and yield of pepper that any GD treatment. The different in fruit yield was significant ($p>0.05$) (Table 8). This is attributable to quicker release of N, P and K from the fertilizer (Smith and Ayenigabra, 2001). The positive response of pepper to NPK fertilizer has been recorded in Nigeria (Babalola and Babtola, 1997).

Table 8: Effect of goat manure and NPK fertilizer on fruit yield of *C. annuum.*

	Number of fruits per plant		Weights of fruits per plant	
Treatments	Trial 1	Trial 2	Trial 1	Trial 2
0 t ha^{-1} GM	40.0	38.0	200.0	232.0
2.5 t ha^{-1}	60.0	62.0	215.0	240.0
5.0 t ha^{-1}	70.0	72.0	250.0	260.0
7.5 t ha^{-1}	85.0	76.0	300.0	300.0
10.0 t ha^{-1}	98.0	90.0	350.0	364.0
250 kg ha^{-1} NPK	110.0	120.0	430.0	482.0
LSD (0.05)	17.2	12.9	23.0	60.0

GM = Goat Manure

CONCLUSION

Ground goat manure significantly improved nutrient availability in soil, nutrient status, growth and yield of pepper. However goat dung was less effective in improving growth and yield of pepper. The dung applied at 10.0 t ha^{-1} was most effective among the levels investigated. Goat dung is an effective source of N, P, K, Ca and Mg and organic matter for pepper production.

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