EFFECT OF COWDUNG, NPK AND THEIR COMBINATIONS ON SOIL PROPERTIES AND PERFORMANCE OF SWEET POTATO (*Ipomoea batatas* L.) IN SUDAN SAVANNA, NIGERIA

M. Haliru, M. Audu, S.A Lukman, M.M Sawwa, I. Yakubuand N.G Hayatu

Department of Soil Science and Agricultural Egineering, UsmanuDanfodiyo University Sokoto, Nigeria.

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Abstract

In Nigeria, one of the major problems confronting agriculture is poor soil fertility replenishment strategy that could allow sustainable production. Two field trials were conducted simultaneously at Sokoto (UDUS, Vegetable Research farm) and Zamfara (Bakalori Irrigation Project)bothin Sudan-Savanna agro-ecological zone of Nigeria, with the aim of studying the effect of different rates of cowdung, NPK and their combinations on soil properties and performance of sweet potato. The research was conducted during the 2011/2012 dry season using ten treatments: CD(H), CD(M), CD(L), NPK(H), NPK(M), NPK(L), CD+NPK(H) CD+NPK(M), CD+NPK(L) and control. The result was consistent with regard to locations and indicated no significant effect on soil pH. However, the treatments resulted to a decrease in the soil pH from 5.63 to (5.38-4.95) and 5.90 to (5.88-5.01) at UDUS and Bakalori respectively.No significant effect was also recorded on soil organic carbon,cation exchange capacity(CEC), percentage nitrogen, available phosphorus, exchangeable calcium and potassium but was foundtoincreased due to treatments application as compared to the initial values. NPK(M) was determine to have significantly ($p<0.05$)the highest sweet potato performance at both Location. This research therefore, recommended the treatments used as important materials for soil nutrients replenishment. In terms of sweet potato yield,NPK(M) can be recommended to farmers in the study areas.

Key words;fertilizer, Rates, Soil properties and Sweetpotato

Introduction

Plant nutrients are essential for the production ofhigh quality crops to providenutrient requirement for the world's expanding population. Plant nutrients are therefore, a vital component of sustainable agriculture. Increased crop production largely relies on the type of fertilizer used to supplement essential nutrients for plants. The nature and the characteristics of nutrients released by mineral and organic fertilizer are different and each type of fertilizer has its advantages and disadvantages with regard to crop growth and soil fertility.**Cow dung is used extensively and historically in India as an organic manure. It has been shown as having soil binding properties and anti-soil erosion activity (apart fertilising/manure effect) and helps Permanent Agriculture, significantly.**The sound management of fertilization must attempt to ensure both an enhanced crop productivity and safeguarded environment. Therefore, a balanced fertilization strategy that combines the use of mineral and organic fertilizers must be developed and evaluated (Chen, 2006).

Sweet potato (*Ipomoea batatas*L.)belongs to the family convolvulaceae. The family has about 45 genera and 1000 spp, but only sweet potato (*Ipomoea batatas* L.) is of economic importance as food [Nwauzor et al., 2010). It is an important food and vegetable crop that is widely distributed throughout the world particularly in the Tropics [Nwauzor et al., 2010). Sweet potato originated from Tropical America and has been cultivated probably from B.C. Today, the crop remains one of the three most important root crops in the world, following potato (Solanumtuberosum) and cassava (Manihotesculenta) [Nwauzor et al., 2010).

In an effort to reduce over and under application as well as establishing appropriate types of fertilizer that will enhance both nutrient availability to plant and the soil fertility, the need therefore, arises for assessing the comparative effect of different rates of organic, mineral and organo-mineral fertilizers on the soil, growth and yield of crops. This research was therefore, aimed at assessing the effect of different rates of cow dung, NPK and their combinations on soil properties, growth and yield of sweet potato in Sudan savanna agro ecological zone of Nigeria.

Materials and Method

The trials were conducted in Sokoto and Zamfara States, simultaneously. For Sokoto (L1); the trial was conducted at the UsmanuDanfodiyo University,Sokoto Vegetable Research Farm located at Kwakwalawa village in dundaye district of SokotoState. Sokoto is located between latitudes 12^0 and 13^0 5'N and longitudes 4^0 8' and 6^0 4'E at an altitude of 350m above Sea Level (ASL) (Mamman et al.,2000).InZamfara (L2); the trial was conducted at the Bakalori Irrigation Project. The area lies on both sides of the Sokoto river between latitude 120 30'-120 50'N and longitude 50 59'-60' 20'E near TalataMafara, about 110km from Sokoto on the Sokoto – Gusau road in Zamfara State.

The treatments consisted of three rates of cow dung, three rates of NPK (15:15:15), three rates of cowdung and NPK combinations and control. The ten treatments were arranged in a randomized complete block design (RCBD) replicated three times. The treatments were;

CD (H) = 3t/ha cowdung	NPK (L) 200kg/ha
CD (M) = 2t/ha cowdung	CD+NPK (H) = 2t cowdung + 100kgNPK/ha
CD (L) = 1t/ha cowdung	CD+NPK (M) = 1.5t cowdung+150kgNPK/ha
NPK (H) = 400kg/ha NPK	CD+NPK (L) = 1t cowdung +200kgNPK/ha
NPK (M) = 300kg/ha NPK	CONTROL = No fertilizer applied

Where CD= Cowdung, H = High, M = Medium and L = Low

Cow dung was applied in full dose and incorporated intothe soil one week before transplanting; NPK was applied in split dose: first dose at two weeks after transplanting and the remaining dose at 50 days after the first application, using broadcasting method.

Data was collected for the following growth and yield parameters; Number of leaves and vines per plant, vine length, number of tubers per plant, tuber weight and tuber yield. Soil samples were collected using soil auger from 0 to 30 cm depth before and afterthe experiment and analyzed for soil pH, organic carbon, cation exchange capacity (CEC), total nitrogen and available phosphorus.Data was analyzed usingAnalysis of variance (ANOVA) and Duncan's New Multiple Range Test(DNMRT) for mean separation.

Results and Discussion

Chemical composition of the cowdung used

Table 1; Chemical composition of the cowdung used

Chemical properties	values
pH(H_20) 1:1	8.07
Org. carbon (g/kg)	34.89
Total nitrogen (%)	0.66
Avail. Phosphorus (mg/kg)	0.18
Exchangeable K (cmol/kg)	0.50

InitialSoil analysis

Table 2: Soilanalysis before the experiment during 2011/2012 dry season at UDUS (kwalkwalawa) and Bakalori

Parameters	UDUS(kwalkwalawa)	Bakalori
pH (H_2O) 1:1	5.63	5.9
Organic carbon (g/kg)	0.33	0.45
Total nitrogen (%)	0.16	0.17
Avail. Phosphorus (mg/kg)	4.74	4.67
CEC (cmol/kg)	3.41	3.94
Exchangeable Ca (cmol/kg)	0.29	0.32
Exchangeable Mg (cmol/kg)	0.52	0.72
Exchangeable K (cmol/kg)	0.35	0.40

Result presented in table 2.Showed theinitial chemical composition of soils at the two locations that, soil pH were moderately acidic, low organic carbon, CEC, available phosphorus and medium in total nitrogen.

Soil analysis after the experiment

Table 3: Effect of Cowdung, NPK and their Combinations on Soil pH, Organic Carbon and CEC at UDUS and Bakalori in 2011/2012 Dry Season.

Treatment	L1 (UDUS)					L2 (BAKALORI)				
	pH	O/C (%)	CEC (cmol/kg)	T/N(%)	p(mg/kg)	pH	O/C (%)	CEC(cmol/kg)	T/N(%)	P(mg/kg)
CD(H)	5.33	0.66	5.03	0.23	4.60	5.80	0.61	4.76	0.18	4.37
CD(M)	5.31	0.57	5.16	0.18	4.94	5.81	0.55	5.88	0.2	4.89
CD(L)	5.27	0.34	4.70	0.16	4.22	5.81	0.47	3.70	0.21	4.52
NPK(H)	4.95	0.43	5.00	0.19	4.76	5.01	0.35	5.40	0.18	4.42
NPK(M)	5.15	0.49	4.93	0.15	4.66	5.59	0.27	5.35	0.16	4.71
NPK(L)	5.12	0.55	4.73	0.15	4.56	5.43	0.39	4.83	0.23	4.30
CD+NPK(H)	5.38	0.68	4.83	0.19	4.93	5.63	0.46	4.20	0.2	4.72
CD+NPK(M)	5.23	0.41	4.73	0.2	4.80	5.88	0.54	5.46	0.2	4.36
CD+NPK(L)	5.26	0.47	5.06	0.35	4.54	5.70	0.41	4.90	0.2	4.64
Control	5.10	0.38	4.73	0.16	4.78	5.77	0.41	3.43	0.12	4.62
Level of Sig.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
SE	0.05	0.05	0.08	0.01	0.05	0.06	0.03	0.26	0.02	0.06

ns = Not significant at 5% level of probability

T/N = total nitrogen

P = phosphorus

Effect of cowdung, NPK and their combinations on soil chemical properties is presented inTable 3.The result indicated that, treatments had no significant effect ($p>0.05$) on soil pH, organic carbon, CEC, total nitrogen and available phosphorus at both locations. This result may be due to the time frame at which the experiment was conducted as related to the rate of decomposition, mineralization and crop quality. However, as compared to the initial values,the soil pH declined whereas the concentration of organic carbon, CEC, total nitrogen and available phosphorus increased. With regard to drop in pH, this could be due to formation of organic acid during decomposition of organic treatments and or

accumulation of nitric acid from nitrification process with application of mineral fertilizer.

As stated by Lynch (1983), decrease in soil pH could be linked to accumulation of plant products whichproduces various organic acids. Similar observation was reported by Gattani*et al*, (1976) in his study on the effect of continuous use of chemical fertilizers and manureson soil properties for five years and reported that, the organic carbon level of the soil increased to 0.24 from 0.19 percent by manure application. Mathur (1997) studied the long term effect of farm yard manure on soil properties and yield in cotton – wheat rotation at Northwest Rajasthan. The observation made was that, incorporation of 16 tonnes of farmyard manure accounted for the highest increase in organic carbon content of soil. The increase in CEC was associated with rise in organic matter content. Yaduvanshi*et al*.,(1985) also reported that, application of farmyard manure resulted in a significant increase in CEC. Patiram and Singh (1993) also reported an increased in CEC through manure application and the lowest CEC of the soil was found in the treatment which received only N.Increase in total nitrogen could be attributed to direct addition of nitrogen through organic and inorganic fertilizers. Anderson and Peterson (1973) have reported that, continuous addition of manure for 20 years increased the soil total and available nitrogen content significantly from 0.05 to 0.083 percent, while increase was only 0.05 percent in N fertilizer applied plots as large portion of N was removed by the crops. It was reported by Somani and Saxena (1975) that, an increase in phosphorus with incorporation of wheat crop residue and farmyard manures was observed while inorganic fertilizer alone decreased available phosphorus when compared with initial status. Similarly, Bharandary and Omanwar, 1994 observed that, farmyard manure treated plots showed more increase in available phosphorus than inorganic fertilizer which was due to coating of sesquioxides by organic materials that reduced phosphorus fixing capacity of the soil.

Sweet potato performance

Table 4: Effects of Cowdung, NPK and their Combinations on growth parameters of Sweet Potato at 14 WAT in UDUS and Bakalori during 2011/2012 Dry Season.

Treatment	L1 (UDUS)			L2 (BAKALORI)		
	No. of Leaves	Vine No.	Vine Length (cm)	No. of Leaves	Vine No.	Vine Length (cm)
CD(H)	197.633c	9.320c	48.433b	231.400cde	12.300cd	49.000cd
CD(M)	209.133c	9.700c	34.767c	221.000def	11.267d	38.000e
CD(L)	172.433e	9.420c	27.533d	183.100f	9.100e	53.600c
NPK(H)	329.400a	16.500a	65.000a	300.967ab	16.600a	71.533a
NPK(M)	187.500cde	11.430b	49.800b	327.300a	15.300b	64.267b
NPK(L)	180.933de	12.770b	48.733c	190.967ef	11.300d	63.000b
CD+NPK(H)	181.700de	9.330c	37.897c	212.833def	11.400d	43.600de
CD+NPK(M)	235.733b	10.700bc	51.000b	277.300bc	13.067c	62.000b
CD+NPK(L)	206.033cd	12.300b	49.500b	241.200cd	11.067d	48.300cd
Control	167.433e	9.600e	35.633c	237.000cde	9.300e	37.667e
Level of Sig.	*	*	*	*	*	*
SE	7.17	0.63	1.14	14.00	0.52	3.38

Mean followed by the same letter(s) within the same column are statistically the same at 5% level of probability.

* = Significant at 5% level of probability.

WAT= Weeks after transplanting

Effect of cow dung, NPK and their combinations on growth parameters of sweet potato is presented in Table 4.Theresult indicated that treatments had significant effect ($p<0.05$) on all the considered growth parameters at both locations. Where NPK(H) recorded the best sweet potato growth performance while the least performanceis in the control. This is similarly reported by El-Ghamry (2011), who observed that, vegetative growth parameters of sweet potato tend to increase with increasing application of mineral fertilizer and different forms of organic manure. Najim et al, (2010) reported that, shoot dry matter, leaf area and plant height showed highly significant difference in relation to the rate of nitrogen fertilizer, as they increased significantly and linearly with increasing rate of nitrogen application. Hence, the result of this research could be due to high rate and availability of nitrogen in the best treatment (NPK(H). It

was reported by many researchers (Tam and Magistad, 1935; Chapman and Barreto, 1997; Vos et-al, 1998; Janat, 2001; Abu Hussein et-al, 2003; Rashid et-al, 2005 ; and Zebarth et-al, 2009) that, increased concentration of nitrogen fertilizer can increase nitrogen uptake and this increase has a positive effect on chlorophyll concentration, the photosynthetic rates and leaf expansion.

Table 5: Effects of Cowdung, NPK and their Combinations on Yield and Yield Components of Sweet Potato at UDUS and Bakaloriduring 2011/2012 Dry Season.

Treatment	L1 (UDUS)			L2 (BAKALORI)		
	No.T/plt	T.W/ plt (kg)	T yield (t/ha)	No.T/plt	T.W /plt (kg)	T yield (t /ha)
CD(H)	7.100abc	0.831bc	14.433c	5.917a	0.830b	18.733b
CD(M)	6.150abc	0.433de	8.280ef	5.750a	0.400de	8.580d
CD(L)	6.150abc	0.594d	10.727de	5.850a	0.332de	6.527d
NPK(H)	7.167abc	0.793c	15.263c	6.417a	1.173a	25.900a
NPK(M)	8.000a	1.353a	27.300a	6.583a	0.937b	22 .733a
NPK(L)	6.200abc	0.483de	12.700cd	5.333a	0.543cd	12.533c
CD+NPK(H)	5.967bc	0.910bc	21.133b	5.000a	0.440d	12.533c
CD+NPK(M)	7.600ab	0.953b	19.433b	6.250a	0.630c	14.900c
CD+NPK(L)	5.533c	0.370e	9.633ef	5.000b	0.358de	9.267cd
Control	6.300abc	0.543d	8.050f	3.833b	0.250e	7.933d
Level of Sig.	*	*	*	*	*	*
SE	0.58	0.03	0.64	0.05	0.05	1.05

Mean followed by the same letter(s) within the same column are statistically the same at 5% level of significant.

* = Significant at 5% level of probability

T = tuber, T.W = tuber weight

Effect of cowdung, NPK and their combinations on yield and yield component of sweet potato is presented in Table 4. The result indicated that, treatments had significant effect ($p<0.05$) on the yield and yield component of sweet potato at both locations. Where NPK(M) recorded the highest tuber yield at both location while control plots recorded the least tuber yield. Increased in yield with due toNPK(M) could be as a result of the readily available N P and K nutrient elements in the treatments. Mineral fertilizer was reported to have increased shoot weight, leaf area, plant height and subsequently total yield (Bradley and Praff, 1955; Watson and Wilson, 1956; Logan, 1989; Biemond and Vos, 1992; Vos 1997; Meyer and Marcum, 1998; Vos and Vander Putten, 1998; Zvomuya, *et al*, 2002; Kumar *et al*, 2007; Zelalem*et al*, 2009 and Najm*et al*, 2010). Other researches showed that, leaf area, shoot weight, plant height and tuber yield increased by organic fertilization (Stoner *et al*, 1996; Abou – Hussein *et al*, 2003).The findings of this research was similarly reported by Magagula (2010) who reported significant effect on the total tuber yield of sweet potato with application of different rates of Chicken manure. This could be due to an increase in nutrient level.

Conclusion

This research revealed that, application of different rates of cowdung,NPK and their combination to soil under sweet potato production have no significant effect on soil pH, organic carbon, CEC, total nitrogen and available phosphorus. While performance of sweet potato was significantly influenced by rates of cowdung, NPK and their combination and NPK(M) gave the best sweet potato yield and therefore, recommended.

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