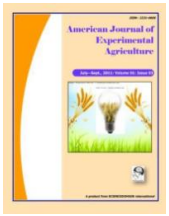

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Effect of Cow Dung, NPK and Their Combinations on Soil Properties and Performance of Sweet Potato (*Ipomoea batatas* L.) in Sudan Savanna, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author MH invented the idea, designed and make the overall supervision of the research. Authors MA and SAL conducted and reviewed the statistical analysis respectively. Authors MMS, IA and NGH conducted both the field and laboratory work of the research.

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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 in Sokoto (UDUS, Vegetable Research farm) and Zamfara (Bakalori Irrigation Project) both in Sudan-Savanna agro-ecological zone of Nigeria, with the aim of studying the effect of different rates of cow dung, nitrogen-phosphorus-potassium fertilizer and their combinations on soil properties and performance of sweet potato. The research was conducted during the 2011/2012 dry season using ten treatments: 3, 2, and 1tons per hectare of cow dung, 400, 300, and 200 kilogram per hectare of nitrogen-phosphorus-potassium fertilizer, 2 tons of cow dung + 100 kilogram nitrogen-phosphorus-potassium fertilizer, 1.5 ton of cow dung + 150 kilogram of nitrogen-phosphorus-potassium fertilizer, 1 ton of cow dung + 200 kilogram of nitrogen-phosphorus-potassium fertilizer per hectare and no fertilizer application (control). The result obtained was consistent with regard to locations indicating a numerical increased in soil organic carbon, cation exchange capacity(CEC), total nitrogen, available phosphorus, exchangeable calcium and potassium due to the treatments

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application as compared to the initial values. However, the effect was not significant ($p>0.05$) among treatments. While on sweet potato yield the treatments effect was significant ($p<0.05$) and application of 300 kilogram of nitrogen-phosphorus-potassium fertilizer per hectare gave the highest sweet potato yield at both locations. This research therefore, recommended that treatments used are important materials for soil nutrients replenishment and application of 300 kilogram per hectare of nitrogen-phosphorus-potassium fertilizer is recommended for better sweet potato yield in the study areas.

Keywords: Fertilizer; rate; soil properties; sweet potato.

1. 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. 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 [1].

Sweet potato (*Ipomoea batatas* L.) Belongs to the family *Convolvulaceae*, the family has about 45 genera and 1000 species but only sweet potato (*Ipomoea batatas* L.) Is of economic importance as food, it is an important food and vegetable crop that is widely distributed throughout the world particularly in the Tropics. It 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 (*Solanum tuberosum*) and cassava (*Manihot esculenta*) [2].

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, nitrogen-phosphorus-potassium fertilizer(NPK) and their combinations on soil properties, growth and yield of sweet potato in Sudan savanna agro ecological zone of Nigeria.

2. MATERIALS AND METHODS

The trials were conducted in Sokoto and Zamfara States, simultaneously. For Sokoto (L1); the trial was conducted at the Usmanu Danfodiyo University, Sokoto Vegetable Research Farm located at Kwakwalawa village in Dundaye district of Sokoto State. Sokoto is located between latitudes 120 and 130 5'N and longitudes 40 8' and 60 4'E at an altitude of 350m above Sea Level (ASL) [3]. In Zamfara (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 Talata Mafara, about 110km from Sokoto on the Sokoto – Gusau road in Zamfara State. The treatments consisted of three rates of cow dung, three rates of nitrogen-phosphorus-potassium fertilizer (NPK 15:15:15), three rates of cow dung and nitrogen-phosphorus-potassium fertilizer combinations and control (no fertilizer application) the treatments were coded as:

Treatment	Code
3 tons per hectare of cow dung	CD(H)
2 tons per hectare of cow dung	CD(M)
1ton per hectare of cow dung	CD (L)
400 kilogram per hectare of nitrogen-phosphorus-potassium Fertilizer (NPK)	NPK (H)
300 kilogram per hectare of nitrogen-phosphorus-potassium Fertilizer (NPK)	NPK(M)
200 kilogram per hectare of nitrogen-phosphorus-potassium Fertilizer (NPK)	NPK (L)
2 tons per hectare of cow dung plus 100 kilogram per hectare of nitrogen-phosphorus-potassium fertilizer	CD+NPK (H)
1.5 ton per hectare of cow dung plus 150 kilogram per hectare of nitrogen-phosphorus-potassium fertilizer	CD+NPK (M)
1 ton per hectare of cow dung plus 200 kilogram per hectare of nitrogen-phosphorus-potassium fertilizer	CD+NPK (L)
No fertilizer application	Control

The treatments were arranged in a randomized complete block design (RCBD) replicated three times. Cow dung was applied in full dose and incorporated into the 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 using analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) for mean separation.

3. RESULTS AND DISCUSSION

3.1 Soil Analysis after the Experiment

The chemical compositions of cow dung and soil before the experiment is presented in Table 1. Result shows that the soil of the two locations was almost the same and cow dung used was rich in nutrients.

Effect of cow dung, NPK and their combinations on soil chemical properties is presented in Table 2. The result indicated that treatments haveno significant effect ($p>0.05$) on soil pH, organic carbon, CEC, total nitrogen and available phosphorus at both locations. This result could be attributed 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 materials and or accumulation of nitric acid from nitrification process with application of mineral fertilizer. Decrease in soil pH could be linked to accumulation of plant products which produces various organic acids [4]. Similar observation was reported in a study on the effect of continuous use of chemical fertilizers and manures on 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 [5]. The long term effect of farm yard manure on soil properties and yield in cotton – wheat rotation at Northwest Rajasthan. The observation made was, incorporation of 16 tons 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 [6].Application of farmyard manure resulted in a significant increase in CEC [7]. 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 [5]. 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 [8]. 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 [9]. It was similarly, 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 [10].

3.2 Sweet Potato Performance

Effect of cow dung, NPK and their combinations on growth parameters of sweet potato is presented in Table 3. The result 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 performance is in the control, this could be attributed to the nutrient availability throughout the crop vegetative period. This was similarly reported that, vegetative growth parameters of sweet potato tend to increase with increasing application of mineral fertilizer and different forms of organic manure [11]. 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) [12]. It was reported by many researchers [13-19] 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 1. Initial soil analysis and chemical composition of cow dung used

Parameters	UDUS (kwalkwalawa)	Bakalori	cow dung
pH (H_2O) 1:1	5.63	5.9	8.07
Organic carbon (g/kg)	0.33	0.45	0.34
Total nitrogen (%)	0.16	0.17	0.66
Avail. Phosphorus (mg/kg)	4.74	4.67	5.06
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	0.50

Table 2. Effect of cow dung, NPK and their combinations on soil ph, organic carbon and cec at udus and bakalori in 2011/2012 dry season

	UDUS					BAKALORI				
Treatment	pH	Organic carbon (%)	CEC (cmol/ kg)	Total nitrogen (%)	Avai. P (mg/ kg)	pH	Organic carbon (%)	CEC (cmol/ kg)	Total nitro gen (%)	Avai . P (mg/ kg)
CD (H)	5.3	0.66	5.03	0.23	4.60	5.8	0.61	4.76	0.18	4.36
CD (M)	5.3	0.57	5.16	0.18	4.94	5.8	0.55	5.88	0.20	4.89
CD (L)	5.2	0.34	4.70	0.16	4.22	5.8	0.47	3.70	0.21	4.52
NPK (H)	4.9	0.43	5.00	0.19	4.76	5.0	0.35	5.40	0.18	4.42
NPK (M)	5.1	0.49	4.93	0.15	4.66	5.5	0.27	5.35	0.16	4.71
NPK (L)	5.12	0.55	4.73	0.15	4.56	5.4	0.39	4.83	0.23	4.30
CD+NPK(H)	5.38	0.68	4.83	0.19	4.93	5.6	0.46	4.20	0.20	4.72
CD+NPK(M)	5.23	0.41	4.73	0.2	4.80	5.8	0.54	5.46	0.20	4.36
CD+NPK (L)	5.26	0.47	5.06	0.35	4.54	5.7	0.41	4.90	0.20	4.64
CONTROL	5.10	0.38	4.73	0.16	4.78	5.7	0.41	3.43	0.12	4.62
SE	0.05	0.05	0.08	0.01	0.06	0.03	0.26	0.02	0.06	0.05
level of sig	ns	Ns	ns	Ns	ns	ns	Ns	ns	Ns	Ns

ns = Not significant at 5% level of probability; Avai. P = available phosphorus

Table 3. Effects of cow dung, NPK and their combinations on growth parameters of sweet potato at 14 wat in udus and bakalori during 2011/2012 dry season

	UDUS			BAKALORI		
Treatment	No. of leaves /plant	No. of vines/plant	Vine length(cm)	No. of leaves /plant	No. of vines/plant	Vine length(cm)
CD (H)	197.6c	9.3c	48.4b	231.4cde	12.3cd	49.0cd
CD (M)	209.1c	9.7c	34.7c	221.0def	11.2d	38.0e
CD (L)	172.4e	9.4c	27.5d	183.1f	9.1e	53.6c
NPK (H)	329.4a	16.5a	65.0a	300.9ab	16.6a	71.5a
NPK (M)	187.5cde	11.4b	49.8b	327.3a	15.3b	64.2b
NPK (L)	180.9de	12.7b	48.7c	190.9ef	11.3d	63.0b
CD+NPK (H)	181.7de	9.3c	37.8c	212.8def	11.4d	43.6de
CD+NPK(M)	235.7b	10.7bc	51.0b	277.3bc	13.0c	62.0b
CD+NPK (L)	206.0cd	12.3b	49.5b	241.2cd	11.0d	48.3cd
CONTROL	167.4e	9.6e	35.6c	237.0cde	9.3e	37.6e
SE	7.17	0.63	1.14	14.00	0.52	3.38
level of sig	*	*	*	*	*	*

Mean followed by the same letter(s) within the same raw are statistically the same at 5% level of probability;
** = Significant at 5% level of probability; WAT= Weeks after transplanting*

Table 4. Effects of cow dung, NPK and their combinations on yield and yield components of sweet potato at udus and bakalori during 2011/2012 dry season

	UDUS			BAKALORI		
Treatment	**No. of Tubers/plant**	**Tuber weight/plant**	**Tuber yield/ha**	**No. of Tubers/plant**	**Tuber weight/plant**	**Tuber yield/ha**
CD (H)	7.1abc	0.8bc	14.4c	5.9a	0.8b	18.7b
CD (M)	6.1abc	0.4de	8.2ef	5.7a	0.4de	8.5d
CD (L)	6.1abc	0.5d	10.7de	5.8a	0.3de	6.5d
NPK (H)	7.1abc	0.7c	15.2c	6.4a	1.1a	25.9a
NPK (M)	8.0a	1.3a	27.3a	6.5a	0.9b	22.7a
NPK (L)	6.2abc	0.4de	12.7cd	5.3a	0.5cd	12.5c
CD+NPK(H)	5.9bc	0.9bc	21.1b	5.0a	0.4d	12.5c
CD+NPK(M)	7.6ab	0.9b	19.4b	6.2a	0.6c	14.9c
CD+NPK (L)	5.5c	0.3e	9.6ef	5.0b	0.3de	9.2cd
CONTROL	6.3abc	0.5d	8.0f	3.8b	0.2e	6.3abc
SE	0.58	0.03	0.64	0.05	0.05	1.05
level of sig	*	*	*	*	*	*

Mean followed by the same letter(s) within the same raware statistically the same at 5% level of significant;
** = Significant at 5% level of probability*

Effect of cow dung, NPK and their combinations on yield and yield component of sweet potato is presented in Table 4 (above). The result indicated that, treatments have 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 locations while the least tuber yield was in plot where no fertilizer was applied (control). Increased in yield due to NPK (M) application could be as a result of the readily available N P and K in the best recorded treatment. Mineral fertilizer was reported to have increased shoot weight, leaf area, plant height and subsequently total yield [20-29,12]. Other researches showed that, leaf area, shoot weight, plant height and tuber yield increased by organic fertilization [30,17]. The findings of this research was similarly reported by [31] who reported significant effect on the total tuber yield of sweet potato with application of different rates of Chicken manure.

4. CONCLUSION

This research revealed that, application of different rates of cow dung, NPK and their combination on 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 cow dung, NPK and their combination where application of 300 kg/ha of nitrogen-phosphorus-potassium fertilizer gave the best sweet potato yield and therefore, recommended.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chen J. The combined use of chemical and organic fertilizer and/or biofertilizer for crop growth and soil fertility. International workshop on sustained management of the soil rhizosphere system for efficient crop production and fertilizer use. 16-20 October 2006. Level Development Department Bangkok Thailand; 2006.
2. Nwauzor EC, Emehute JKU, Okorocha EAO, Njoku AO, Afuape J, Korieocha D. National root crops and Research Institute, Umudike; 2010. Available:http;//www.nreri.org
3. Mamman AB, Oyebanji JO, Peter SW. Nigeria: A people united, a future assured. Survey of states. Gobumo Publishing Company Limited. Calabar, Nigeria. 2000;1(12).
4. Lynch JM. Soil biotechnology. Microbiology factor in crop protection. London, U.K Blackwell. 1983;981.
5. Gattani PD, Jain SV, Seth SP. Effect of continuous use of chemical properties.

Journal of the Indian Society of Soil Science. 1976;24:284-289.
6. Mathur GM. Effect of long term application of fertilizer ad manure on soil properties and yield under cotton wheat rotation in North-West Rayasthan. Journal of the Indian Society of Soil Science. 1997;45:288–292.
7. Yaduvanshi HS, Tripathi BR, Kanwar BS. Effect of continuous manuring on soi roperties of an alfisol. Journal of the Indian Society Of Soil Science. 1985;33:700–703.
8. Anderson FN, Peterson GA. Effective contionous corn (*zea mays* L) manuring fertilization on yield and protein content of the grain and on the soil N content. Agronomy Journal. 1973;65:697–700.
9. Somani LL, Saxena SN. Effect of some organic matter sources on nutrient availability in humus buildup, soil physical properties and wheat yield under field condition. Anals of Arid Zone. 1975;14:149-158.
10. Bharandary V, Omanwar PK. Long–term effect of continuous rational cropping and fertilization on crop yield and soil properties – 11. Effect on EC, pH, organic matter and available nutrient of soil. Journal of Indian Society of Soil Science. 1994;42:387–392.
11. El-Glamry AM. Soil fertility and potato production as affected by conventional and organic systems. Journal of Soil Science and Agricultural Engineering. 2011;2(2):141-156.
12. Najim AA, Hay SeyedHadi MR, Fazali F, TaghiDarzi M, Shamorady R. Effect of utilization of organic and inorganic nitrogen source on the potato shoots, dry matter, leaf area index and plant height, during middle stage of growth. International Journal of Agriculture and Biological Science. 2010;1:1.
13. Tam RK, Magustad OC. Relationship between nitrogen fertilization and chlorophyll content in pineapple leaves, Plantphysiology. 1935;10:159-168.
14. Chapman SC, Barreto HJ. Using a chlorophyll meter to estimate specific leaf nitrogen of tropical maize during vegetative growth. Agronemy Journal. 1997;89:557-562.
15. Vos J, Van Der Putten PEL. Effect of nitrogen supply on leaf growth, leaf nitrogen economy and photosynthetic capacity of potato. Field Crops Research. 1998;59:63-72.
16. Janat M. Efficiency of nitrogen fertilizer for potato under fertigation utilization a nitrogen traler techniques. Communication in Soil Science and Plant Analyses. 2001;38:2401-2422.
17. Abou–Hussein SD, Shorbagy TEL, Abou-Hadid AF, El-Behairy U. Effect of cattle and chicken manure with or without mineral fertilizers on tuber quality and yield of potato crop. ISHS ACta Horticulture. 2003;698:95-100.
18. Rashid MY, Voroney P, Parkin G. Predicting nitrogen fertilizers requirement for corbby chrolophyll metter under different N availability condition. Canadian Journal of Soil Science. 2005;85:149-159.
19. Zebarth BJ, Rosen CJ. Research perspective on nitrogen BMP development for potato. American Journal of Potato Research. 2009;84:3-1.
20. Bradley GA, Pratt AJ. The effect of different combination of soil moisture and nitrogen level on early plant development tuber set of the potato. American Potato Journal. 1995;32:254-258.
21. Watson DJ, Wilson JH. An analysis of the effects of infection with leaf roll virus on the growth and yield of potato plants, and of its interation with nutrient supply and shading. Annuals of Applied Biology. 1956;44:390-396
22. Logan BJ. Effect of irrigation and nitrogen on yield and quality of potatoes growth in semi-arid westerm. N.W.S ISHSACT A Horticulture. 1989;247:243-247.
23. Biemond H, Vos J. Effect of nitrogen on the developmet and growth of the potatos plant. 2. The partitioning of dry matter nitrogen and nitrate. Annals of Botany; 1992.
24. Vos J. The nitrogen response of potato (*Solanun tuberosum* L) in the field: Nitrogen uptake and yield, harvest index and soil nitrogen response to water and nitrogen. Agronomy Journal. 1997;90:420–429.
25. Meyer RD, Marcum DB. Potato yield, petoide nitrogen, and nitrogen response to water nitrogen. Agronomy Journa. 1998;90:420–429.
26. Vos J, Van Der Putten PEL. Effect of nitrogen supply on leaf growth, leaf nitrogen economy and photosynthetic capacity of potato. Field Crops Research. 1998;59:63-72.
27. Zvomuya F, Rosen CJ, Miller JC. Response of russet nortokah clonal

selections to nitrogen fertilization. American Journal of Potato Research. 2002;79:231-239.
28. Kumar P, Pandey SK, Singh BP, Singh SV, Kumar D. Effect of nitrogen rate on growth, yield, economic and crop quality of Indian potato processing cultivars. Potato Research. 2007;50:143-155.
29. Zelalem A, Ekalign TT, Nigussies D. Response of potato (*Solanum tuberosum* L.) to different rate of nitrogen and phosphorus fertilization on vertisols at Debre Berhan, in the central highlands of Ethiopia. African Journal of Plant Science. 2009;3:16-24.
30. Stoner KA, Ferrandino FJ, Gent MPN, Elmer WH, Lamendia JA. Effect of straw mulch, spent musroom compost, and fumigation on the density of Colorada potato be bttbee the (*Coleopteran*: *Chrysomelidae*) in potatoes. Journal of Economic Entomology. 1996;89:1265-1280.
31. Magagula NEM, Ossom EM, Rhykered RL, Rhykerd CL. Effect of chicken manure on soil properties under sweet potato (*Ipomoea batatas* (L) Lam) culture in Swaziland. American – Eurasian Journal of Agronomy. 2010;3(2):36-43.

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