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Effect of Cow Dung 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 designed the study, supervised, wrote the protocol, and wrote the first draft of the manuscript. Authors AUD and MA managed the Statistical and laboratory analyses of the study and Author IA managed the fieldwork of the research. All authors read and approved the final manuscript.

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ABSTRACT

The study was conducted during the 2011/2012 dry season at two locations simultaneously, to evaluate the effect of cow dung rates on some selected soil chemical properties and performance of sweet potato. The trials were conducted at Usmanu Danfodiyo University, Sokoto vegetable research farm (Kwalkwalawa) and Bakalori irrigation project, Talata Mafara, Zamfara State, Nigeria. The three rates of cow dung were; 3, 2 and1 t/ha which was laid in randomized complete block design (RCBD) replicated three times. The soil properties considered were; soil pH, organic carbon, cation exchange capacity, total nitrogen and available phosphorus. Number of vines and leaves per plant, tuber weight and fresh tuber weight were among the growth and yield parameters considered for assessing the sweet potato performance. Result obtained were consistent as per locations, indicating that treatments have no significant effect ($P>0.05$) on soil properties, while significant ($P<0.05$) on growth and yield parameters of sweet potato. Application of 3t/h cow dung recorded

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the highest yield of 18.73t/ha. The result therefore, emphasized that, 3t/ha of cowdung is the best for better sweet potato yield without changes in soil properties.

Keywords: Cow dung; rate; sweet potato; soil properties.

1. INTRODUCTION

Plant nutrients are essential for the production of qualitative crops that provide healthy food for world expanding population. Plant nutrients are therefore, a vital component for sustainable agriculture [1]. Increase in crop production largely relies on the type of fertilizer used to supplement essential nutrients for plant. However, the use of any fertilizer type depends on several factors such as soil type, nature of crop and socio-economic condition of the area [2].

Among the tropical tuber crops, sweet potato (*Ipomoea batatas* L.) is the 7th most important one producing substantially high edible energy per hectare per day compared to rice, wheat, maize and cassava [3]. Sweet potato is a short duration crop adaptable to a wide range of growing conditions. It exhibits no strict seasonality, making it suitable as a combined crop with other crops [4].

In an effort to reduce over and under application as well establishing an appropriate rate of fertilizer that will enhance both nutrient availability to plant and soil, the need therefore, arises for assessing the effect of different rates of fertilizers on soil and crop performance. This research was therefore, aimed at assessing the effect of different rates of cow dung on soil and sweet potato performance in Sudan savannah, agro-ecological zone of Nigeria. Knowledge obtained from this study would assist in identifying the suitable rate of cow dung needed for sweet potato production in the study areas as well as its effect on soil properties.

2. MATERIALS AND METHODS

The trials were conducted during 2011/2012 dry season at two locations simultaneously (Usmanu Danfodiyo University Sokoto, vegetable research farm Kwalkwalawa, [L1] and Bakalori Irrigation Project Talata Mafara, Zamfara State, Nigeria [L2]), where both areas are located within the Sudan savanna agro-ecological zone of Nigeria at latitude 13º 01'N: longitude 5º 15' E and latitude 12º 30' - 12º 50' N: longitude 5º 59' - 60', respectively.

The treatments were;

CD(H) = Three tons of cow dung per hectare,
CD(M) = Two tons of cow dung per hectare,
CD(L) = One tone of cow dung per hectare and
Control = No cow dung was applied.

The experiment was laid in a randomized complete block design (RCBD) replicated three times. The plot size was 3 x 4.5 m (13.5 m^2). Plots were pegged and separated from each other by 0.5 m and 1 m between blocks leading to an area 222.75 m^2 in each location.

The treatments were applied and incorporated into the soil one week before transplanting. Data was collected on plot basis; five stands were selected within the net plot for numbers of leaves per plant, and vines per plant and vine length at three weeks interval, while number of tubers, tuber weight per plant and fresh tuber yield were recorded at harvest i.e. five months after transplanting. Soil samples were collected using soil auger at depth of (0-30 cm) before and after the experiment and was analyzed for soil pH, organic carbon, available phosphorus, total nitrogen (%), exchangeable bases ($Ca,^{2+}$ and K^+) and CEC using 1:1 soil-water ratio using a glass electrode pHmeter, modified Walkley-Black method as described in [5], Bray's no. 1 method as described in [6], Kjeldahl digestion and distillation procedure as described in [7], 1.0N neutral ammonium acetate (NH_4OAC) solution, respectively. Data were analyzed using (ANOVA) and DNMRT for mean separation.

3. RESULTS AND DISCUSSION

Results presented in Table 1 shows the chemical composition of soils and cow dung before the experiment at the two locations, soil pH were moderately acidic, low in organic carbon, CEC and available phosphorus content and medium in total nitrogen content.

3.1 Soil Analysis after the Experiment

Data in Table 2 showed the effect of cow dung rates on soil chemical properties. The results indicated no significant effect ($p>0.05$) on all the above soil chemical properties at both locations. This may be due to the time frame at which the

experiment was conducted as related to the rate of decomposition, mineralization and crop quality. It was similarly reported that, there was no significant effect ($p>0.05$) on soil pH with the different application rates of different organic fertilizer (Ten tons per hectare compost, ten tons per hectare fresh cattle manure, ten tons per hectare fresh chicken manure, ten tons per hectare fresh (chicken manure 30% + cattle manure 70%) and Untreated Control) on growth and yield of tomato [2]. However, there was an increase tendency in pH, organic carbon, cation exchange capacity, total nitrogen and available phosphorus contents due to treatment application. With regard to pH, it could be due to production of organic acid during the decomposition of the organic materials it was also reported that, pH increase by one unit due to application of 15tonnes of farmyard per ha manure over a period of four years [8]. A significant decrease in soil reaction due to organic manure application as compared to mineral to fertilizer application was observed [9]. The effect of continuous use of chemical fertilizers and manures on soil properties for five years was examined and reported that, the organic carbon level of the soil was increase to 0.24 from 0.19 percent by manure application [10]. Incorporation of 16tonnes per ha of farmyard manure accounted for the highest increase in organic carbon content of soil. Increased in CEC was associated with rise in organic matter content [11]. Application of farmyard manure resulted in a significant increase in CEC [12]. Increased in total nitrogen as compared to initial values at both locations could be attributed to addition of nitrogen through the treatments application as they decomposed. This was similarly 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 [13]. Application of organic manures such as farmyard manure and green manure, increased the soil available nitrogen [14].

3.2 Sweet Potato Performance

3.2.1 Growth parameters

Data in Table 3 indicated the effect of cow dung rates on growth parameters of sweet potato. Result showed no significant effect ($p>0.05$) on the number of leaves and vines per plantat UDUS (Kwalkwalawa) but significant ($p<0.05$) on vine length. At Bakalori, similar results were obtained with regard to number of leaves per plant. Number of vines per plant and vine length recorded significantly higher ($p<0.05$) in CD(H) than other rates at both the locations. This could be attributed to the quantity difference which is related to the amount of nutrients released into the soil for plant absorption. An increase in N level presumably enhanced vegetative growth [3].

3.2.2 Yield and yield component

Effect of cow dung rates on yield and yield components of sweet potato is presented in Table 4. Results indicated significant effect ($p<0.05$) on all the yield and yield components considered at both the locations, except for the number of tubers per plant at UDUS (Kwalkwalawa). In all the parameters that showed significant effect, CD(H) recorded the highest values of 0.83(kg), 14.4(t/ha) and 0.83(kg), 18.73(t/ha) on tuber weight per plant and fresh tuber yield at UDUS(Kwalkwalawa) and Bakalori, respectively. However, plots that received no cow dung (control) recorded the lowest values of 8.28(t/ha) and 6.52 (t/ha) of fresh tuber yield at UDUS (Kwalkwalawa) and Bakalori respectively, this could also be attributed to the effect of cow dung rates on growth parameters. It was also stated that, increase in availability of nutrients and production of growth hormones might have resulted in a higher nutrient uptake by the crops which increased bulking of tubers [3].

Table 1. Soil and cow dung analysis before the experiment

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 on soil pH, organic carbon, CEC, total nitrogen and available P content of UDUS (Kwalkwalawa) and Bakaloriin 2011/2012 dry season

	UDUS (Kwalkwalawa)					Bakalori				
Treatment	**pH**	**O/C**	**CEC**	**TN**	**A.P**	**pH**	**O/C**	**CEC**	**TN**	**A.P**
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	0.20	4.89
CD (L)	5.27	0.34	4.70	0.16	4.22	5.77	0.47	3.70	0.21	4.52
CONT.	5.10	0.38	4.73	0.16	4.78	5.77	0.41	3.43	0.12	4.02
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=no significant(p>0.05), O/C=Organic corbon, CEC=Cation exchange capacity, TN=Total nitrogen, A.P=Available phosphorus

Table 3. Effect of cow dung rates on growth parameters of sweet potato 14 WAT in UDUS (Kwalkwalawa) and Bakalori during 2011/2012 dry season

Treatment	**UDUS (Kwalkwalawa)**			**Bakalori**		
	No. of leaves/plant	**No. of vines/plant**	**Vine length (cm)**	**No. of leaves/plant**	**No. of vines/plant**	**Vine length (cm)**
CD (H)	53.6[a]	197.63	9.30	48.43[a]	231.4	12.3[a]
CD (M)	49.0[b]	209.13	9.76	37.76[b]	237.0	11.26[b]
CD (L)	38.6[c]	172.43	9.46	34.53[b]	221.0	9.1[c]
CONT.	37.6[c]	167.43	9.60	27.5[b]	183.1	9.3[c]
Level of sig.	*	ns	ns	*	Ns	*
SE	2.16	3.76	0.53	1.39	5.7	0.21

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; ns= not significant at 5% level of probability*

Table 4. Effect of cow dung rates on yield and yield components of sweet potato at UDUS (Kwalkwalawa) and Bakalori during 2011/2012 dry season

Treatment	**UDUS (Kwalkwalawa)**			**Bakalori**		
CD (H)	18.73[a]	7.1	0.83[a]	14.4[a]	5.91[a]	0.83[a]
CD (M)	8.58[b]	6.3	0.59[b]	9.28[b]	5.85[a]	0.40[b]
CD (L)	7.93[b]	6.15	0.53[b]	10.11[b]	5.83[a]	0.33[b]
CONT.	6.52[b]	6.15	0.43[c]	8.28[c]	3.83[b]	0.25[b]
Level of sig.	*	ns	*	*	*	*
SE	0.93	0.39	0.15	0.46	0.58	0.05

Mean followed by the same letter (s) within the same raw are not statistically different 5% level of probability
*ns= no significant at 5% level of probability; *= significant at 5% level of probability*

4. CONCLUSION

This research revealed that application of different rates of cow dung to soils under sweet potato production might have no significant effect on soil pH, organic carbon content, CEC, total nitrogen and available phosphorus contents. However, performance of sweet potato was significantly influenced by cow dung rates and application 3t/ha gave the best potato yield. Therefore, 3t/ha of cow dung is recommended to improve potato yield at both locations.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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