

Effect of Site-Specific Application of N and K Fertilizers on Cashew Growth and Yield in Ochaja, Kogi State, Nigeria

ABSTRACT

An experiment was conducted at the Ochaja Substation of the Cocoa Research Institute in Ibadan, Nigeria. Ochaja is located in the guinea savanna zone of Nigeria. Plantation soil nutrient requirements were determined prior to applying the required fertilizers. The soil was deficient in nitrogen (N) and potassium (K), with values of 0.41 g/kg soil and 0.012 cmol/kg soil, respectively, at depths 0–40 cm. This value was used to calculate cashew fertilization rates of 54 kg N/ha and 84 kg K₂O/ha. Based on these values, four treatment combinations of two rates of nitrogen fertilizer and two rates of potassium fertilizer were formed and applied to young cashew trees on the field. Nitrogen fertilizer was applied at 0 and 54 kg N/ha while the Potassium was applied at 0 and 84 kg K/ha. Treatments were placed in a Randomized Complete Block Design (RCBD) with three replications. Cashew growth, nut yield and soil nutrient characteristics were measured. The first dose was applied in June 2019 while the second dose was applied in September and 2020. Application of N fertilizer had a significant lowering effect on soil pH at both soil depths compared to the control and compared to N and K fertilizers applied together. Similarly, application of potassium-based fertilizer, with or without nitrogen fertilizer, slightly increased soil pH by 5.4%. Soil N had a significant effect ($P < 0.05$). Total N ranged from 0.5 g/kg to 0.7 g/kg soil for fertilizer treatments. N and K fertilizers did not significantly improve available soil phosphorus (P) across fertilization treatments. Exchangeable K in soil followed a similar trend with available P in different treatments. Yield of cashew nuts improved significantly ($P < 0.05$) under application of sole nitrogen fertilizer (without K) and the control. Application of fertilizers to nitrogen-deficient plots yields better results in terms of efficiency than extensive application of fertilizers without consideration of the natural fertility of the soil.

Comment [a1]: Change to be K₂O

Comment [a2]: Add the keywords

INTRODUCTION

Cashew is an important commercial crop and has great potential as a source of foreign exchange earnings and industrial raw materials, and has the potential to become a

important commercial tree in Nigeria. Due to its wide adaptability, cashews are often grown in very poor soils

which have hampered their survival and establishment (Topper, *et al.*, 2001). Cashew cultivation is subject to different limitations, both biotic and abiotic factors, especially in poor soils. The soil in which cashews are grown is of low or low fertility due to the misleading claim that cashews can survive in any soil, regardless of fertility. In most cashew plantations, fertilizer is not part of the production input system, so productivity is highly dependent on natural soil abundance (Ibiremo *et al.*, 2017 and Agbongiarhuoyi, *et al.*, 2014). As a result, the soil in which cashews are grown has been preserved by waste and other bounties of nature, and has not reached its full harvest potential.

Fertilizers are rarely used in cashew production as an input to the production system, and when they are used, they are widely applied. This practice leads to over-fertilization in some areas and under-

fertilization in others, or results in an unbalanced soil nutrient balance (Bruulsema *et al.*, 2012). Fertilization is unavoidable to compensate for the depletion of soil nutrients during the annual harvest of apples and nuts. Site-

specific fertilizer management (SSFM) improves nutrient use efficiency and yield shi gher return on fertilizer investments (Ortiz-Monasterio and Raun 2007). At Ochaja Substation, the site under consideration is deficient in nitrogen and potassium, and for effective soil management, additional nitrogen and potassium-

based fertilizers can increase productivity. Traditionally, among the few farmers who use fertilizer on their crops in Nigeria, the use of solid fertilizers containing the main nutrients nitrogen, phosphorus and potassium is common. The aim of this study

therefore, was to evaluate the effects of N and K fertilizer applications and their effects on soil properties based on soil test values on cashew yield.

MATERIALS AND METHODS

Soil samples were randomly collected within the plantations of Ochaja, and samples were processed and analyzed for both physical and chemical properties using standard laboratory procedures using the IITA Laboratory Manual (1982). Calculated fertilizer rates are based on the result of analysis of soil samples from 0 to 40 cm depths. The result of the analysis indicated that the total nitrogen was 0.04 g/kg soil which is adequate to sustain cashew as it requires 1 g/kg soil and the available P was adequate while the exchangeable potassium was also deficient having a value of 0.012 cmol/kg which is far below the critical of 0.12 cmol/kg

soil. From these values, four treatment combinations of two rates of nitrogen fertilizer and two rates of potassium fertilizer were formed and applied to young cashew trees in the field. Nitrogen fertilizers were applied at 0 and 54 kg N/ha, potassium at 0 and 84 kg K

Comment [a3]: Delete it

Comment [a4]: Add ,here and in all next references

Comment [a5]: Delete it

Comment [a6]: Italic form

/ha, treatments were placed in three replicate RCBDs, and crop morphological parameters, nut yield and soil nutrient characteristics were measured. The fertilizers were applied in two splits application. The first dose was applied in June while the second dose was applied in September of 2019 and 2020. Early plant growth parameters were used to form the basis for evaluating the effects of fertilizer treatments. Collected data were subjected to ANOVA and means separated using LSD with 5% probability.

Comment [a7]: Delete it

RESULTS AND DISCUSSION

a) Results of pre – cropping soil analysis

The pre-cropping soil properties indicated that the soil was sandy loam, with average values for sand, silt, and clay of 888, 20, and 92 g/kg soil, respectively (Table 1). The pH was slightly acidic and very close to neutral averaging 6.7, and organic carbon (OC) was low averaging 0.82 g/kg soil. Block BOC was higher than Block AOC. Total nitrogen in soil was 0.41 g/kg soil, which is below the critical value of 1 g/kg soil. A deficiency of 0.6 g/kg soil required 54 kg N for optimal production, whereas the average available P was 5.28 mg/kg soil. This value exceeds the level required by cashews for optimal productivity. The mean potassium value was 0.012 cmol/kg soil. A deficit of 0.108 cmol/kg requires 84 kg/ha. Exchangeable calcium ranged from 1.26 to 2.26 cmol/kg at soil depth of 0 to 40 cm, with an average of 1.68 cmol/kg. The exchangeable Mg ranged from 0.25 – 0.35 cmol/kg soil with an average of 0.29 cmol/kg soil.

Comment [a8]: Try to use similar font in the main parts of manuscript such as Introduction, materials and methods and results and discussion

b) Effects of Urea and Potassium fertilizer on the soil pH

Table 2 revealed the influence of Nitrogen and Potassium fertilizers on some soil chemical properties at Ochaja cashew plot. The soil pH of the two soil depths (0-20 and 20-40 cm) was significantly ($p < 0.05$) affected by the application of nitrogen and potassium fertilizers. The Urea

Comment [a9]: In capital letter and italic

(N) fertilizer application had a significant depressive effect on soil pH at both soil depths compared to the control and the plots where urea (N) and K fertilizers were applied in combination.

c) Influence of N and K fertilizer application on soil N

The control (T1) and plots that received K fertilizer recorded a significantly ($P < 0.05$) higher N value of 0.07 g/kg soil urea (N) fertilizers (T4) were applied. The differences were significantly ($P < 0.05$) different among the treatments. However, the control plot and those that were treated with sole potassium (K) fertilizer recorded similar effect on the amount of N content in the soil. The amount of N in each of the plot number consideration are in the following descending order: T1 and T3 > T2 and T4 at 0 to 20 cm depths, At 20 to 40 cm depths, the plots that received combined application of Urea and Potassium fertilizers recorded the highest N values relative to the rest. The mean differences of N values across the treatments were not different statistically from one another. This may be due to the properties of urea fertilizers that lower soil pH, as observed by Agbede (2009) and Adejumo (2010). Similarly, application of N and K fertilizers significantly ($P < 0.05$) affected total soil N at soil depths of 0-20 cm. However, the effect was not significant for soil depths of 20-40 cm, notably, total soil N appeared lower at urea-applied sites than in controls (no fertilizer). A high sand content in the soil may be the reason for the low retention of the applied N. Similarly, Sandy

Comment [a10]: Delete it
I think you mean from 0-20

Comment [a11]: Delete it
I think you mean from 20-40

textured soils generally have limited nutrient holding capacity. Nitrogen is prone to leaching in sandy soil as water flows through the more porous structure (Agriculture Victoria, 2023). This observation contradicted the observations of Adejumo, (2010) that application of urea fertilizer increased the total soil N.

d) *Effects of Urea and Potassium fertilizer application on soil Phosphorus*

The application of Urea and potassium fertilizers significantly depressed the amount of available phosphorus in the soil irrespective of the depths. The plots without fertilizer application recorded the highest soil available P relative to the other plots with fertilizer addition. Similar trend was observed at both depths (0 – 20 & 20 - 40cm) with the control plots recording the mean values of 11.17 and 10.35mg/kg soil respectively (Table 2). The mean differences were significant. The order of significance in descending order is as follows: Control (T1) > T2 > T4 > T3 at 0 – 20cm depths while at the lower depths (20 -40cm) Control (T1) > T4 > T2 > T3.

e) *Influence of application of Urea and Potassium fertilizer on soil K*

Similar trend was observed in the amount of exchangeable K in the soil arising from the effects of applied K and Urea fertilizers. The control plot recorded the highest mean K values relative to the other plots where Urea and K fertilizers were applied irrespective of whether the fertilizers were applied sole or in combination. T2 and T3 recorded similar effects and values 0.14cmol/kg soil respectively at 0 - 20cm depths (Table 2), these values were significantly ($p < 0.05$) higher than T4 at the same depth. At 20 - 40cm depth, T2 produced a significantly ($p < 0.05$) higher K in the soil compared to the rest, T1 and T2 were not statistically different from each other but were both higher significantly when compared with T3.

f) *Influence of application of Urea and Potassium fertilizer on raw cashew nuts*

Application of N fertilizer (Urea) promoted cashew growth, which was reflected in an increase in cashew nut yield. The Cashew nut yield was significantly ($P < 0.05$) improved by nitrogen and potassium fertilizers (Figure 1). In particular, N fertilizer application significantly ($p < 0.05$) increased cashew nut yield compared to the control. Relative to other fertilizer type, Cashew plots that were treated with sole Urea fertilizer (T2) positively enhanced the vegetative and the reproductive growth of cashew thus increased the yield of raw nuts. This observation is consistent with the result obtained by Adejumo, (2010) and Babuet *et al.*, (2015) that, application of N P K fertilizer significantly enhanced the yield of Cashew nuts relative to the control. In a separate study on Nitrogen and potassium application effects on productivity, profitability and nutrient use efficiency of irrigated wheat (*Triticum aestivum* L.), Sandeep *et al.*, (2022) revealed that wheat productivity, plant growth and yield attributes, nutrients uptake and use efficiency increased significantly ($p < 0.05$) with fertilizer-N application, although the interaction effect of N x K application was statistically non-significant ($p < 0.05$). (Sir, read thru the results and correct accordingly)

Comment [a12]: Change to be influence of urea application

Comment [a13]: In capital and italic letter

Comment [a14]: Change to be who found that

Comment [a15]: Not capital

Comment [a16]: In capital letter

Comment [a17]: What did you mean????????

CONCLUSION

Fertilization based on the result of soil test and the needs of the site yields optimal results in terms of efficiency of fertilizer use, yielding better crop yields compared to blanket application of fertilizers without relying on the inherent nutrients of the soil. Potassium (K) and nitrogen (N) are two vital nutrients that create greater benefits working together than alone. However, high nitrogen fertilization resulted in higher crop yields and high nitrogen accumulation. It is also beneficial when SSF is used in combination with other soil management techniques such as integrated soil fertility management and conservation agriculture (CA).

UNDER PEER REVIEW

Table 1: Initial soil physical and chemical properties of the cashew plot

Block	Soil Depth (cm)	Sand g/kg soil	Silt g/kg soil	Clay g/kg soil	pH	O.C g/kg	Total N g/kg	Ava.P Mg/kg	Exch K ⁺ Cmol/kg	Exch Ca ²⁺ Cmol/kg	Exch Mg ²⁺ Cmol/kg	CEC Cmol/kg	Base saturation (%)
A	0-20	885.20	22.80	92.00	6.7	0.78	0.07	5.03	0.012	2.26	0.35	2.78	95.83
A	20-40	895.20	12.80	92.00	6.8	0.66	0.02	5.20	0.011	1.73	0.29	2.18	95.05
B	0-20	895.20	12.80	92.00	6.6	0.97	0.05	5.35	0.012	1.26	0.27	1.70	92.81
B	20-40	875.20	32.80	92.00	6.7	0.86	0.02	5.55	0.012	1.34	0.25	1.15	91.62
	Mean x	887.70	20.30	92.00	6.7	0.82	0.04	5.28	0.012	1.65	0.29	1.95	93.83

Table 2: Influence of Nitrogen and Potassium fertilizers on some soil chemical properties at Ochaja cashew plot.

Treatment	pH (H ₂ O)		Total N (g/kg)		Available P (mg/kg)		Exchangeable K (cmol/kg)	
Soil depth	0-20cm	20-40cm	0-20cm	20-40cm	0-20cm	20-40cm	0-20cm	20-40cm
N ₀ K ₀ -T1(Control)	5.13	4.94	0.07	0.03	11.17	10.35	0.16	0.10
N ₁ K ₀ -T2	5.77	4.77	0.05	0.03	10.22	9.74	0.14	0.11
N ₀ K ₁ -T3	5.27	5.17	0.07	0.03	7.39	8.98	0.14	0.09
N ₁ K ₁ -T4	5.54	5.37	0.05	0.04	9.37	10.32	0.13	0.10
LSD (P<0.05)	0.19	0.20	0.01	0.02	0.72	0.60	0.01	0.01

Legend: N₀K₀-T1(Control); N₁K₀-T2, N₀K₁-T3, N₁K₁-T4

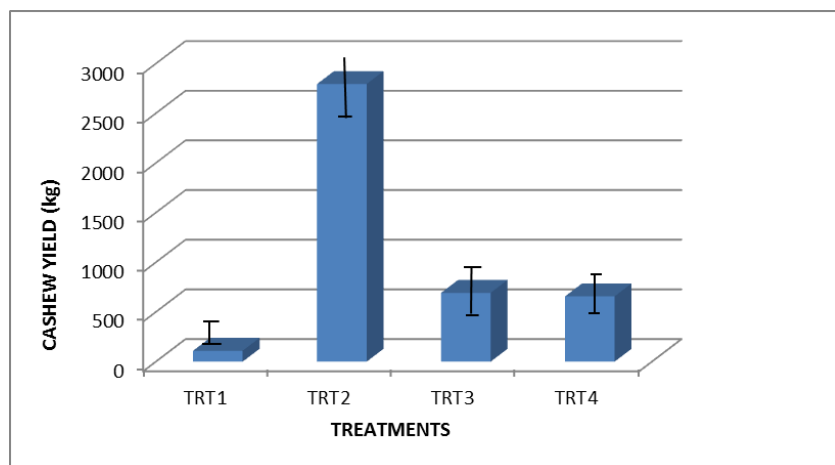


Figure 1: Effects of Nitrogen and Phosphorus based fertilizer on raw cashew yield (kg)

REFERENCES

Adejumo, O.O(2010). Effect of NPK fertilization on yield and inflorescence blight of cashew (*Anacardium occidentale*). *Journal of Agricultural Biotechnology and Sustainable Development* Vol. 2(5), pp. 66-70, May 2010 Available online <http://www.academicjournals.org/JABSD> ISSN – 2141 – 2340 © 2010 Academic Journals

Agbede, O.O (2009). Understanding soil and plant nutrition, 1st ed. Salma Press Nig. Ltd, Keffi-Nasarawa State

Agbongiarhuoyi, E., Uwagboe, E. O., Ibiremo, O. S., Olasupo, F. O. and Aigbekaen, E. O. (2014). Assessment of Factors Associated with Low Yield of Cashew among Farmers in Growing Areas of Nigeria. *American Journal of Experimental Agriculture* 6(4): 258-266.

AgricultureVictoria (2023): Sandy textured soils generally have limited nutrient holding capacity. Nitrogen is prone to leaching in sandy soils as water flows through the more porous structure. <https://agriculture.vic.gov.au/>

Babu, V., Reddy, M.N.N., Rajanna, K.M. and Vidya, M. (2015). Performance of cashew to NPKfertilizers. *ActaHortic.* 1080, 291-294; DOI: 10.17660/ActaHortic.2015.1080.37

Bruuselma, T.W, Fixen, P.E, Sulewski, G.D (eds) (2012). 4R Plant Nutrition Manual: A manual for improving the management of plant nutrition. International Plant Nutrition Institute(IPNI) Norcross, GA, USA

Sandeep Sharma; GagandeepKaur; Pritpal Singh; Pritpal Singh; Saud Alamri; Ritesh Kumar; Manzer H. Siddiqui; (2022) Nitrogen and potassium application effects on productivity, profitability and nutrient use efficiency of irrigated wheat (*Triticumaestivum* L.). *PLoS One.* 2022; 17(5): e0264210. Published online 2022 May 24. doi: [10.1371/journal.pone.0264210](https://doi.org/10.1371/journal.pone.0264210)

Ibiremo, O. S. and Iloyanomom, C. I. (2015). Cashew soil requirements and fertilizer management for optimum productivity: In Training Manual on Good Agricultural Practices in the management of cashew farms in Nigeria edited by Agbeniyi, S.O and Uwagboe, E.O: Pp: 18-21.

Comment [a18]: Please follow the style of journal for writing the references here and in the following references

Ibiremo O. S, Iloyanomom C. I, Oloyede A.A, Lawal J. O and I. Alhassan I. (2017). Strengthening Cocoa Production through Site Specific Fertilizer Recommendation in Five Local Government Areas of Cross River State, Nigeria. *Journal of Agriculture and Ecology Research International* 13(4): 1-11.

International Institute of Tropical Agriculture (IITA, 1982). Automated semi-automated methods of soil and plant analysis manual, Series No.7. IITA, Ibadan, Nigeria: 79.

Ortiz-Monasterio, J.I and Raun, W (2007). Reduced nitrogen and improved farm income for irrigated spring wheat in Yaqui Valley, Mexico, using sensor based nitrogen management. *J.Agric.Sci.* 145: 215-222. Doi:10.1017/S0021859607006995.

Topper, C.P., Caligari, P.D.S., Camara, M., Diaora, S., Djaha, A., Coulibay, F., Asante, A.K., Boamah, A., Ayodele, E.A. and Adebola, P.O. (2001). West Africa regional cashew survey report Guinea, Guinea Bissau, Cote d'Ivoire, Ghana and Nigeria). Sustainable Tree Crop Programme (STCP) and Biohybrids Agrisystem Ltd. U.K. 110.

UNDER PEER REVIEW