EffectofSite-SpecificApplicationofNandKFertilizersonCashewGrowthandYieldinOchaja,KogiState,Nigeria

ABSTRACT

AnexperimentwasconductedattheOchajaSubstationoftheCocoaResearchInstituteinIbadan,Nigeria.Ochaja is located in the guina savanna zone of Nigeria. Plantationsoilnutrientrequirementsweredeterminedpriortoapplyingtherequiredfertilizers.Thesoilwasdeficientinnitrogen(N)andpotassium(K),withvalues of0.41g/kgsoiland0.012cmol/kgsoil,respectively,atdepths0–40cm.Thisvaluewasusedtocalculatecashewfertilizationratesof54kgN/haand84kgK$_2$O/ha.Based on thesevalues,fourtreatmentcombinationsoftworatesofnitrogenfertilizerandtworatesofpotassiumfertilizerwereformedandappliedtoyoungcashewtreesonthefield.Nitrogenfertilizerwasappliedat0and54kgN/ha while the Potassium was applied at0and84kgK/ha. Treatmentswereplacedina Randomized Complete Block Design (RCBD) with three replications, Cashew growth, nutyieldandsoilnutrientcharacteristicsweremeasured. ThefirstdosewasappliedinJune while theseconddosewasappliedinSeptember of 2019 and 2020.ApplicationofNfertilizerhadasignificantloweringeffectonsoilpHatbothsoildepthscomparedtothecontrolandcomparedtoNandKfertilizersappliedtogether.Similarly,applicationofpotassium-basedfertilizer,withorwithoutnitrogenfertilizer,slightlyincreasedsoilpHby5.4%.SoilNhadasignificanteffect(P<0.05).TotalNrangedfrom0.5g/kgto0.7g/kgsoilforfertilizertreatments.NandKfertilizersdidnotsignificantlyimproveavailablesoilphosphorus(P)acrossfertilizationtreatments.ExchangeableKinsoilfollowedasimilartrendwithavailablePindifferenttreatments.Yieldofcashewnutsimprovedsignificantly(P<0.05)under application of solenitrogenfertilizer(withoutK)andthe control.Applicationoffertilizers tonitrogen-deficient plots yieldsbetterresultsintermsofefficiencythanextensiveapplicationoffertilizerswithoutconsideration ofthenaturalfertilityofthesoil.

INTRODUCTION

Cashewisanimportantcommercialcropandhasgreatpotentialasasourceofforeignexchangeearningsandindustrialrawmaterials,andhasthepotentialtobecomeanimportantcommercialtreeinNigeria.Duetoitswideadaptability,cashewsareoftengr

Formatted: Subscript

Comment [x1]: Mention the studied parameters of cashew with values to justify your results.

Comment [x2]: Mention the fertilizers rate??

Comment [x3]: Add 1-2 sentences of specific conclusion.

owninverypoorsoils whichhavehamperedtheirsurvivalandestablishment(Topper,*etal*.2001).Cashew cultivationissubjecttodifferentlimitations,bothbioticandabioticfactors,especiallyinpoorsoils.Thesoilinwhichcashewsaregrownisofloworlowfertilityduetothemisleadingclaimthatcashewscansurviveinanysoil,regardlessoffertility.Inmostcashewplantations,fertilizerisnotpartoftheproductioninputsystem,soproductivityishighlydependentonnaturalsoilnutrients abundance(Ibiremo*et al*.2017andAgbongiarhuoyi,*etal*.2014).Asaresult,thesoilinwhichcashewsaregrownhasbeenpreservedbywasteandotherbountiesofnature,andhasnotreacheditsfullharvestpotential. Fertilizersarerarelyusedincashewproductionasaninputtotheproductionsystem,andwhentheyareused,theyarewidelyapplied.Thispracticeleadstoover-fertilizationinsomeareasandunder-fertilizationinothers,orresultsinanunbalancedsoilnutrientbalance(Bruulselmaetal.2012).Fertilizationisunavoidabletocompensateforthedepletionofsoilnutrientsduringtheannualharvestofapplesandnuts.Site-specificfertilizermanagement(SSFM)improvesnutrientuseefficiencyandyieldshigherreturnsonfertilizerinvestments(Ortiz-MonasterioandRaun2007).AtOchajaSubstation,thesiteunderconsiderationisdeficientinnitrogenandpotassium,andforeffectivesoilmanagement,additionalnitrogenandpotassium-basedfertilizerscanincreaseproductivity.Traditionally,amongthefewfarmerswhousefertilizersontheircropsinNigeria,theuseofsolidfertilizerscontainingthemainnutrientsnitrogen,phosphorusandpotassiumiscommon. Theaimofthisstudy therefore, wastoevaluatetheeffectsofNandKfertilizerapplicationsandtheireffectsonsoilpropertiesbasedonsoiltestvaluesoncashewyield.

MATERIALS AND METHODS

Soilsampleswererandomlycollectedwithintheplantationsarea ofOchaja,andsampleswereprocessedandanalyzedforbothphysicalandchemicalpropertiesusingstandardlaboratoryproceduresusingtheIITALaboratoryManual(1982).Calculatedfertilizer ratesarebasedon the result of analysisofsoilsamplesfrom0to40cmdepths.The result of the analysis indicated that the total nitrogen was 0.04g/kg soil which is in adequate to sustain cashew as it requires 1g/kg soil and the available P was adequate while the exchangeable potassium was also deficient having a value of 0.012cmol/kg which is far below the critical limit of 0.12cmol/kg soil.Fromthesevalues,fourtreatmentcombinationsoftworatesofnitrogenfertilizerandtworatesofpotassiumfertilizerwereformedandappliedtoyoungcashewtreesinthefield.Nitrogenfertilizerswereappliedat0and54kgN/ha,potassiumat0and84kgK/ha,treatmentswereplacedinthreereplicateRCBDs,andcropmorphologicalparam

Comment [x4]: Add some latest references describing the role of fertilizers on growth and yield of cashew

Comment [x5]: Keep the same font size throughout the manuscript

Comment [x6]: Sources of fertilizers???

Comment [x7]: What about the phosphatic fertilizer? Why do you not included the phosphatic fertilizers in treatment plan eters,nutyieldandsoilnutrientcharacteristicsweremeasured.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.-Earlyplantgrowthparameterswereusedtoformthebasisforevaluatingtheeffectsoffertilizertreatments.CollecteddataweresubjectedtoANOVAandmeansseparatedusingLSDwith5%probability.

Comment [x8]: Please also mention the age of plants and studied morphological parameters. How much plants were taken as experimental unit.

RESULTS AND DISCUSSION

a) Results of pre – cropping soil analysis

The pre-cropping soilpropertiesindicatedthatthesoilwassandyloam,withaveragevalues forsand,silt,andclayof888,20,and92g/kgsoil,respectively(Table1).ThepHwasslightlyacidic andveryclosetoneutralaveraging6.7,andorganiccarbon(OC)waslowaveraging0.82g/kgsoil.BlockBOCwashigherthanBlockAOC.Totalnitrogeninsoilwas0.41g/kgsoil,whichisbelowthecriticalvalueof1g/kgsoil.Adeficiencyof0.6g/kgsoilrequired54kgNforoptimalproduction,whereastheaverageavailablePwas5.28mg/kgsoil.Thisvalueexceedsthelevelrequiredbycashewsforoptimalproductivity.Themeanpotassiumvaluewas0.012cmol/kgsoil.Adeficitof0.108cmol/kgrequires84kg/ha.Exchangeablecalciumrangedfrom1.26to2.26cmol/kgatsoildepthsof0to40cm,withanaverageof1.68cmol/kg. The exchangeable Mg ranged from 0.25 – 0.35cmol/kg soil with anaverage of0.29cmol/kgsoil.

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 SoilpHof thetwosoildepths(0-20and20-40cm)wassignificantly(p<0.05)affectedbytheapplicationofnitrogenandpotassiumfertilizers.TheUrea (N)fertilizerapplicationhadasignificantdepressiveeffectonsoilpHatbothsoildepthscomparedtothecontroland the plots whereurea (N)andKfertilizerswere 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 0.07g/kg soil where urea (N) fertilizers (T4) were applied. The differences were significantly (P<0.05) different among the treatments. However, the control plot and those that was 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 20cm depths, At 20 to 40cm 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 textured soils generally have limited nutrient holding capacity. Nitrogen is prone to

Comment [x9]: Mention the highest value??

Comment [x10]: ????

Comment [x11]: Did you mean 20-40 cm

leaching in sandy soil as water flows through the more porous structure (Agriculturevictoria, 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.

Comment [x12]: Give the values

f) Influence of application of Urea and Potassium fertilizer on raw cashew nuts
ApplicationofN fertilizer (Urea) promotedcashewgrowth,whichwasreflectedinanincreaseincashewnutyield. The Cashewnutyieldwassignificantly (P < .05)improvedbynitrogenandpotassiumfertilizers(Figure1).Inparticular,Nfertilizerapplicationsignificantly ($p< 0.05$) increasedcashewnutyieldcomparedtothecontrol.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 byAdejumo, (2010) andBabu *et al.,* (2015) that, application of NPK 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 [x13]: Give the vlue of nut yield
Also add results of some other important morphological parameters.

CONCLUSION

Fertilizationbasedon the result of soil test andtheneedsofthesiteyieldsoptimalresultsintermsofefficiencyoffertilizeruse,yieldingbettercrop yieldscomparedto blanket applicationoffertilizerswithoutrelyingontheinherentnutrientsofthesoil.Potassium (K) and nitrogen (N) are two vital nutrients that create greater benefits working together than alone. However,highernitrogenfertilizationresultedinhighercropyieldsandhighernitrogenaccumulation.ItisalsobeneficialwhenSSFMisusedincombinationwithothersoilmanagementtechniquessuchasintegratedsoilfertilitymanagementandconservationagriculture(CA).

Comment [x14]: Add 1-2 lines of specific conclusion// mention the economical rate of nitrogen and K fertilizer.
Message for farming community. What about the phosphatic fertilizers. Why you did not include in treatment plane.

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_2O)**		**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_0K_0–T1Control)	5.13	4.94	0.07	0.03	11.17	10.35	0.16	0.10
N_1K_0-T2	5.77	4.77	0.05	0.03	10.22	9.74	0.14	0.11
N_0K_1-T3	5.27	5.17	0.07	0.03	7.39	8.98	0.14	0.09
N_1K_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: N_0K_0–T1(Control); N_1K_0-T2, N_0K_1-T3, N_1K_1-T4

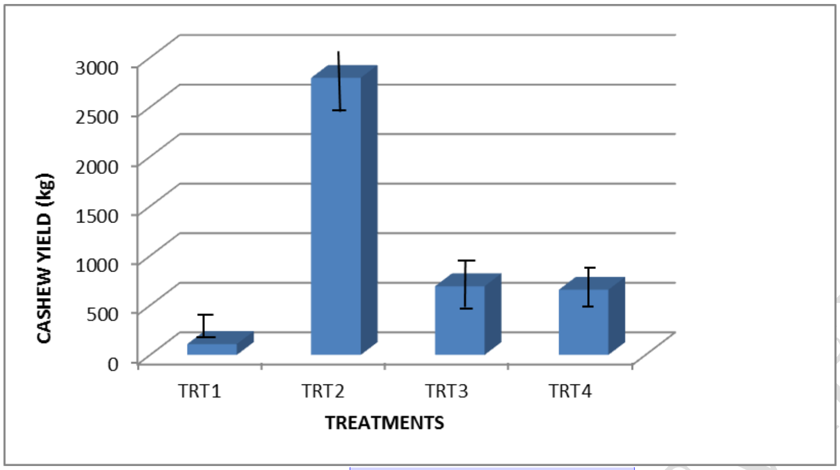

Figure 1: Effects of Nitrogen and Phosphorus based fertilizer on raw cashew yield (kg)

Comment [x15]: It is potassium fertilizer

REFERENCES

Comment [x16]: Cross check the references and arrange according to style of journal

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 . Acta Hortic. 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; Gagandeep Kaur; 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 (*Triticum aestivum* L.). PLoS One. 2022; 17(5): e0264210. Published online 2022 May 24. doi: 10.1371/journal.pone.0264210

Ibiremo, O. S. and Iloyanomon, 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.

Ibiremo O. S, Iloyanomon C. I, OloyedeA. A, LawalJ. O and I. AlhassanI. (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 plantanalysis 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, usingsensor 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'Ivore, Ghana and Nigeria). Sustainable Tree Crop Programme (STCP) and Biohybrids Agrisystem Ltd. U.K. 110.