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Research paper

Effect of nitrogen starter dose and phosphorus fertilizer application on growth, yield characters and grain crude protein content of three varieties of cowpea in anyigba, kogi state, Nigeria

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Anyigba Soils (Lat 7^{0}29' and Long 7^{0}11'E) in Kogi State is deficient in Nitrogen and Phosphorus which retard growth and yield of cowpea crop. A field experiment was therefore conducted during the rainy seasons of years 2018 and 2019 respectively, at the student Research and Demonstration Farm, Faculty of Agriculture, Kogi State University, Anyigba. The aim of the trial was to evaluate the influence of Nitrogen-fertilizer-starter dose and phosphorus on growth, yield attributes, final Grain yield and Grain Crude Protein content of three varieties of cowpea in Anyigba. The N-fertilizer rates were – 0, 10 and 20kg N/ha applied as urea, while the P rates were 0, 37.5 and 75.0 Kg P_2O_5/ha as single super phosphate (26.0% P_2O_5). Factorial experiment was used and treatments were arranged and laid out in Split Plot Design (SPD) and replicated three times. The results indicated that for both years, Nitrogen and Phosphorus application resulted in significant ($P < 0.05$) increases in growth, some yield attributes and final Grain Yield of the three varieties of cowpea. One major significant outcome of the experiment was that while Nitrogen application significantly ($P<0.05$) increased number of nodules produced/plant for all the sampling periods and for both years, phosphorus application however had no significant ($P>0.05$) influence on the character (nodule) throughout the sampling periods and for both years. The highest grain yield of 0.93tonha^{-1} was obtained with application of 10 kg N and 37.5 Kg P_2O_5/ha. Application of 10.0 Kg N ha^{-1} and 37.5 Kg P_2O_5 ha^{-1} of Phosphorus significantly ($P<0.05$) yielded a Crude Protein Content of 20.83% and 23.31% over the control plot which gave 20.54% and 19.17% Crude Protein respectively in 2018 trials. This trend was equally maintained in 2019 trials.

Key words: *crude protein, biomass, harvest index, grain yield, 100 seed weight, threshing percent*

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important grain legumes produced and consumed in sub Saharan Africa (SSA). In addition to the current challenges of climate change, soil nutrient deficiency is on the significant increase in the dry savannah regions where both water stress deficit and poor soil fertility are frequently observed. As a legume, cowpea has the ability to fix atmospheric nitrogen (Ishiyaku et al., 2013). Cowpea is an important grain legume in the dry savannah of the tropics covering 12.5 million hectares with annual production of 3 million tons (FAO, 2005). Nigeria is one of the world largest producers of cowpea with average production of 2.92 million tons followed by Niger republic with 1.1 million tons (FAO, 2012) cowpea can be grown under rain-fed conditions as well as irrigation or residual moisture along rivers, lakes or flood plains during dry season, provided the minimum and maximum temperatures ranges from 18^{0}C (Night) and 30^{0}C (Day) during the growing season. Depending on the variety, cowpea performs well in agro-ecological zones where rainfall ranges between 500mm – 1200mm per year (Madamba et al., 2006). Best yields are obtained in well drained sandy loam soils with pH range of 5 – 7 (Ecocrop, 2009).Cowpea is a major staple food crop in Sub-Saharan Africa, especially in the dry savanna regions of West Africa.

Table 1. Metrological data showing mean monthly rainfall (mm), temperature (^{O}C) and relative humidity (%) of the study area (Anyigba)

Variables		Months															
		2018								2019							
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp (^{0}C)	Min	21.61	21.17	20.71	20.26	20.50	20.00	18.00	15.31	20.3	22.7	22.4	22.1	22.40	21.8	19.3	15.1
	Max	29.52	27.35	27.35	26.61	27.43	27.00	25.31	21.30	31.3	30.7	31.3	27.40	28.33	28.33	23.11	7.61
Rainfall		135.13	170.43	170.43	126.73	201.92	180.62	33.52	4.57	128.4	171.3	173.20	134.30	218.71	123.42	7.61	----
R.H(%)		74.77	74.90	74.90	76.13	77.00	72.00	63.00	57.00	75.00	73.0	75.00	54.00	76.00	86.00	53.00	49.0

Source: *metrological station, department, geography, and physical planning, Kogi state University, Anyigba.*

The grains are major source of plant proteins and vitamins for man, feed for animals, young leaves and immature pods are eaten as vegetable and also source of cash income (Sheahan, 2012). There are available markets for the sale of cowpea grains and fodder across West-Africa. Cowpea does not require too much nitrogen fertilizer because it fixes its own nitrogen from the atmosphere using nodules in its roots. In areas where soils are deficient in nitrogen, there is a need to apply a small quantity such as 15 kg N ha^{-1} as a starter dose for the crop. If too much nitrogen is used, the plant will grow luxuriantly with very low grain yield. Cowpea requires more phosphorus than nitrogen in the form of single superphosphate or SUPA (FAO, 2005). Tropical soils are inherently low in nutrients especially nitrogen and phosphorus (Haruna and Aliyu, 2011). Phosphorus is critical to cowpea yield because it is reported to stimulate growth, initiate nodules formation as well as influence the efficiency of rhizobium-legume symbiosis (Haruna and Aliyu, 2011). In Nigeria under farmers practice, legumes usually receive little mineral phosphorus fertilizers, they therefore rely partly on the natural available soil phosphorus and other nutrients for nitrogen fixation and growth and this has resulted in low yields (Singh et al., 2011 and Nkaa et al., 2014). From the above mentioned problems this study was conducted to determine the best level of phosphorus and Nitrogen (starter dose) that will enhance the growth and yield of the crop. The result of this work is expected to fine-tune phosphorus and nitrogen recommendations for cowpea varieties in Nigeria to the needs of small scale farmer of Anyigba environment.

Table 2. Physio-chemical characteristics of soil taken from experimental site before the establishment of the experiment

Soil Properties	Year	
	2018	2019
Physical properties	0-30cm depth	0-30cm depth
Sand (%)	86.24	85.29
Silt (%)	2.61	03.44
Clay (%)	11.15	11.27
Textural class	Sand-clay loam	Sand-clay loam
Chemical properties		
P^{H} in H_2O	6.13	6.27
Organic Carbon (%)	0.51	0.43
Organic matter (%)	0.88	0.78
Total nitrogen (%)	0.03	0.01
Available phosphorus. (ppm)	9.00	11.40
Exchangeable cation (Cmol/kg)		
K^{+}	2.75	3.65
Mg^{2+}	1.97	2.62
Ca^{2+}	4.16	5.11
Na^{+}	0.95	0.87
CEC (Cmol kg^{-1})	9.83	12.23

MATERIALS AND METHODS

Field experiments were conducted during the 2018 and 2019 cropping seasons in the Research Farm of the Faculty of Agriculture (FA), Kogi State University, Anyigba, Kogi State, Nigeria, located on latitude $7^{0}29^{'}$N and longitude $7^{0}11^{'}$ E on elevation of 420m above sea level. Anyigba which is located within the southern Guinea Savanna Ecological Zone of Nigeria is characterized by an average rainfall of about 180mm mostly distributed between the months of April and October. Mean monthly minimum and maximum temperature of about 17^{0}c and 36.2^{0}c respectively. The soil is generated sandy to sandy-loam. Climatological data collected during the 2018 and 2019 growing seasons are presented in table 1. The physico-chemical properties of the soils of the two sites used for the experiments are presented in table 2. Soil samples were collected from randomly selected points from the research fields. Samples were taken at two depths (0 – 15cm and 15 – 30cm) using tabular auger and bulked. The soils samples were analyzed for physio-chemical properties such as percent clay, silt and sand. Percent organic carbon, total Nitrogen, available P, exchangeable bases, Cation – Exchange – Capacity (CEC), and soil pH. The particle size analysis of the soil was carried out using hydrometer method as described by Day (1965), soil pH in H_2O and 0.01M $CaCl_2$ using a pH meter (Black, 1965), total Nitrogen by Kjedahl method (Bremer and Malvaney, 1982) and (IITA, 1975). Available phosphorus by Bray I method (Bray and Kurtz, 1945). Exchangeable bases by ammonium acetate saturation and Cation Exchange Capacity by ammonium acetate saturation and Cation Exchange by Ammonium Acetate and Extraction and distribution method (Black, 1965). Analyses were conducted for all the bulked samples in both years of the experiments. The experimental site measuring an area of 34.5mx49m (0.169ha) was cleared, ploughed, harrowed to a fine tilt and ridged. Ridges were spaced 75cm apart as the only ridger available to the university had been so calibrated.

Treatment and experimental design

Treatments consisted of three (3) different cowpea varieties (Sampea, 7, Sampea 9 and Local); three (3) phosphorus levels (0, 37.5, and 75.0 kg P_2O_5 ha^{-1}) and three Nitrogen fertilizer level (0, 10.0, and 20 kg N ha^{-1}). This gives 3x3x3 factional combinations of treatments. The experimental Design used was essentially a Randomized Complete Block Design which was arranged in a split-plot manner. Cowpea varieties and phosphorus fertilizers in the form of single-super-phosphate (18% P_2O_5) were allocated to the main plots, while Nitrogen in the form of Urea (46% N) was allocated to the subplots. The main and subplots measured $45m^2$ and $15m^2$ respectively. The main plots consisted of 12 ridges of 75cm width and 500cm (5.0m) length, while the subplots contained four (4) ridges. The experiments were replicated three times with 27 treatments in each replicate making a total of 81 plots in all. The main and subplot areas were 45 m^2 and 15 m^2 respectively.

Cultural practices/data collection

Three to four seeds were sown 25cm apart within the ridges on 9th September, 2018 and on 31st August in 2019 planting seasons. In both years, the young plants were vigorously thinned to two growing plants two-weeks after sowing, giving a plant population of 106, 667 plants per hectare. Phosphorus fertilizer in the form of single super phosphate (18% P_2O_5) was applied at three different rates (0, 37.5 and 75.0 kg P_2O_5 ha^{-1}) at the time of sowing the seeds. However, Nitrogen in the form of urea (46% N) was applied three weeks after sowing to minimize leaching and optimize absorption by the growing crop. The crops were manually hoe weeded at 3 and 6 other sowing. However, weeds that emerged after flowering were hand-pulled. For the control of insect pests such as grasshoppers, crickets and beetles observed on the field, cypermethrin (10% EC) was used at a rate of 100ml/20 litres of water using a knapsack sprayer. At flowering, certain pod sucking insects – such as clavigralla and aphids were prevalent, "sunpyrifos" (48%E.C) (Chlorpyrifos-methyl) at a rate of 50ml / 15 litres of water was used throughout the period of the experiments. Six randomly selected plants were tagged for growth related studies enumerated below: Except for number of branches where studies start 5WAS, all other growth character measurement commenced, 3 weeks after sowing and subsequently at 5, 7 and 9 WAS. The height of each of the tagged plants was measured using a meter rule. This involved measuring the height of all tagged plants from the soil surface to the apical bud of the leaves. Total plant heights for the tagged plant were therefore averaged to get mean plant height. Number of leaves/plant was obtained by simple counts of the total functional leaves produced for the six tagged plants. The total number of leaves was then divided by the total number of tagged (counted plants) to give the average number of leaves per plant. The number of branches produced by the total tagged plants was averaged for the six plants. Counting started five weeks after sowing when primary branches were observed. Dry Weight (Total Biomass): To reduce the rate of duplication of plants from the discard rows, three plants were randomly selected, uprooted, in an envelope and oven-dried to a constant weight at 70^0c for 48 hours. The total weights for the three plants were then averaged. Mature pods were harvested when 90 – 98% of the pods turned brown. This happened at about 13 – 15 WAS. Harvest Index (HI) was calculated by weighing the total grains obtained per plot and divided by the total biological yield (stem + leaves + roots) and multiplied by 100. Grain yield per plot was determined by weighing the grains after shelling and winnowing the pods harvested from each plot. The grain yield per plot was expressed in Kg/ha by multiplying the grain weight from each net plot by a factor of 1333.3.The number of pods per plant was determined by counting the total number of pods in the net plot and dividing it by the total number of plants (80). Length of Ten and only selected Pods from each sub plot were determined using a twin rope. The exact length of the pods was then obtained by matching the rope against a measuring ruler. From the harvested pods a total of 10 randomly selected pods were carefully shelled and counted. The average number of seed/pod was obtained by dividing the total number of grains by 10. Number of Nodules/plant was carried out by carefully uprooting three plants with their nodules in fact. After washing the soil from the roots, the nodules which was clearly be seen are therefore counted with the aid of a hand lens. From the threshed seeds of each subplot, 100 seeds were randomly picked a weighed using a weighing scale (an electronic meter). Threshing percent was determined by dividing the threshed grain weight by the pod weight per plot and multiplied by 100.

Analysis of data

Analysis of Variance (ANOVA) was carried out as described by (Snedecor and Cochran, 1967). The multiple comparison procedure of the Duncan Multiple Range (DMRT) was used to compare means for nitrogen, phosphorus levels, varieties and their interactions. Significant interactions of N x P, N x V, P x V and P x N x V on all characters measured were however ignored, as only main effects of Nitrogen, Phosphorous and Varieties on the different characters were considered.

RESULTS AND DISCUSSION

Mean number of leaves produced/plant by three varieties of cowpea under varying nitrogen and phosphorus fertilizer applications and their interactions for both 2018 and 2019 rainy seasons are presented in table 3.Increased application of nitrogen progressively led to increase ($P<0.05$) in average number of leaves/plant in 2018 for all the sampling periods (Table 3). However, increasedamount of Nitrogen fertilizer application from 0 kg N ha^{-1} to 20.0 kg N ha^{-1} had no significant ($P>0.05$) influence in number of leaves per plant except for 3 WAS in 2019, where N application significantly ($P<0.05$) influenced the character, phosphorus applicationon the other hand had no significant influence on number of leaves throughout the sampling periods and for both years.Response of varietyto either Nitrogen and Phosphorus fertilizer applications vary significantly ($P<0.05$) throughout the sampling periods in both years (Table 3).Local variety consistently produced more leaves/plant than the remaining two improved varieties (Sampea 7 and Sampea 9) through the sampling periods during 2019 rainy season (Table 3).Application of Nitrogen and phosphorus fertilizers significantly ($P<0.05$) led to increase in number of leaves produced per plant in the three varieties planted throughout the sampling periods.

Effects of varying Nitrogen, Phosphorus fertilizers applications on plant height of three varieties of cowpea and their interactions during 2018 and 2019 rainy seasons are presented in table 4. Throughout the sampling periods in 2018, increasing Nitrogen and Phosphorus fertilizers applications significantly ($P<0.05$) produced taller plant. However, in 2019,neither Nitrogen nor phosphorus produced significantly ($P>0.05$) taller plants throughout the sampling Periods. During the 2019 trial, Sampea 9 significantly ($P<0.05$) produced taller plants than the two other varieties throughout the sampling periods. Sampea 9 consistently produced shorter plants in 2018. The coefficient of variabilities for this characters (Plant Height) were: 11.5, 20.6, 32.2 and 26.2% in 2018 and 9.6, 10.5, 12.7 and 9.3% in 2019 for 3, 5, 7 and 9 WAS respectively. N x P, N x V and P x V interactions were significant in 2018 and 2019 respectively while P x V x N was significant only at 7 WAS in 2019 (Table 4). Leaf area production by the three varieties of cowpea under varying Nitrogen and Phosphorus fertilizer applications and their interactions both years are presented in table 5. Application of nitrogen and phosphorus fertilizer progressively led to significant ($P<0.05$) increase in leaf area expansion in both years. However, this trend changed in 2019 where Nitrogen and phosphorus applications hadinsignificantly influenced ($P>0.05$) leaf area expansion during 3 and 5 WAS sampling periods for nitrogen, and 3 WAS for phosphorus (Table 5).Local variety consistently produced larger leaf area during 2018 growing season and early part of 2019. Sampea 7 however out grew the Local varietyand Sampea 9 during the latter part of 2019 rainy season. The Coefficient of Variability (C.V) for this character (leaf area) in 2018 were 29.8, 31.9, 29.6 and 29.0% for 3, 5, 7 and 9 WAS respectively. For 2019 however the C.V were 13.0, 34.8, 68.7 and 32.3% for 3, 5, 7 and 9 WAS corresponding to the serial sampling periods in that order. Only P x V x N interaction was found to be insignificant in both years of the trial.

Table 3. Effect of Phosphorus and Nitrogen fertilizer starter dose on average leaf number produced by three varieties of cowpea at different sampling periods in Anyigba during 2017 and 2018 raining seasons.

	Mean Number of Leaves WAS							
Treatments	2018				2019			
	3	5	7	9	3	5	7	9
Nitrogen (kg ha^{-1}) (N)								
N_0	17.03	40.87	72.70	62.97	14.12	56.28	96.20	86.56
N_1	19.40	45.03	83.80	72.84	14.36	56.64	100.11	86.56
N_2	20.77	49.41	91.68	87.98	15.32	56.09	110.09	90.00
LSD (0.05)	2.00	5.77	11.93	10.67	1.00	n.s	n.s	*
Phosphorus (kg P_2O_5 ha^{-1}) (P)								
P_0	17.85	42.74	70.74	61.86	13.97	48.42	87.47	82.18
P_1	19.60	48.27	86.79	82.61	15.50	59.58	106.63	87.79
P_2	19.75	44.30	90.65	79.31	14.33	61.01	112.30	96.20
LSD (0.05)	n.s	n.s	n.s	n.s	n.s	n.s	n.s	*
Variety (v)								
V_1 (Local)	18.72	41.17	81.50	75.11	17.56	70.79	139.26	116.85
V_2(Sampea 7)	19.41	43.21	86.67	76.44	13.48	54.70	108.16	107.05
V_3(Sampea 9)	19.07	44.94	80.02	72.23	14.33	61.01	112.30	96.20
LSD (0.05)	4.06	13.27	27.45	24.54	2.3	17.71	21.24	32.73
Interactions								
N x P	*	**	*	*	*	**	**	*
N x V	*	*	*	**	**	**	**	**
P x V	*	*	*	**	**	**	**	**
P x V x N	n.s	n.s	n.s	*	n.s	n.s	n.s	*
C.V%	19.1	23.2	26.1	25.9	12.40	24.8	25.3	29.1

*WAS=weeks after sowing; *= 5%; **= 1% level probability; ns= not significant*

Table 4. Effect of Phosphorus and Nitrogen fertilizer starter dose on average plant height of three varieties of cowpea at different sampling periods in Anyigba during 2017 and 2018 raining seasons.

	Plant Height WAS							
Treatment	2018				2019			
	3	5	7	9	3	5	7	9
Nitrogen (kg ha^{-1}) (N)								
N_0	10.41	19.34	56.23	64.77	10.11	17.00	20.89	19.80
N_1	11.00	21.56	65.10	75.90	10.03	17.14	20.89	19.80
N_2	11.66	24.27	78.76	85.69	09.96	17.31	21.21	19.07
LSD (0.05)	0.70	2.46	11.91	10.93	n.s	n.s	n.s	n.s
Phosphorus (kg P_2O_5 ha^{-1}) (P)								
P_0	10.65	18.29	56.52	66.60	9.77	16.06	20.34	18.52
P_1	11.04	21.48	71.02	81.57	10.39	17.86	21.50	19.13
P_2	11.36	25.40	73.44	78.20	9.93	17.54	20.83	19.69
LSD (0.05)	n.s	4.60	15.00	23.69	n.s	n.s	n.s	n.s
Variety (v)								
V_1 (Local)	11.22	24.00	74.88	91.15	9.61	16.10	18.42	15.57
V_2(Sampea 7)	11.04	21.54	66.41	70.00	9.60	16.14	19.23	18.17
V_3(Sampea 9)	10.80	19.67	59.69	65.21	10.90	19.22	25.02	23.60
LSD (0.05)	n.s	4.60	15.00	23.69	n.s	2.30	3.45	2.25
Interactions								
N x P	**	**	*	**	*	*	*	*
N x V	*	*	*	**	**	**	**	**
P x V	*	*	*	*	*	**	**	**
P x V x N	n.s	n.s	n.s	n.s	n.s	n.s	*	n.s
C.V%	11.5	20.6	32.2	26.2	9.6	10.5	12.7	9.3

*WAS=weeks after sowing; *= 5%; **= 1% level probability; ns= not significant.*

Table 5: Effect of Phosphorus and Nitrogen fertilizer starter dose on average Leaf area/plant produced by three varieties of cowpea at different sampling periods in Anyigba during 2017 and 2018 raining seasons.

	Leaf Area/plant (LAP) WAS							
Treatment	2018				2019			
	3	5	7	9	3	5	7	9
Nitrogen (kg ha^{-1}) (N)								
N_0	396.90	1533.71	2929.31	2227.35	388.13	2989.54	2655.96	2813.34
N_1	476.30	1746.75	3508.71	2473.93	426.12	3010.88	2952.78	2817.93
N_2	543.37	2014.96	4029.26	3297.49	575.20	3027.87	3880.86	2789.49
LSD (0.05)	77.59	310.76	570.75	426.11	n.s	n.s	1199.43	501.15
Phosphorus (kg P_2O_5 ha^{-1}) (P)								
P_0	366.12	1536.43	2671.05	2129.13	324.88	2305.97	2218.96	2423.63
P_1	502.26	1954.30	3614.83	2861.64	666.87	3319.20	3926.51	2870.99
P_2	548.24	1804.69	4181.39	3008.00	397.71	3403.12	3344.13	3126.14
LSD (0.05)	178.46	n.s	1312.73	860.05	n.s	1000.31	1499.43	693.15
Variety (v)								
V_1 (Local)	518.84	1821.07	3519.13	2858.79	690.99	2691.12	327869.69	3152.66
V_2(Sampea 7)	454.53	1738.57	3503.31	2609.41	394.56	2928.63	3104.13	3411.00
V_3(Sampea 9)	443.25	1735.78	3444.84	2530.57	353.89	3408.54	3106.78	1857.14
LSD (0.05)	178.46	713.00	1312.73	n.s	n.s	1000.31	n.s	693.15
Interactions								
N x P	**	**	**	**	*	*	*	*
N x V	*	*	*	*	*	n.s	*	**
P x V	**	*	**	**	*	*	**	**
P x V x N	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
C.V%	29.8	31.9	29.6	29.0	13.0	34.8	68.7	32.3

*WAS=weeks after sowing; *= 5%; **= 1% level probability; ns= not significant.*

Table 6: Effect of Phosphorus and Nitrogen fertilizer starter dose on average number of branches/plant produced by three varieties of cowpea at different sampling periods in Anyigba during 2017 and 2018 raining seasons.

	No of Branches/plant WAS					
Treatment	2018			2019		
	5	7	9	5	7	9
Nitrogen (kg ha^{-1}) (N)						
N_0	2.04	2.41	2.63	2.21	2.71	3.10
N_1	2.41	2.75	2.89	2.55	2.90	3.38
N_2	2.81	3.11	3.29	2.80	3.17	3.90
LSD (0.05)	0.43	n.s	0.40	0.30	0.21	0.22
Phosphorus (kg P_2O_5 ha^{-1}) (P)						
P_0	2.03	2.54	2.61	2.09	2.64	3.01
P_1	2.63	2.74	2.93	2.68	2.87	3.27
P_2	2.60	3.00	3.27	2.90	3.25	4.02
LSD (0.05)	n.s	n.s	n.s	0.60	0.46	0.51
Variety (v)						
V_1 (Local)	2.20	2.54	2.90	2.29	2.62	3.42
V_2(Sampea 7)	2.79	2.97	3.15	2.78	3.08	3.45
V_3(Sampea 9)	2.27	2.77	2.75	2.50	3.07	3.49
LSD (0.05)	n.s	n.s	n.s	n.s	0.46	n.s
Interactions						
N x P	*	**	**	*	**	**
N x V	*	*	*	*	**	**
P x V	*	*	*	*	**	**
P x V x N	n.s	n.s	n.s	n.s	n.s	n.s
C.V%	31.9	23.7	24.8	21.2	12.9	11.6

*WAS=weeks after sowing; *= 5%; **= 1% level probability; ns= not significant.*

Table 7: Effect of Phosphorus and Nitrogen fertilizer starter dose on average number of nodules/plant by three varieties of cowpea at different sampling periods in Anyigba during 2017 and 2018 raining seasons.

	No of Nodules/plant WAS					
Treatment	2018			2019		
	4	6	8	4	6	8
Nitrogen (kg ha^{-1}) (N)						
N_0	7.39	8.10	13.09	12.54	17.43	21.73
N_1	10.65	13.83	19.43	17.08	23.24	27.07
N_2	15.98	19.63	25.02	22.02	29.15	33.13
LSD (0.05)	3.97	2.71	2.31	2.56	1.95	1.91
Phosphorus (kg P_2O_5 ha^{-1}) (P)						
P_0	11.31	14.50	18.27	18.10	23.20	27.79
P_1	12.65	13.54	20.26	16.83	22.09	26.17
P_2	10.06	13.51	19.01	16.71	24.53	27.69
LSD (0.05)	n.s	n.s	n.s	n.s	n.s	n.s
Variety (v)						
V_1 (Local)	9.22	12.47	16.77	15.34	20.57	25.69
V_2(Sampea 7)	13.41	15.99	20.88	19.88	26.52	29.71
V_3(Sampea 9)	11.39	13.10	19.90	16.42	22.73	26.53
LSD (0.05)	n.s	n.s	n.s	n.s	4.48	4.00
Interactions						
N x P	**	**	**	**	**	**
N x V	*	*	*	**	**	**
P x V	**	**	**	**	**	**
P x V x N	n.s	n.s	n.s	n.s	n.s	n.s
C.V%	63.4	38.1	21.8	26.90	15.22	12.70

*WAS=weeks after sowing; *= 5%; **= 1% level probability; ns= not significant.*

Table 8: Effect of Phosphorus and Nitrogen fertilizer starter dose on average numbers of pod/plant, seed/pod and pod length (cm) produced by three varieties of cowpea in Anyigba, during 2017 and 2018 raining seasons.

	Means Values					
Treatment	2018			2019		
	NP/P	NS/P	PL/P	NP/P	NS/P	PL/P
Nitrogen (kg ha^{-1}) (N)						
N_0	41.46	7.77	14.88	5.83	9.27	18.77
N_1	48.73	8.61	15.50	5.86	9.49	19.08
N_2	56.19	8.96	16.03	6.24	9.78	19.10
LSD (0.05)	6.41	0.97	1.01	0.31	n.s	0.79
Phosphorus (kg P_2O_5 ha^{-1}) (P)						
P_0	42.87	8.24	14.70	5.54	9.22	15.35
P_1	49.05	8.63	15.78	6.76	9.44	15.56
P_2	54.46	8.47	15.93	5.64	9.88	26.04
LSD (0.05)	n.s	n.s	1.2	0.78	0.56	0.79
Variety (v)						
V_1 (Local)	48.74	8.42	15.15	5.70	9.39	15.72
V_2(Sampea 7)	49.66	8.24	16.03	6.42	9.51	18.41
V_3(Sampea 9)	47.99	8.67	15.23	5.82	9.63	22.80
LSD (0.05)	n.s	n.s	n.s	n.s	0.84	0.79
Interactions						
N x P	**	n.s	*	*	*	**
N x V	*	n.s	*	**	*	**
P x V	**	n.s	*	**	*	**
P x V x N	n.s	n.s	n.s	n.s	n.s	n.s
C.V%	23.8	20.8	11.8	34.2	16.00	7.60

*WAS=weeks after sowing; *= 5%; **= 1% level probability; ns= not significant. NP/P= number of pods/plants, NS/P= number of seeds/pods, PL/P= pod length/plant.*

Table 9. Effect of Phosphorus and Nitrogen fertilizer starter dose on 100-seed weight (g), threshing% and final grain yield (tons/ha) of three varieties of cowpea in Anyigba, during 2017 and 2018 raining seasons.

	Means values.					
Treatment	2018			2019		
	100SW	T%	GY(T/ha)	100SW	T%	GY(T/ha)
Nitrogen (kg ha^{-1}) (N)						
N_0	20.96	49.48	0.25	30.04	74.09	0.82
N_1	22.24	51.42	0.29	30.67	74.01	0.93
N_2	23.91	50.53	0.31	30.06	71.63	0.93
LSD (0.05)	1.75	n.s	0.01	1.86	4.49	0.05
Phosphorus (kg P_2O_5 ha^{-1}) (P)						
P_0	22.43	49.96	0.27	29.50	74.07	0.84
P_1	22.15	50.35	0.28	30.50	74.27	0.92
P_2	22.54	51.12	0.30	31.06	71.39	0.92
LSD (0.05)	n.s	n.s	0.02	n.s	4.49	0.07
Variety (v)						
V_1 (Local)	23.67	48.78	0.34	39.93	70.21	0.92
V_2(Sampea 7)	22.02	49.12	0.23	25.72	78.78	0.74
V_3(Sampea 9)	21.43	53.53	0.29	25.11	70.75	1.02
LSD (0.05)	n.s	n.s	0.02	1.86	4.49	0.07
Interactions						
N x P	n.s	n.s	n.s	*	*	n.s
N x V	n.s	n.s	n.s	**	*	*
P x V	n.s	n.s	n.s	**	*	*
P x V x N	n.s	n.s	*	n.s	n.s	n.s
C.V%	14.2	30.4	36.0	11.1	11.1	22.1

*WAS=weeks after sowing; *= 5%; **= 1% level probability; ns= not significant. 100SW= 100seed weight, T%= threshing%, GY(T/ha) = seed yield/ha.*

Table 10. Effect of Phosphorus and Nitrogen fertilizer starter dose on crude protein (%), biomass yield (tons/ha) and harvest index (%) of three varieties of cowpea in Anyigba, during 2017 and 2018 raining seasons.

	Means values.					
Treatment	2018			2019		
	100SW	T%	GY(T/ha)	100SW	T%	GY(T/ha)
Nitrogen (kg ha^{-1}) (N)						
N_0	20.96	49.48	0.25	30.04	74.09	0.82
N_1	22.24	51.42	0.29	30.67	74.01	0.93
N_2	23.91	50.53	0.31	30.06	71.63	0.93
LSD (0.05)	1.75	n.s	0.01	1.86	4.49	0.05
Phosphorus (kg P_2O_5 ha^{-1}) (P)						
P_0	22.43	49.96	0.27	29.50	74.07	0.84
P_1	22.15	50.35	0.28	30.50	74.27	0.92
P_2	22.54	51.12	0.30	31.06	71.39	0.92
LSD (0.05)	n.s	n.s	0.02	n.s	4.49	0.07
Variety (v)						
V_1 (Local)	23.67	48.78	0.34	39.93	70.21	0.92
V_2(Sampea 7)	22.02	49.12	0.23	25.72	78.78	0.74
V_3(Sampea 9)	21.43	53.53	0.29	25.11	70.75	1.02
LSD (0.05)	n.s	n.s	0.02	1.86	4.49	0.07
Interactions						
N x P	n.s	n.s	n.s	*	*	n.s
N x V	n.s	n.s	n.s	**	*	*
P x V	n.s	n.s	n.s	**	*	*
P x V x N	n.s	n.s	*	n.s	n.s	n.s
C.V%	14.2	30.4	36.0	11.1	11.1	22.1

The responses of three varieties of cowpea to application of varies nitrogen and phosphorus fertilizer levels as it relates to the number of branches produced per plant of the crop in both years of the trial are presented in table 6.The application nitrogen fertilizer led significantly (P<0.05) to increase in number of branches produced per plant at 5, and 9 WAS in 2018. However, in 2019 all the plots treated with nitrogen fertilizer significantly (P<0.05) produced more branches than the control plots. In 2019 season, control plots had an average of 2.21, 2.71 and 3.10 branches for 5, 7 and 9 WAS sampling periods. However, plots treated with 20 kg N ha^{-1} significantly (P<0.05) produced 2.8, 3.17 and 3.90 branches for the same sampling periods. The number of branches produced by plants treated with 20 kg and 10 kg N per hectare were however statistically at par. Phosphorus application had no significant (P>0.05) influence on number of branches produced per plant during 5, 7 and 9 WAS sampling periods in 2018 rainy season. This trend however changed in 2019, where application of P-fertilizer significantly (P<0.05) led to increase in number of branches/plant at all sampling stage (table 6). Varietal response to nutrient application was however not significant (P>0.05) for both years and sampling period, but improved varieties Sampea 7and Sampea 9 significantly (P<0.05) produced more branches (3.07 and 3.08) than the local variety (2.62) at 7 WAS in 2019 rainy season.The interactions of N x P, N x V and P x V with respect to number of branches produced per plant were however significant (P<0.05) for both years and sampling periods.

Table 7 shows the number of Nodules produced per plant in both years of the trials. Application of nitrogen progressively led to significant (P<0.05) increase in number of nodules produced per plant for both 2018 and 2019 rainy seasons. This finding corroborate those of Atkins, (1986) who reported that mineral nitrogen application enhance nodulation, but according to him at later stages of the plant growth. Phosphorus application however had no significant (P>0.05) effect on the number of nodules / plant for all the sampling periods and for both years of the trial. The non-significant response of nodulation to application of phosphorus is supported by works of Tewari, (1965) who recorded significant response of nodulation in cowpea to P-application. Varietal differences in relation nodule production per plant were however not significant (P>0.05) for 2018 for all sampling periods, except for 2019 where Sampea 7 significantly (P<0.05) produced more nodules/plant than either of the remaining two varieties (Local and Sampea 9) Table 7. The interactions of N x P, N x V and P x V on number of nodules/plants were significant (P<0.05) for both years and for all the sampling periods. Coefficient of variability for this character in 2018 were 63.4, 38.18, 21.8% for 4, 6 and 8 WAS respectively. The C.V in 2019 were 26.90%, 15.22% and 12.70% for 4, 5, and 8 WAS respectively.

Most Growth and Yield attributes studied increased significantly with increase in Nitrogen and Phosphorus application. This observation agrees with the results obtained by (Kow and Nabwani, 2015), who observed that Nitrogen and phosphorus promote rapid growth, increase leaf size, enhances fruit and seed development as according to them, they form an integral component of many important components in plants including aminoacids that are building blocks of proteins and enzymes, that are involved in catalyzing most biochemical processes (Brady and Weil, 2008). As determined by its functions, Nitrogen influences the rate of crop growth and crop quality.

The influence of Nitrogen, Phosphorus, Variety and the various interactions existing between and among the factors on these characters are presented in table 8. Nitrogen application significantly (P<0.05) influenced the number of pod/plant, number of seed/pod and pod length/plant 2018. Application of phosphorus significantly (P<0.05) increased all the parameters (Pod/plant, number of seed/pod and pod/length/plant) in 2019 planting seasons only, while in 2018 phosphorus application resulted in increased pod length/plant. In 2018, application of 75.0 kg P_2O_5 ha^{-1} resulted in increased pod length from 14.70 cm (control plots) to 15.90 cm. The cowpea varieties grown in 2018 had not significantly (P>0.05) influence in the three characters studied except in 2019, when Sampea 9 significantly (P<0.05) produced longer pods (22.80 cm) and more seeds/pod (9.63) than the remaining two varieties (table 8). Research has determined that Phosphorus improves crop quality in a number of ways including: reduced grain moisture content, winter hardiness, increased sugar content, increased protein content, increased phosphorus content, increased proportion or marketable yields, better feed value, and improved drought and disease resistance in crops such as wheat and maize (Halvin*et al.,* 2005 and Anonymous 1999).The interactions of N x P were significant for NP/P, PL/P (in 2018) and NP/P, and PL/P in 2019 rainy season only. N x V and P x V were significant (P<0.05) for the three characters in 2019 rainy season NP/P and PL/P were only significant for N x V interactions only in 2018 rainy season. The P x V x N on all the three characters studied was neither significant (P>0.05) for the characters and for the both years. The coefficient of variabilities obtained for NP/P, NS/P and PL/P were 23.8%, 20.8% and 11.8% in 2018; and 34.2%, 16.00% and 7.60% respectively in 2019 rainy season. The three varieties grown did not differ significantly (P>0.05) in NP/P and NS/P, except for PL/P where control plots (local variety) produced significantly (P<0.05) longer pods (18.74cm) than Sampea 7 (15.88cm). In 2018 trial significantly (P<0.05) higher number of pod/plant (48.79) were recorded than those recorded in 2019 (32.21)

The effect of Nitrogen, Phosphorus fertilizer applications, variety and the various interactions existing between and among the factors on the various characters are presented in table 9. Increasing nitrogen application from 0 kg ha^{-1} to 20 kg N ha^{-1} significantly (P<0.05) resulted in increased 100-seeds wt, threshing percentage in 2019. Phosphorus application however gave aninsignificant (P>0.05) yield in 100-seed wt and threshing % (in 2018), however, in 2019, application of P-fertilizer resulted in significant (P<0.05) increase in Threshing % and final grain yield.Application of 75.00 kg P_2O_5 ha^{-1} P-fertilizer in 2018 and 2019 resulted in 10% and 9.5% increases respectively, over the control plot (table 9)In 2018, non-response of the three varieties to100-seed wt (100SW) and Threshing Percentage (T%) was observed (Table 9). For both years, Sampea 9 yielded significantly (P<0.05) higher grain weight per hectare than either of the two remaining varieties. In 2019, a grain yield of 1.02 ton/ha representing a 10% yield difference with local variety was recorded for Sampea 9. In 2018, the average grain yield of Sampea 9 was 0.29 ton ha^{-1}, while the local was 0.34 ton/ha^{-1}, there was however no significant difference between the yield obtained from the local variety (0.34 ton ha^{-1}) and that for Sampea 9 in 2018.

Table 10 presents results of N, P and V on Crude Protein (C.P), Biomass yield and Harvest index during 2018 and 2019.Increasing Nitrogen and Phosphorus fertilizers applications per hectare significantly (P<0.05) resulted in increased C.P and Biomass Yield in both 2018 and 2019 rainy seasons. N and P have been found to increase plumpness in cereal grains, the protein content of both seeds and foliage, and the succulence of crops such as lettuce and radish (Foth and Ellis, 1998). However, nitrogen and phosphorus applications had no influence on harvest index in 2018, and phosphorus application on C.P in 2019. Application of 10.0kgNha^{-1} in 2018 and 2019 resulted in significant increase in crude protein values of 1.41% and 1.00% respectively over the 10. The improved varieties (Sampea 7 and 9) consistently produce higher (P<0.05) crude protein content than the local variety in both 2018 and 2019. Most nutrients produce the best results under balanced nutrition. A 25% maximum protein content was reported from a plot fertilized at a combination of 50 – 75 Kg N P ha^{-1} as compared to other combinations of N (0, 25 and 50 Kg N ha^{-1}) and P (0, 50, 75 and 100 Kg ha^{-1}) in

Pakistan (Malik et al., 2003). The interactions of N x P, N x V and P x V were significant (P<0.05) for C.P, Biomass Yield and Harvest Index in 2018 and 2019. The interaction of P x V x N on these three factors (C.P, HI and Biomass Yield) was however not significant (P>0.05) for both years of the trials. The coefficient of variability (C. V%) for these characters were 1.7%, 23.9% and 35.30% (2018) and 3.0 26.20 and 36.30% (2019) respectively. Synergistic effect is one of the factors that increases crop quality as far as N and P applications are concerned. Application of 40 kg P ha^{-1} increased N and K accumulation in maize grain by 22.5% and 21.2% respectively (Husseini et al., 2008). Generally, crude protein in cowpea seeds significantly increased with an increase in the rate of N-fertilizer application. This was mainly due to the structural role of nitrogen in building of amino acids (Chintala et al., 2012). This result is in agreement with the report of (Singh et al., 2006), that the application of N significantly increased the percentage of protein in cowpea.

CONCLUSION

One significant major outcome of these experiments, is that Nitrogen, applied in the form of starter dose is not only essential for cowpea growth and development in soils precariously deficient in soil N, but more importantly in the improvement in quality of seed-grain cowpea (Crude Protein). One reason for the prevalent malnutrition in developing countries, Nigeria inclusive, is the extreme poverty status of most people, which makes it difficult for them to afford the necessary quality of protein in their diet. Therefore, the application of N-Starter dose for cowpea which improves the quality (increase crude protein) of the crop may serve as perquisite for improving the diet's quality and thus combating malnutrition not only in Nigeria, but in the entire Sub-Saharan Africa (SSA).

AUTHOR CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author Musa, Umaru Tanko designed the study, wrote the protocol and interpreted the data. Author Yusuf Momohjimoh anchored the field study, gathered the initial data and performed preliminary data analysis. Both authors managed the literature searches and produced the initial draft. Both authors read and approved the final manuscript.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

ETHICS APPROVAL

Not applicable.

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