YIELD AND AGRONOMIC EFFICIENCY QF COWPEA VARIETIES *(Vigna unguiculata L.* Walp) UNDER VARYING PHOSPHORUS RATES IN LAFIA, NASARAWA STATE

I. M. Haruna[1]* and U. Alhassan[2]

'Department of Agronomy, Nasarawa State University P.M.B. 1022, Keffi, Nigeria
'Department of Plant Science, Ahamadu Bello University, Samaru Zaria, Nigeria
* *Corresponding author: ibrahimmharuna@yahoo.com
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Abstract

Savanna soils of Nigeria are inherently low in nutrients (particularly nitrogen and phosphorus) thereby resulting in low yield of crops. To this end, field experiments were conducted at the Teaching and Research Farm of College of Agriculture Lafia in the Southern guinea savanna zone of Nigeria (08° *3tfNand* 08° *3(fE, 18m above sea level) during the rainy seasons of 2009, 2010 and 2011 to evaluate the yield and agronomic efficiency ofcowpea varieties under varying phosphorus application rates. The experiment consisted of four levels of phosphorus in the form of single super phosphate (0, 30 and 60 kg* P *ha'[1]) and four varieties (DAN ILA,* JAR-45, *IT90K-277-1 and IT93K-452-1). The twelve treatment combinations were laid out in a randomized complete block design with three replications. The results obtained showed that number of pods per plant, pod yield per plant, seed yield per plant, number of seeds per pod, 100 seed weight and seed yield per hectare were significantly increased by the application of 30 kg* P *ha'[1] in all the years of the experiment. Variety IT90K-277-1 consistently produced significantly, the highest values for all yield and yield characters measured. Agronomically, application of 30 kg* P *ha'[1] was significantly more efficient than 60 kg* P *ha[1]. Application of30 kg* P *ha' to variety IT90K-277-1 produced significantly, the highest seed yieldper hectare and is therefore recommended.*

Key words: Number of pods, seed yield, pod yield, number of seeds pod, agronomic efficiency

INTRODUCTION

Cowpea *(Vigna unguiculata* L.) Walp) is an important grain legume in the dry savanna of the tropics covering 12.5 million hectares with annual production of about 3.3 million tons (FAO, 2005). Nigeria is the world's largest producer with 2.1 million tones followed by Niger with 650,000 tones and Mali with 110,000 tones (HTA, 2003). Cowpea remains a leading legume in the recipe of the people in sub-Sahara Africa, supplying majority of the plant protein for human nutrition. The crop is essentially grown for the seed grains although the use of the green pods as vegetable cowpea is becoming important too. Despite the various uses to which the crop is put to, its yields are very low due to several constraints including poor soil and use of low yielding variety of seeds as planting material.

Savanna soils are inherently low in nutrients particularly nitrogen and phosphorus (Haruna *et al.,* 201'i}. Phosphorus (P) is among the most needed elements for crop production in many tropical soils. Phosphorus! is critical to cowpea yield because it is reported to stimulate growth, initiate nodule formation as well as influence the efficiency of the rhizobium legume symbiosis (Haruna and Aliyu, 2011). All growing plants require P for growth and development in significantly large quantity. Other workers have reported that phosphorus application influences the content of others nutrients in leaves and seeds (Muleba and Ezumah, 1985). The deficiency can be so acute in some soils of the savanna zone of western Africa that plant growth ceases as soon as the P stored in the seed is exhausted (Kang and Naggos, 1983).

High productive potential of cowpea has been reported by various workers through the use of organic and inorganic fertilizers (Abd Elmajeed *et al,* 2001; Madukwe *et al.,* 2008; Singh et al., 2011) but efficiency of the applied fertilizer^) is rarely documented. This work therefore seeks to evaluate the yield and agronomic efficiency of cowpea varieties under varying phosphorus rates,

MATERIALS AND METHODS

Field experiments were conducted at the research farm of College of Agriculture Lafia in the Southern guinea savanna zone of Nigeria (08° 30[7] N and 08° 30/E, 18m above sea level) on a sandy soil low in total nitrogen, available phosphorus and organic carbon (0.02%, 2.613 Cmol kg[1] and 1.07% respectively) during tiie rainy seasons of 2009,2010

and 2011 to evaluate the yield and agronomic efficiency of cowpea varieties under varying phosphorus rates. The experiment consisted of four levels of phosphorus in the form of single super phosphate (0,30 and 60 kg P ha'1) and four varieties pAN ILA, IAR-48, IT90K-277-1 and IT93K-452-1). The twelve treatment combinations were laid out in ,a randomized complete block design with three replications.

The gross plot size was 18m2 (4.5m x 4m) while the net plot size was 9m2 (3m x 3m). The experimental area was disc-ploughed and harrowed twice to a fine tilt. This was then followed by ridging at 75cm apart (between rows) and the field marked into plots and replications. The plots were separated by 1.0m unplanted boarder while replications were separated by 2.0 m unplanted boarder. The four rates of phosphorus were incorporated into the plots according to treatment and field plan before sowing. Sowing was done on ridges 75cm apart at 30cm intra row spacing according to field plan and treatment combinations. Manual hoe weeding was done at 3, 6, and 9 WAS to keep the experimental plots weed-free.

The crop was harvested at physiological maturity when the pods had turned yellow. Yield data per plant such as number of pods per plant was obtained by plugging all the pods from ten randomly selected plant samples and the mean recorded. Pod yield per plant was obtained by weighing all the pods plugged from ten selected plant samples and the mean recorded. Seed yield per plant was obtained by threshing the pods from the ten randomly selected plant samples, winnowed, the clean seeds weighed and the mean recorded. Number of seeds per pod was obtained by counting the seeds from twenty randomly selected pods from each net plot and the mean recorded. Pod yield per hectare was obtained by plugging and weighing all the pods in the net plot and the value so obtained was converted to per hectare basis. Seed yield per hectare was obtained by weighing the cleaned seeds from each net plot and the value so obtained was converted to per hectare basis. Hundred seed weight was obtained by weighing hundred randomly selected seeds from each 'net plot. Agronomic efficiency of the phosphorus fertilizer applied was calculated using theformular:

AE = (yield Fyield C)/Quaritity of nutrient applied

Where: yield F = yield of fertilized cowpea (kg), Yield C = yield of the control cowpea to which no fertilizer was applied (kg). The data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967) and significant differences among the treatment means were evaluated using Duncan's Multiple Range Test as described by Duncan(1955).

RESULTS AND DISCUSSION

Tables 1,2 and 3, shows the effects of phosphorus and variety on the yield characters of cowpea during the rainy seasons of 2009, 2010 and 2011 respectively. Application of 30 kg P ha'1 produced significantly higher number of pods per plant, pod yield per plant, seed yield per plant, number of seeds per pod and 100 seed weight compared with the control in all the years of the experiment. Increasing the rate of applied P from 30 kg P ha"1 to 60 kg P ha'1, significantly decreased all the yield characters measured in 2009,2010 and 2011.

In 2009, 2010 and 2011, Variety rT90k-277-l produced significantly, higher number of pods per plant, pod yield per plant, seed yield per plant, number of seeds per pod and 100 seed weight compared with other varieties tested. This is followed by varieties IT93K-452-1, IAR-48 and DAN ILA in descending order. Similarly, application of 30 kg P ha"1 produced significantly higher seed yield of cowpea per hectare in 2009, 2010 and 2011 compared with the control and other level of applied P (Table 4). The highest seed yield of cowpea per hectare in all the years of the experiment was produced by variety IT90K-277-1 followed by varieties IT93K-452-1, IAR-48 and the DAN ILA.

Highly significant interaction occurred between applied P and the varieties tested (Table 5). The result of the interaction showed that application of 30 kg P ha'1 to variety IT90K-277-1 produced significantly higher seed yield per hectare compared with other rate of applied P to any variety. The least seed yield per hectare was produced by the local variety to which no P was applied.

Agronomic efficiency of phosphorus fertilizer applied to cowpea varieties indicated that application of 30 kg P ha"1 was more efficient (with an efficiency values of 23.1,16.2 and 25.5 in 2009, 2010 and 2011 respectively) compared to any other applied rates of P (Table 6). This was followed by application of 60 kg P ha'1 with efficiency values of 21.7, 15.2 and 23.8 in 2009, 2010 and 2011 respectively.

The significant response of the yield and yield characters of cowpea measured to P application

could be attributed to the very low content of the soil available P (as stated in the materials and methods above). It could also be attributed to the role of P in seed formation and grain filling (Haruna, 2011). The highest yield and yield characters recorded by the application of 30 krj P ha" 1 and not the highest rate of applied P (60 kg ha"1) could probably be attributed to fact that 30 kg P ha"1 is the optimum rate of P required for higher yield in cowpea. This result is in conformity with the findings of Abd El-Majeed *et al*, (2011); Singh *et al*., (2011),

The highest yield produced by variety IT90K-277-1 compared with other varieties tested could be due to its superior genetic composition which efficiently utilised the available resources for growth and development that eventually translated to higher yield and yield characters. The higher values recorded for yield and yield characters of cowpea varieties in 2011 compared to 2009 and 2010 could be attributed to the fact that in 2011, rainfall during the growing period (August to October) was uniformly distributed and there was no rain in the month of November that could damage the ripped pods thereby reducing the yield as it occurred in 2009 and 2010 (Table 7). The higher values of agronomic efficiency of applied P at 30 kg ha"1 could be attributed to the fact that, consistently that applied rate produced the highest yield in 2009,2010 and 2011.

Table 1: Effects of phosphorus and variety on the yield attributes of cowpea during the rainy seasons of 2009 at Lafia

Treatments	No. of pods per plant	Pod yield per plant (e)	Seed yield per plant (g)	No. of seed per pod	100 seed weight (g)
Phosphorus (kg ha"		.-			
0	13.1c	63.8c	3.7v2c	8.4c	8.9c
30	25.2a	108.3a	63.2a	15.8a	33.8a
60	19,0b	85.0b	49.6b	12.5b	ll.lb
LSD	0.70	1.07	0.65	0,52	0.24
Variety					
DANELA	I6.1d	73.6d	42.9d	10.4d	10.2d
IAR-48	17.7c	77.5c	45.2c	10.7c	11.0c
IT90K-277-l	22.8a	100.2a	58.4a	14.9a	12.4b
IT93K-452-1	19.8b	91.6b	53.5b	13b	11..4b
LSD	0.81	1.23	0.75	0.60	0,27

Means followed by different letters) within the same treatment group and column are statistically different at 5% level of probability.

Table 2: Effects of phosphorus and variety on the yield attributes of cowpea during the rainy

seasons of 2010 atLafia

Treatments	No. of pods per plant	Pod yield per plant (g)	Seed yield per plant (g)	No. of seed per pod	100 seed weight (g).
Phosphorus (kg ha0 . 0	9.2c	. 44.7c	26.1c	5.2c	6.2c
30	17.4a	75,8a	44.2a	8.6a	9.6a
60	13.3b	59.5b	34.7b	7.5b	7.8b
LSD	0.42	0.75.	0.45	0.34	0.16
	11.3d				
	113dl· Mi				
IAR-48	12.4c	54.2c	31.7c	6.5c	7.7c
TT90K-277-1	15.7a	70.1a	40.9a	8.2a	8.7a
TT93K-452-1	13.8b	64.1b	37.2b	7.5b	8.0b
LSD	0.49	0.86	0.53	0.39	0.19

Means followed by different letter(s) within the same treatment group and column are statistically diffierent at5% level of probability.

Table 3: Effects of phosphorus and variety on the yield attributes of cowpea during the rainy seasons of 2011 at Lafia

Treatments	No. of pods per plant	Pod yield per plant (g)	Seed yield per plant (g)	No. of seed per pod	100 seed . weight (g)
Phosphorus (kgha1}'					
0	14.4c	70.2c	41.0c	8.2c	9.8c
30	27.4a	119.1a	69.5a	13.6a	15.2a
60	20.9b	93.5b	54.6b	ll.Tb	12.2b
LSD	0.66	1.17	0.72	0.53	0.26
Variety					
DANELA	17.7d	80.9d	47.2d	9.8c	11.2d
IAR-48	19.4c	85.2c	49.7c	10.3c	12.1c
IT90K-277-1	24.7a	110.2a	64.3a	12.8a	13.6a
1T93K-452-1	21.8b	100.8b	58.8b	11. 7b	12.5b
LSD	0.77	1.36	0.08	0.61	0.30

Means followed by different letters) within the same treatment group and column are statistically different at 5% level of probability.

Table 4: Effects of phosphorus and variety on the yield attributes of cowpea during the rainy seasons of 2009 - 2011 atLafia

Treatments Phosphorus (kg ha^{-1}) (P)	Seed yield per hectare (kg)		
	2009	2010	2011
0	2050c	1435c	2255c
30	3442a	2409a	3786a
60	2700b	1890b	2970b
LSD	40.1	28.1	44.2
Variety (V)			
DANILA	2333d	1633d	2567d
IAR-48	2478c	1734c	2726c
IT90K-277-1	3200a	2240a	3520a
IT93K-452-1	291 Ib	2037b	3202b
LSD	46.3	32.4	51.0
Interaction			
P X V	**	**	**

Means followed by different letters) within the same treatment group and column are statistically different at 5% level of probability.

Table 5: Interaction between phosphorus and variety on the seed yield (ha^{-1}) of cowpea during the rainy seasons of 2009 - 2011 at Lafia

Treatments Phosphorus (kg ha^{-1})(P)	Variety			
	DANILA	IAR-48	IT90K-277-1	IT93K-452-1
0	16531	1791k	2652g	2377i
30	3066f	3686b	3961a	3513c
60	2204J	2514h	3307d	3134e
LSD		55.5		

Means followed by different letters) within the same row and column are statistically different at 5% level of probability.

Table 6: Agronomic efficiency of applied phosphorus on the seed yield of cowpea during the rainy seasons of 2009 - 2011 at Lafia

Treatments Phosphorus	**Seed yield per hectare**	**(kg)**				
	Seed yield 2009	**AE 2009**	**Seed yield 2010**	**AE 2010**	**Seed yield 2011**	**AE 2011**
0	**2050c**		**1435c**		**2255c**	
30	**3442a**	**23.2**	**2409a**	**16.2**	**3786a**	**25.5**
60	**2700b**	**21.7**	**1890b.**	**15.2**	**2970b**	**23.8**
LSD	**40.1**		**28.1**		**44.2**	

Means followed by different letters) within the same treatment group and column are statistically different at 5% level of probability.

Table 7: Mean annual rainfall during the the rainy seasons of 2009 - 2011 at Lafia

Month	2009	Rainfall (mm) 2010	2011
January	TR	0.0	0.0
February	0.6	0.0	9.3
March	0.0	TR	0.0
April	128.3	75.0	28.11
May	190.2	116.3	197.7
June	324.0	125.0	222.0
July	229.9	382.0	74.4
August	192.6	230.3	274.6
September	145.9	312.3	228.2
October	376.0	177.4	227.1
November	88.8	20.0	0.0
December	O.O	0.0	0.0-

Source: Lafia weather station.

CONCLUSION

From the foregoing, it can be concluded that application of 30 kg P ha"[1] and planting of variety IT90K-277-1 produced the highest yield and yield characters of cowpea in all the years of the experiment. Application of 30 kg P ha'[1] and planting of variety IT90K-277-1 seems to be ideal phosphorus rate and cowpea variety respectively for this agro ecology and is therefore Recommended.

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