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INFLUENCE OF PHOSPHORUS FERTILIZER ON GROWTH COMPONENTS AND DRY MATTER YIELD OF LABLAB (*LABLAB PURPUREUS* L.) IN A SEMI-ARID ENVIRONMENT

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ABSTRACT

A study was conducted in Maiduguri, Borno State, Nigeria during the 2014 and 2015 raining season to determine the effect of phosphorus application on growth components and dry matter yield, of lablab. The experimental plot was divided into sub plots by an alley of 50 X 50cm between and within rows. Each sub plot measured 3 X 4m (12m^2) and consisted of 8 rows with 6 plants per row. While the net plot size was 3m^2. The treatments consisted of four phosphorus rates (0, 12, 24, and 36 kg/ha) laid out in a Completely Randomized Block Design (CRBD) replicated thrice. Two (2) seeds were planted at 50cm intra row spacing. Stands were thinned to one plant per stand at two weeks after planting. Urea fertilizer was applied at a rate of 15kg of N/ha as starter N. Plant height, leaf length, number of leaves per plant, leaf widths were measured at weeks 4, 8, 10 and 12 after sowing. The plants were harvested at 12 weeks after planting and herbage yield was recorded. Highest number of leaf was obtained at 36kgP/ha in 2014. Fertilizer rate significantly ($P<0.05$) influenced plant height with the tallest plants observed at week 10 for the different fertilizer rates. Leaf number was significantly higher at 36kgP/ha with 102 leaves in week 8 of 2014. In 2014 and 2015 highest herbage yields of 29.50 and 15.26 t/ha were obtained at phosphorus rate of 36kgP/ha. It was concluded that application of phosphorus fertilizer at 36kg P/ha to lablab improved dry matter yield. It was recommended that 36 kg P/ha be used for cultivation of lablab under semi-arid conditions for optimum yield.

Key Words: lablab, leaf number, leaf length, herbage yield, fertilizer

INTRODUCTION

Pasture is a major agricultural resource supporting both intensive and extensive livestock production. One the major problems confronting animal production in Nigeria, most especially in the arid and semi-arid zone, is wide variability in the availability and quality of feeds over the feeding and grazing period, attributable to variation in weather and climate (Hopkins *et al*., 1988; Mohammed and Muhammad, 2015). Long period of dry season tends to limit the availability of feeds and has adverse effect on the development of ruminant animal production (Arigbede *et al*., 2002). There is need to mitigate the problem with the use of sown and purposely managed pastures. The shortage of feed for ruminants can be solved through cultivation of forage crops with better nutritional values than existing feed resources. This can be achieved with the establishment of leguminous forage (Poppi and McLennan, 1995). High quality sown forages such as leguminous fodder has been found to provide adequate dry season supplementation and improve the productivity of ruminants (Amole *et al.*, 2013).

Lablab purpureus (L) sweet is a fodder legume that combines a great number of qualities that can be used successfully under various conditions. It is palatable and possesses the ability to out yield other crops, especially during the dry season and serves as cover crop (Murphy and Colucci, 1999). In Nigeria, lablab is a forage crop and is grown mostly in in the northern part of the country. Despite the importance of lablab as a feed for livestock, the yield obtained by farmers in Nigeria is low (Malami and Abdullahi, 2007) because of poor cultural practices and inadequate fertilizer application. In other to obtain lablab of high quality during the dry season, there is need for adequate supply of water and nutrients (fertilizer) for enhanced growth and in turn maximum profit for farmer throughout the year.

All plants require phosphorus for growth and development in significantly large quantity. The application of phosphorus in relative quantities therefore, plays a vital role ' in plant growth (Crowder and Chheda, 1982; Malami and Abdullahi, 2007). The objective of this study was to determine the effect of phosphorus application on growth components and dry matter yield, of lablab.

MATERIALS AND METHODS

The study was conducted in Maiduguri, the Borno State capital during the 2014 and 2015 raining seasons. Borno State lies between latitude $11^0 32^1$ and $11^0 41^1$ north and longitude $13^0 20^1$ and $13^0 25^1$ east. It is on an elevation of 345m above sea level and located in the semi-arid region of Nigeria. It is characterized by short raining season of 3-4 months (June – September) annual rainfall ranges from 500-600mm. the mean temperature of this region ranges from 39.8 – 40.7^0C while during the wet season the temperature drops to around 31^0C (Alaku, 1983).

The land used for the experiment was cleared, ploughed and harrowed to soften the soil for ease of planting and germination and to get a clean seed bed. Ridges were made at 0.75m apart with hoe. The experimental area was divided into plots by an alley of 50 X 50cm between and within rows. Each plot size measured 3 X 4m ($12m^2$). Each plot consisted of 8 rows with 6 plants per row with a total of 48 plants per plot. While the net plot size was $3m^2$. The treatments consists of four P rates (0, 12, 24, and 36 kg/ha) and three lablab varieties (Grif 1246, black ILRI 147 and brown NAPRI 3) laid out in a Completely Randomized Block Design (CRBD) replicated thrice.

Two seeds were planted at 50cm intrarow spacing. Stands were thinned to one plant per stand at two weeks after planting. Urea fertilizer was applied at the rate of 15kg of N/ha as N, while P was as per treatments. Weeding was done manually by hoe at two weeks after sowing. The plants were harvested at 12 weeks after planting (that is at the blooming stage).

Plant Characteristics Measured

Plant Height (cm): Six plants were randomly selected and tagged from the net plot area. The height of the plant was measured from the ground to the tip using meter ruler at 2, 4, 6, 8, 10 and 12 weeks of the planting.

Number of Leaf per Plant: Leaf number per six plants sampled was taken by counting and average recorded.

Leaf Length (cm): This involved measuring the leaf of six sampled plants by measuring the base of the leaf stalk to the tip of the leaf using meter ruler.

Leaf Width: The widest portion of the leaf was measured using a ruler to obtain the leaf width. This was measured from six sampled plants and average recorded.

Herbage yield: The net plot area was harvested, measured and converted to herbage yield t/ha.

Statistical analysis

All data collected were subjected to Analysis of Variance (ANOVA) in a Randomized Complete Block Design using the General Linear Model of SPSS 20 (2010). Where significant differences existed between means Duncan Multiple Range test (DMRT) was used to separate them.

RESULTS

The soil physical and chemical properties are shown in Table 1. The pH of 7.22 was observed at the soil depth of 0-15cm and decreased to 7.03 at a depth of 15 – 30cm. Generally, the soil texture of the experimental site was sandy loam; Nitrogen was 0.10 for 0-15 and 0.007mg/kg 15 – 30cm, while phosphorus was 8.75 for 0-15 cm and 14.70mg/kg for 15-30 cm.

Table 1: Physical and chemical properties of soil in the study site

	Parameters	Location		Control	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm
pH in H_20	1:2.5	7.22	7.03	5.76	6.03
EC	$UScm^{-1}$	34.00	12.00	23.00	10.00
	Total acidity	2.50	1.90	0.90	0.60
	Ca^{2+}	3.20	6.20	4.80	4.40
Meg/100g soil	Mg^{2+}	5.80	7.20	3.60	2.80
	K^{+}	2.43	2.30	1.66	1.54
	Na^{+}	6.53	8.27	4.79	3.92
	CEC	17.96	23.97	14.45	12.66
	ECEC	20.46	25.87	15.35	13.26
	Base Salt	87.78	92.66	94.14	95.48
	N	0.10	0.07	0.08	0.04
%	O.C	0.43	0.33	0.37	0.21
	Clay	15.80	15.80	10.80	10.80
	Sand	63.50	56.00	66.00	66.00
	Silt	20.70	28.20	23.20	23.20
mg/kg soil	P	8.75	14.70	3.50	3.85
Textural	Class	Sandy loam	Sandy loam	Sandy loam	Sandy loam

EC = Exchange capacity, CEC = Cation exchange capacity and ECEC =Effective cation exchange capacity, O.C = organic content, SL = Sandy loam, P = Phosphorus and N = Nitrogen.

The effect of fertilizer rate on plant height for 2014 and 2015 cropping season are presented in Table 2. Fertilizer rate significantly ($P<0.05$) influenced plant height at 6, 10, and 12 weeks after planting for the year 2014 with the tallest plants observed at week 10 for the different fertilizer rates (0, 12, 24 and 36% kg/ha).

Table 2: Effects of phosphorus fertilizer rates on plant height (cm) of lablab

	Weeks after planting (2014)					Weeks after planting (2015)				
Fertilizer rate	**4**	**6**	**8**	**10**	**12**	**4**	**6**	**8**	**10**	**12**
0	9.65	51.68^{c}	68.36	85.58^{b}	49.58^{c}	10.74^{b}	18.39	50.07	51.69^{b}	78.67^{b}
12	14.45	79.76^{b}	79.13	87.60^{ab}	60.80^{b}	11.72^{ab}	21.91	39.73	79.76^{ab}	87.97^{b}
24	13.31	85.06^{a}	82.18	93.40^{ab}	65.77^{b}	12.39^{b}	20.09	43.77	85.06^{a}	86.59^{b}
36	10.94	65.76^{b}	100.14	108.45^{a}	70.89^{a}	13.33^{a}	24.38	44.57	63.76^{ab}	101.78^{a}
SEM	0.43	13.54	15.55	10.52	9.60	0.06	2.87	4.35	9.79	6.30
LS	NS	*	NS	*	*	*	NS	NS	*	*

^{a,b,c} Mean in the same column with different superscripts are significantly different; SEM = Standard Error of Means, LS = Level of Significance, NS = Non-Sgnificant; * = (P< 0.05)

The mean value for effect of phosphorus rates on plant leaf number at various weeks for 2014 and 2015 is presented in Table 3. There was no significant difference observed throughout the experimental weeks of 2014 except weeks 8. Highest number of leaf was obtained at 36kgP/ha with 146 and 102 in week 10 and 8 of 2014. Similarly, there was no significant difference observed in the second year (2015) of the experiment, except at weeks 4 which recorded a significant (P<0.05) difference with the highest leaf number of 14 and 13 at 36 and 24kgP/ha respectively.

Mean leaf length as affected by fertilizer rate at various weeks in 2014 and 2015 is presented in Table 4. There was significant (P<0.05) difference in all the experimental weeks of 2014, except weeks 4, at week 6, longest leaf was 13.2cm at 12 kgP/ha, similarly at week 10, longest leaf length were 9.04, 9.25 and 9.13cm at all phosphorus levels except at 0, followed by a 7.14 and 6.97cm at 12 and 24 P/ kg/ha respectively. However, there was no significant (P>0.05) difference observed throughout the experimental weeks of 2015, except at week 8 which was significantly (P<0.05) influenced. Where leaf length at 0, 24 and 36kgP/ha were 8.34, 7.97 and 7.79cm respectively.

Table 3: Effect of Phosphorus fertilizer rates on Leaf Number (cm) of lablab

	Weeks after planting (2014)					Weeks after planting (2015)				
Fertilizer rate	**4**	**6**	**8**	**10**	**12**	**4**	**6**	**8**	**10**	**12**
0	13	35	69[b]	99	45	11[ab]	20	38	39	68
12	17	48	90[ab]	139	49	10[b]	22	35	36	57
24	15	51	75[ab]	131	53	12[a]	21	36	36	55
36	13	97	102[a]	146	50	13[a]	25	46	47	68
SEM	0.39	5.93	10.83	20.74	0.36	0.26	1.73	4.11	4.21	8.37
LS	NS	NS	*	NS	NS	*	NS	NS	NS	NS

[a,b,c] Mean in the same column with different superscripts are significantly different; SEM = Standard Error of Means, LS = Level of Significance, NS = Non-Significant; * = (P< 0.05)

Table 4: Effect of phosphorus fertilizer rates on leaf length (cm) of lablab

	Weeks after planting (2014)					Weeks after planting (2015)				
Fertilizer rate	**4**	**6**	**8**	**10**	**12**	**4**	**6**	**8**	**10**	**12**
0	5.57	8.04[b]	8.56[b]	7.96[b]	6.55[b]	5.16	7.33	8.34[a]	8.36	8.09
12	6.64	13.22[a]	9.44[ab]	9.04[a]	7.14[ab]	5.44	7.16	6.89[b]	6.90	8.25
24	6.14	9.57[ab]	9.08[ab]	9.25[a]	6.97[ab]	5.38	7.84	7.97[a]	7.50	8.24
36	5.93	8.90[ab]	9.66[a]	9.13[a]	7.39[a]	5.62	7.33	7.79[a]	7.81	8.39
SEM	0.12	1.83	0.37	0.34	0.29	0.26	0.05	0.21	0.25	0.37
LS	NS	*	*	*	*	NS	NS	*	NS	NS

[a,b,c] Mean in the same column with different superscripts are significantly different; SEM = Standard Error of Means, LS = Level of Significance, NS = Non-Significant, *= Significance (P<0.05)

Means of leaf width as affected by phosphorus rates for 2014 and 2015 is presented in Table 5. There was no significance (P>0.05) difference observed throughout the experiment weeks of 2014 except at week 6. The thickest leaf width was 3.10cm at 36kgP/ha, followed by lower but similar value of 2.17 and 2.49cm at 12 and 24 kgP/ha respectively; lowest value of 1.86cm was obtained at 0%P similarly. There was no significant (P>0.05) difference observed in (2015), except at weeks 4 and 6. In week 4, the thickest plant width was at 36kgP/ha with 1.67cm followed by 1.62 and 1.51cm at 24 and 0kgP/ha respectively and phosphorus level of 12kgP/ha produced 1.48cm. in week 6, the thickest plant with was at 12, 24 and 36kgP/ha with values of 1.42, 1.41 and 1.44cm respectively and 1.24cm was also obtained at 0kgP/ha.

Table 5: Effects of phosphorus fertilizer rates on leaf width (cm) of lablab

	Weeks after planting (2014)					Weeks after planting (2015)				
Fertilizer rate	**4**	**6**	**8**	**10**	**12**	**4**	**6**	**8**	**10**	**12**
0	1.72	1.86^{b}	2.34	3.66	2.60	1.51^{b}	1.24^{b}	2.11	2.11	3.17
12	1.69	2.17^{ab}	2.60	3.13	2.67	1.48^{c}	142^{a}	2.09	2.07	3.09
24	1.75	2.47^{ab}	2.94	3.40	2.88	1.62^{ab}	1.41^{a}	2.06	2.08	3.18
36	1.65	3.10^{a}	2.93	3.02	2.73	1.67^{a}	1.44^{a}	3.27	3.20	3.24
SEM	0.12	0.33	0.22	0.25	0.13	0.04	0.06	0.49	0.51	0.16
LS	NS	*	NS	NS	NS	*	*	NS	NS	NS

^{a,b,c} Mean in the same column with different superscripts are significantly different; SEM = Standard Error of Means, LS = Level of Significance, NS = Non-Significant; * = (P< 0.05)

Mean dry matter yield as affected by phosphorus rates for 2014 and 2015 is presented in Table 6. In 2014, highest (27.40 and 29.50t/ha) yield was obtained at phosphorus rates of 24 and 36kgP/ha were. While 15.53, 14.53 and 15.26t/ha were obtained at 12, 24 and 36kgP/ha respectively.

Table 6: Effects of phosphorus fertilizer rates on Dry matter yield (kg/ha) of lablab

	Fertilizer levels				
Year	0	12	24	36	SEM
2014	23.03^{b}	23.10^{b}	27.40^{a}	29.50^{a}	1.68*
2015	12.10^{b}	15.53^{a}	14.53^{a}	15.26^{a}	0.92*

^{a,b} Mean in the same row with different superscripts are significantly different; SEM = Standard Error of Means, LS = Level of Significance, NS = Non-Significant; * = (P< 0.05)

DISCUSSION

The pH of soil from the experimental site was within the 6.6 - 7.3 that have been categorized as very good for normal crop response (Hoskins, 1997). Total nitrogen 0.07-0.10% and phosphorus 8.75-14.70mg/kg^{-1} obtained for this experimental site were low. Nitrogen and phosphorus are two major limiting nutrients in agricultural soils in the tropics and their low levels of availability is a major cause of the low dry matter productivity and poor nutrient quality of sown and natural pastures in the tropics (Mohammed-Saleem, 1994). However, legumes have been noted to contribute nitrogen to the soil in order to supply phosphorus which will serve as energy driving process for nitrogen fixation potential of the legumes (Ndakemi and Dakora, 2007).

It was generally observed that plant height values for 2014 were much higher than values of 2015. This could be attributed to the incident of insect infestation that was recorded in the early stage of plant cultivation in 2015, must have altered the growth components and the high rainfall recorded in June might also have had a negative impact on germination and early growth of *Lablab purpureus*. However, plant height responded well to all fertilizer rates in both 2014 and 2015. Plant height increased with increase in age and fertilizer rates. This might be attributed to the role of phosphorus in plant growth which enhances cell division, fat formation, flowering, fruiting, seed formation and development of lateral and fibrous root (Ogedegbe *et al.*, 2011). The values obtained

in this study were much higher than 42.2cm height at 3 weeks reported by (Tanko *et al.*, 2013) for unspecified variety of lablab. Similarly (Suleiman, 2006) reported a height of 32cm when phosphorus fertilizer was applied at 80kgp/ha. However, plant height obtained in this study recorded its peak at 36%P in the 12th week of 2015 respectively, this agree with(Suleiman, 2006) who stated that application of phosphorus in relative quantities play a vital role in plant growth, and all plants require phosphorus for growth and development in significantly large quantity. Similarly (Malami and Kankia, 2010) produced best plant height when 40kg P/ha was applied to *Stylosanthesguianensis* with plant height of 21cm.

Leaf number in both years followed the same trend as plant height. It responded well to phosphorus application, it increased as plants increase in age and fertilizer rates and peaked at 10th week of 2014 similarly a better result at higher rate of fertilizer (36%p/ha in 2015) was also obtained. However, the values obtained in this study were higher than leaf number (4.33 under dibbling and 3.66 drilling methods) for lablab reported by (Malamiand Abdullahi, 2007). Similarly, Abdullahi (2006) also reported a lower values of 5.44 and 6.66 when SSP fertilizer was applied at 40 and 80kg P/ha on *Lablab purpureus*. The result obtained for leaf number in this study is in conformity with the result obtained by Krasilnikoff et al. (2003) and Nyoki et al. (2013). The high values obtained in this study might be due to the fact that phosphorus applied at the rate of 36%p/ha was utilized judiciously for the production of leaves.

Longest leaf length obtained in this study was in week 10 of plant growth at 12 kg P/ha. This result compared favourably with the value of 11.7cm reported by (Malami and Abdullahi, 2007) when 12kg P/ha was applied on lablab. Furthermore, the outstanding plant leaf lengths in this study were within the range of 7-15cm reported by Hendricksen and Minson (1985). However, the poor performance at the earlier weeks reported in this study might be due to the fact that phosphorus fertilizer did not benefit early growth of lablab as reported by Kolawole and Kang(1997).

Leaf width values obtained in this study were much lower than 7.7cm reported for leaf width by (Malami and Abdullahi, 2007) and 6.9cm obtained by Abdullahi (2006)when 12kg P/ha were applied to lablab. The lower values obtained in this study might be due to phosphorus response dependence on available phosphorus in this study area as low level of phosphorus was recorded (8.75 for 0-15cm soil) and (14.70 for 15-30cm soil) was obtained in this study site. This agrees with Meseret and Amin (2014) who stated that when phosphorus is below the optimum level, it may interrupt other nutrients which in turn can bring decrease in leaf width growth.

Dry matter yield in this study was affected by phosphorus rates. Highest yield were obtained at 36%p/ha and increased as rates of fertilizer increased. In other words, dry matter yield were better in plots with applied fertilizer compared to plots without fertilizer. This agrees with (Ogedegbe *et al.*, 2011) who produced a dry matter yield of 9.3 tons /ha^{-1} as against 8.2 tons/ha^{-1} for 0%. Similarly it also agrees with Malami and Abdullahi (2007) who reported high dry mater yield at 40 and 80kgp/ha. It also agree with Nworgu and Ajayi (2005) who obtained herbage yield of 46.6 tons/ha when 60kgp/ha was applied to lablab. However, Shehu (1994) reported that there was no response recorded in white lablab dry matter yield to fertilizer applied alone or in combination of nitrogen, potassium and phosphorus. The differences recorded in the yield in this study with other works of different authors could be attributed to the levels of soil fertility, climatic zones, seasons and agronomic practices adapted.

CONCLUSION

It was concluded that application of phosphorus fertilizer at 36 kg P/ha to lablab improved dry matter yield. It was recommended that 36 kgP/ha be used for cultivation of lablab under semi-arid conditions for optimum yield.

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