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RESPONSE OF FORAGE COWPEA GENOTYPES TO GRADED DOSES OF PHOSPHORUS APPLICATION

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SUMMARY

A field experiment was carried out at AICRP on Forage Crops and Utilization, Dr. Rajendra Prasad Central Agricultural University, Pusa during *Kharif* season, 2020 to study the response of forage cowpea genotypes to phosphorus (P) levels. The experiment was conducted in factorial randomized block design with four forage cowpea genotypes and three P levels (30, 60 and 90 kg P_2O_5/ha) with three replications. The results revealed that genotype Bundel Lobia-1 recorded 11.26, 36.18 and 66.66% higher green forage yield (GFY), dry matter yield (DMY) and crud protein yield (CPY), respectively than UPC 628. Similarly, application of 90 kg P_2O_5/ha recorded 8.99, 17.96 and 26.04% higher GFY, DMY and CPY, respectively than application of 30 kg P_2O_5/ha. Among genotypes, significantly higher net return (Rs. 12269 /ha) and B:C ratio (1.52) was registered with genotype Bundel Lobia-1. Among P levels, application of 60 kg P_2O_5/ha registered the highest net return (Rs. 10430/ha) while application of 30 kg P_2O_5/ha resulted in the highest B:C ratio (1.45).

Key words : Cowpea, Phosphorus level, Green fodder yield, Crude protein, Economics

Cowpea (*Vigna unguiculata* L.) is an important multipurpose crop cultivated for grain, vegetable and fodder. It is mostly cultivated in extreme conditions of tropical and sub-tropical regions and has the ability to withstand drought (Nguyen *et al.*, 2019; Naguyen *et al,* 2016; Arya *et al.,* 2019 & 2021). It is also an important source of both green and dry fodder. It is cultivated as sole, inter-crop, mixed crop and in agro-forestry systems (Nguyen *et al.*, 2019; Panchta *et al.,* 2020 & 2021). Further, it is mixed or intercropped with cereal fodder crops like sorghum, maize and pearl millet for enriching the nutritive quality (crude protein) of fodder (Singh *et al.,* 2020). Cowpea being a legume crop is sensitive to phosphorus (P) deficiency as P is required for initiation of nodules (Haruna and Aliyu, 2011) and phosphate deficiency hampers N fixation since it is a major source of energy for Rhizobium bacteria for converting atmospheric nitrogen to ammonium for plant use (Crowder and Chheda, 1982). Jha *et al.* (2014) showed that number of nodules per plant and fresh and dry weight of nodules per plant in forage cowpea increased with P application. So, different doses of P may impact the N-fixation by forage cowpea genotypes and affect the crude protein content. P deficiency is also reported to be the most limiting soil fertility factor for cowpea production (Singh *et al.*, 2011). So, there is a need to study the performance of cowpea genotypes to P doses for enhancement of green and dry fodder yield along with improved crude protein contents.

MATERIALS AND METHODS

The present experiment was carried out at Forage Research Block (Plot no. 12) of Cattle Farm, Animal Production Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar under AICRP on Forage Crops and Utilization during *Kharif* season, 2020. Four forage cowpea genotypes (RFC-2, Bundel Lobia-1, UPC-5286 and UPC-628) and three phosphorus levels (30, 60 and 90 kg P_2O_5/ha) were accommodated in a factorial randomised complete block design with three replications. The crop was sown on 12.08.2020 at a row spacing of 30 cm using a seed rate of 35 kg/ha. Recommended dose of 20 kg of N and 40 kg of K was applied as basal application. Application of phosphorus was done as per the treatments. The sources for nitrogen, phosphorus and potassium were urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. All other cultural operations were done as per recommended package of practices. Harvesting of green fodder was done at 50% flowering and the green forage yield (GFY) of the plot was recorded and converted to q/ha. 500g of green fodder samples were taken from each plot and placed in hot air oven at 70 ± 2°C temperature till constant weight was achieved to determine the dry matter content for determination of dry matter yield (DMY) when multiplied with GFY. Total N of the dry matter was determined and it was multiplied by the DMY to get nitrogen uptake. Per day productivity in terms of GFY/DMY was calculated by dividing the yield (green forage/dry matter) by the number of days taken to 50% flowering. The nitrogen content in dry matter was multiplied by a factor 6.25 to get crude protein (CP) content. CP content (%) was multiplied by DMY to get crude protein yield (CPY). The economics of forage cowpea was calculated using prevailing market price of the inputs and Rs. 150/q was considered as the price of the green forage. Data were subjected to Analysis of Variance for factorial experiment in randomized block design (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth attributes and yield

Genotypes had a significant influence on plant height, leaf: stem ratio, green forage yield (GFY) and dry matter yield (DMY). Bundel Lobia-1 recorded the highest plant height, L:S ratio, GFY and DMY which was significantly higher than rest of the genotypes tested. The GFY and DMY recorded with Bundel Lobial-1 was 11.26 and 36.18% superior over UPC-628, respectively which recorded the lowest GFY and DMY. Similarly, genotypic variation in cowpea with respect to plant height, L:S ratio, GFY and DMY has been reported (Shekara *et al.*, 2012; Jha *et al.*, 2014 and Kumar *et al.*, 2017). Phosphorus levels had a significant influence on plant height, L:S ratio, GFY and DMY. With increasing P application significant increments were observed for L:S ratio, GFY and DMY up to 90 kg P_2O_5/ha but for plant height it was only up to 60 kg P_2O_5/ha. Kumar *et al.* (2016) also observed significant increment in plant height with increase in P levels up to 60 kg P_2O_5/ha with improvement in L:S ratio with increase in P levels up to 80 kg P_2O_5/ha. The GFY and DMY recorded with application of 90 kg P_2O_5/ha was 2.68% and 5.96% higher than application of 60 kg P_2O_5/ha. This is consistent with the results of Kumar *et al.* (2016) who reported that GFY and DMY increased with application of P fertilizers up to 80 kg P_2O_5/ha. Higher growth attributes and

TABLE 1
Effect of different P levels on growth attributes and yield of forage cowpea genotypes.

Treatments	Plant height (cm)	L:S ratio	GFY (q/ha)	DMY (q/ha)
Genotypes				
RFC-2	123.1b	0.55c	224.2b	38.3b
Bundel Lobia-1	137.7c	0.61d	240.2c	47.8c
UPC-628	118.3a	0.48a	215.9a	35.1a
UPC-5286	122.4b	0.51b	221.8b	37.8b
P levels (kg P_2O_5/ha)				
30	122.2a	0.47a	214.7a	36.2a
60	126.3b	0.56b	227.9b	40.3b
90	127.6b	0.60c	234.0c	42.7c

Means marked with atleast a common letter are not significantly different from each other according to LSD test (p=0.05).

yield of forage cowpea under application of 90 kg P_2O_5/ha compared to lower doses could be due to higher availability of P that would have stimulated more number of nodules and increased N-fixation. Increased N-fixation would have supplied more N for plant growth thereby registering higher values of growth attributes and yield of forage cowpea (Singh *et al.*, 2011).

Productivity and quality

Genotypes had a significant influence on per day productivity of green forage and dry matter and crude protein content and its yield. Bundel Lobia-1 recorded the highest per day productivity of green forage (4.21 q/ha/day) and dry matter yield (0.84 q/ha/day) and crude protein content (19.09%) and crude protein yield (9.15 q/ha) which was significantly higher than other genotypes with per cent increments of 11.08, 35.48, 22.78 and 66.66% than UPC-628, respectively. Genotypic variation in forage cowpea with respect to CP (Kumar *et al.*, 2017) and CPY (Shekara *et al.*, 2012; Jha *et al.*, 2014 and Kumar *et al.*, 2017) has also been reported. Phosphorus levels impacted the per day productivity of green forage and dry matter yield and crude protein content and its yield significantly. With increasing P application, per day productivity in terms of GFY and DMY increased up to the highest P level (90 kg P_2O_5/ha). However, application of 90 kg P_2O_5/ha was comparable with application of 60 kg P_2O_5/ha for per day productivity of green forage. CP content and CPY responded to P levels significantly and increased up to application of 90 kg P_2O_5/ha. Similar findings have been observed

TABLE 2
Effect of different P levels on per day productivity (green fodder and dry matter) and crude protein content and yield of forage cowpea genotypes

Treatments	GFY (q/ha/day)	DMY (q/ha/day)	CP (%)	CPY (q/ha)
Genotypes				
RFC-2	3.93b	0.67b	16.44b	6.30b
Bundel Lobia-1	4.21c	0.84c	19.09c	9.15c
UPC-628	3.79a	0.62a	15.63a	5.49a
UPC-5286	3.89b	0.66ab	16.59b	6.27b
P levels (kg P_2O_5/ha)				
30	3.77a	0.63a	16.43a	5.99a
60	4.00b	0.71b	16.89b	6.87b
90	4.10b	0.75c	17.49c	7.55c

Means marked with atleast a common letter are not significantly different from each other according to LSD test (p=0.05).

by for crude protein content (Rathore *et al.*, 2015a; Kumar *et al.*, 2017) and CPY (Kumar *et al.*, 2017). The interaction effect of genotypes and P levels for CPY was found to be significant Table 3. The highest CPY was recorded with Bundel Lobia-1 with application of 90 kg P_2O_5/ha which was significantly higher than rest of the treatment combinations. CPY with increasing P dose from 30 to 60 kg P_2O_5/ha and 60 to 90 kg P_2O_5/ha increased the CPY by 19.56 and 11.84%, respectively in Bundel Lobia-1 while in UPC-628, it was 15.11 and 17%, respectively. Ansah *et al.* (2016) observed varied response of cowpea genotypes in terms of CP content of haulm due to application of different P doses. Varied responses of CPY among genotype and P level combinations in our study were due to differential response of genotypes to P levels for crude protein and dry matter yield. Similarly, Shekara *et al.* (2012) and Kumar *et al.* (2017) also found significant interaction effect between forage cowpea genotypes and P levels for crude protein yield.

TABLE 3
Interaction effect of genotypes and different P levels on crude protein yield (q/ha) of forage cowpea

Genotypes	P levels (kg P_2O_5/ha)		
	30	60	90
RFC-2	5.59g	6.33ef	6.99d
Bundel Lobia-1	7.77c	9.29b	10.39a
UPC-628	4.83h	5.56g	6.07fg
UPC-5286	5.77g	6.29e	6.76de

Means marked with atleast a common letter are not significantly different from each other according to LSD test (p=0.05)

TABLE 4
Effect of different P levels on economics of forage cowpea genotypes

Treatments	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
Genotypes				
RFC-2	23754	33623b	9869b	1.42b
Bundel Lobia-1 (NC)	23754	36023c	12269c	1.52c
UPC-628 (ZC)	23754	32392a	8638a	1.36a
UPC-5286 (NC)	23754	33277b	9523b	1.40b
SEm ±	-	213	213	0.01
CD (P= 0.05)	-	737	737	0.03
P levels (kg P_2O_5/ha)				
30	22179	32206a	10027ns	1.45b
60	23754	34184b	10430ns	1.44b
90	25329	35096c	9767ns	1.39a

NS–Non-significant.
Means marked with atleast a common letter are not significantly different from each other according to LSD test (p=0.05).

Production economics

Genotypes had a significant influence on gross and net return and B:C ratio. Bundel Lobia-1 recorded the maximum gross and net return and B:C ratio which was significantly higher than other genotypes with per cent increments of 11.21, 42.04 and 11.76 than UPC-628, respectively. The highest gross return, net return and B:C ratio with Bundel Lobia-1 was due to its higher green forage yield than other genotypes. Phosphorus levels impacted the gross return and B:C ratio significantly. With increasing P application, the gross return increased significantly up to the highest P level (90 kg P_2O_5/ha). However, net return increased up to 60 kg P_2O_5/ha. Rathore *et al.* (2015b) reported that net return increased up to 60 kg P_2O_5/ha in fodder cowpea and thereafter it decreased. Similarly, Dixit *et al.* (2014) also found higher maximum net return with 60 kg P_2O_5/ha. B:C ratio decreased with increasing P levels and the highest B:C ratio of 1.45 was registered with application of 30 kg P_2O_5/ha. With increase in P levels, the B: C ratio decreased in our study which could be due to lesser yield increase (which affects the gross return) compared to investment in P fertilizer for higher dose of P application.

CONCLUSION

Based on the present investigation, it can be concluded that among forage cowpea genotypes, Bundel Lobia-1 and among phosphorus levels, application of 90 kg P_2O_5/ha was found to produce higher green forage and dry matter yield and crude protein yield under North Bihar condition.

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