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Effect of time of sowing and phosphorus levels on yield and nutrient uptake of fodder cowpea

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Abstract
The present study was undertaken during summer, 2019 on sandy loam soils of dryland farm, S. V. Agricultural College, Tirupati. The main objective of the study was to assess the optimum sowing window and graded levels of phosphorus for achieving higher yield and nutrient uptake of fodder cowpea. The experiment was conducted in a split plot design with three sowing windows *viz.,* I FN of January, II FN of January and I FN of February allocated to main plots and four levels of phosphorus *viz.,* 0, 20, 40 and 60 kg P_2O_5 ha^{-1} allotted to subplots. From the results, it was found that leaf to stem ratio, green fodder yield and uptake of nutrients were higher with earlier sown crop *i.e.* I FN of January. Higher post-harvest soil available nutrients were with the crop sown during I FN of February. Application of 60 kg P_2O_5 ha^{-1} resulted in significant increase in yield, yield attributes, post-harvest soil nutrient status and uptake of nutrients. The interaction between sowing window and phosphorus levels in determining all the above parameters were found to be non-significant. In conclusion, the current study found that fodder cowpea produces optimum green fodder yield with high uptake of nutrients when sown during I FN of January with 60 kg P_2O_5 ha^{-1}.

Keywords: Fodder cowpea, phosphorus and sowing window

Introduction
Agriculture and animal husbandry in India are interwoven with the intricate fabric of the society in cultural, religious and economical ways as mixed farming and livestock rearing forms an integral part of rural living. Livestock production is the backbone of Indian agriculture and plays a key role in providing employment especially in rural areas. However, there has been a rapid change in agriculture (*viz.,* cropping systems, water resources, diversification of crops, intensification of agriculture, increasing use of mechanical power, transformation from sustenance farming to market oriented farming, changing food habits). All these factors have their impact on animal husbandry practices. India has 15% of the world cattle population and due to pressure of ever increasing human population, arable land is mainly used for food and cash crops, thus there is a little chance of having good quality arable land available for fodder production. The country currently has a net deficit in green fodder of 61.1 per cent, 21.9 per cent in dry agricultural leftovers, and 64 per cent in concentrated feeds. To meet current livestock production levels and population growth, the deficit in all components of fodder, dry crop residues, and feed concentrates must be filled by increasing productivity, utilising untapped feed resources, expanding land area (which is not possible due to human pressure on food crops), or importing. As leguminous fodders generate and supply the majority of the world's plant protein, they are regarded as Natural Protein Banks for livestock (Babu *et al.,* 2016) [2]. Legume forages are comparable to concentrates and are likely to be used in place of them. Cowpea is an excellent annual herbaceous and leafy leguminous fodder crop because of its high nutritional content and short growing season. It contains 20 – 24 per cent crude protein and has a digestibility of more than 70%. It has high feeding value which is however comparable with Lucerne. Among the several agronomic approaches, time of planting and fertilizer application is the most essential elements impacting the production potential of the crops. By selecting the best sowing window, distinct stages of plant growth are aligned with optimal environmental conditions, resulting in increased photosynthesis and increased crop yields. The requirement of phosphorus in legumes is higher than in cereals. Among the nutrients, phosphorus has an adverse impact on legume production as it required for energy transformation in nodules and enhanced N-fixation (Yadav *et al.,* 2017) [13]. In light of the foregoing, the current study was undertaken in order to determine the optimal planting window and phosphorus dose for the production of fodder cowpea.

Materials and Methods

The present experiment was conducted at S.V. Agricultural College Farm, Tirupati campus of Acharya N. G. Ranga Agricultural University during summer, 2019. The experiment was conducted in a split plot design with three sowing windows *viz.*, I FN of January, II FN of January and I FN of February allocated to main plots and four levels of phosphorus *viz.*, 0, 20, 40 and 60 kg P_2O_5 ha^{-1} allotted to subplots. The soil of the experimental field was sandy loam in texture, neutral in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and available potassium. Phosphorus was supplied as per the sub plot treatments whereas nitrogen was applied in common to all the treatments.

Results and Discussion

Yield and Yield attributes

The early sown crop *i.e.* during I FN of January realized higher leaf to stem ratio and green fodder yield followed by that with II FN of January with no significant disparity between them. The greater leaf to stem ratio and fodder yield with earlier sowings might be due to higher leaf weight than green stem weight, as well as the fact that early sown crops required the longest calendar days to harvest, resulting in a longer vegetative phase, which reflected on green fodder production. The results are in accordance with the findings of Ashwathi (2016) [1] and Ram *et al*. (2014) [9]. Lowest leaf to stem ratio and fodder yield of fodder cowpea was recorded with late sown crop *i.e.* during I FN of February (Table.1).

Table 1: Leaf: Stem ratio and green fodder yield of fodder cowpea at harvest as influenced by times of sowing and graded levels of phosphorus

Treatments	Leaf to stem ratio	Green fodder yield (t ha^{-1})
Times of Sowing		
T_1-I FN of January	0.97	16.7
T_2-II FN of January	0.93	16.0
T_3-I FN of February	0.87	14.7
S.Em±	0.01	0.26
CD (P= 0.05)	0.05	1.1
Phosphorus levels		
P_1 - 0 kg P_2O_5 ha^{-1}	0.85	14.2
P_2 - 20 kg P_2O_5 ha^{-1}	0.90	15.4
P_3 - 40 kg P_2O_5 ha^{-1}	0.94	16.1
P_4 - 60 kg P_2O_5 ha^{-1}	0.99	17.1
S.Em±	0.012	0.28
CD (P= 0.05)	0.04	0.8
Times of sowing × Phosphorus levels		
P at T		
S.Em±	0.028	0.53
CD (P= 0.05)	NS	NS
T at P		
S.Em±	0.023	0.49
CD (P= 0.05)	NS	NS

The highest leaf to stem ratio and green fodder yield of fodder cowpea was with the crop receiving phosphorus level of 60 kg P_2O_5 ha^{-1} followed by that with 40 kg P_2O_5 ha^{-1} which was on par with that of 20 kg P_2O_5 ha^{-1} (Table.1). The lowest leaf to stem ratio and green fodder yield was recorded with control (Table.1). Highest leaf to stem ratio and green fodder yield could be attributed to adequate nutrient supply and efficient nutrient utilisation through an extensive root system developed by application of phosphorus that resulted in growth parameters. These results are in confirmation with findings of Shekara *et al.* (2012) [11], Godara *et al.* (2016) [3] and Kumawat and Khinchi (2017) [7].

Post-harvest soil nutrient status

Fodder cowpea sown during I FN of February recorded higher postharvest soil available nitrogen, phosphorus and potassium which was however on par with that of II FN of January sowing (Table.2). Early sown crop results in higher postharvest soil available nutrients which might be due to longer duration of crop that have efficiently utilized the soil applied nutrients. The present findings were in conformity with those of Ashwathi (2016) [1] and Kumar *et al.* (2015) [6]. Crop sown during I FN of January resulted in lower postharvest soil nutrient status (Table.2). Among the phosphorus levels tried, application of 60 kg P_2O_5 ha^{-1} revealed higher postharvest soil available nutrient status (N, P_2O_5 and K_2O) which was however on par with that of 40 kg P_2O_5 ha^{-1} (Table.2). The lowest postharvest soil nutrient status was with control (0 kg P_2O_5 ha^{-1}) except for the available nitrogen where it was comparable with that of 20 kg P_2O_5 ha^{-1} (Table. 2). The higher doses of phosphorus resulted in highest postharvest soil nutrient status (N, P_2O_5 and K_2O) which could be due to the role of phosphorus in promoting the root growth and nodulation in legumes resulting in better fixation of nitrogen. The leguminous plants with nitrogen fixing ability were reported to require more phosphorus than the plants which are dependent on mineral nitrogen fertilizers as nodules are the richest sink of phosphorus (Sinclair and Vandez, 2002) [12]. Similar findings were reported from the studies of Nadeem *et al.* (2017) [8].

Nutrient uptake at harvest

The early sown crop *i.e.* during I FN of January recorded higher nutrient uptake at harvest followed by that with II FN of January with no significant disparity between them (Table.2).

Table 2: Post harvest soil available N, P_2O_5 and K_2O and nutrient uptake as influenced by times of sowing and graded levels of phosphorus.

Treatments	Postharvest soil available N, P_2O_5 and K_2O			Nutrient uptake (kg ha^{-1})		
	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Nitrogen uptake	Phosphorus uptake	Potassium uptake
Times of Sowing (T)						
T_1 - I FN of January	189.2	36.1	288.8	90.2	9.4	76.7
T_2 - II FN of January	207.6	39.5	302.7	87.1	8.8	74.1
T_3 - I FN of February	211.1	42.0	312.6	77.8	7.5	63.8
S.Em±	2.76	1.11	4.00	2.00	0.23	1.81
CD (P= 0.05)	11.1	4.5	15.9	8.0	0.9	7.3
Phosphorus levels (P)						
P_1 - 0 kg P_2O_5 ha^{-1}	192.2	25.3	282.4	72.3	7.0	58.6
P_2 - 20 kg P_2O_5 ha^{-1}	202.3	38.8	297.3	77.7	7.76	5.4
P_3 - 40 kg P_2O_5 ha^{-1}	205.0	46.0	309.2	87.8	8.8	74.9
P_4 - 60 kg P_2O_5 ha^{-1}	211.2	49.5	316.3	102.1	10.5	87.5
S.Em±	3.56	0.81	4.09	2.5	0.25	1.90
CD (P= 0.05)	10.7	2.4	12.3	7.5	0.7	5.7
Times of sowing (T) × Phosphorus levels (P)						
P at T						
S.Em±	5.52	2.22	7.89	4.00	0.47	3.63
CD (P= 0.05)	NS	NS	NS	NS	NS	NS
T at P						
S.Em±	6.01	1.66	7.30	4.3	0.44	3.38
CD (P= 0.05)	NS	NS	NS	NS	NS	NS

The lowest nutrient (N, P and K) uptake was recorded with I FN of February sown crop (Table.2). Higher nutrient uptake with the early sown crop was due to the crop's prolonged vegetative lag phase, which could have better utilised growth resources, resulting in higher nutrient content, dry matter production, and hence nutrient uptake. Similar findings were reported by Kumar *et al.* (2015) [6] The higher nutrient uptake was with the application of 60 kg P_2O_5 ha^{-1} followed by that with 40 kg P_2O_5 ha^{-1}, 20 kg P_2O_5 ha^{-1} in the sequence of descent with significant disparity between any two of the phosphorus levels tested (Table.2). Application of 20 kg P_2O_5 ha^{-1} resulted in lower nitrogen and phosphorus uptake which was comparable with control whereas potassium uptake was significantly lower with control (Table.2). Increased nutrient uptake by fodder cowpea at higher phosphorus doses, *i.e.* 60 kg P_2O_5 ha^{-1}, can be attributed to improved microbial activity due to increased nodulation and increased nutrient translocation resulted from root proliferation, which may have contributed to higher nitrogen, phosphorus, and potassium contents in the plant tissue, as well as higher dry matter production. These results are in line with the findings of Indoria and Majumdar (2007) [4], Rathore *et al.* (2015) [10] and Kumar *et al.* (2016) [5].

Conclusion

The present study found that fodder cowpea produces optimum green fodder yield with high nutrient uptake (nitrogen, phosphorus and potassium) with I FN of January sown crop and 60 kg P_2O_5 ha^{-1}. If sowing is limited by any of the reasons, it can be postponed until the second half of January without sacrificing yield or quality.

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