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PHOSPHORUS NUTRITION IN FODDER COWPEA

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SUMMARY

Fodder cowpea (*Vigna unguiculata* L.) is an important leguminous forage crop valued for its rapid growth, high biomass production and superior nutritive quality, particularly under dryland and semi-arid conditions. Among plant nutrients, phosphorus plays a critical role in enhancing growth, yield, and quality parameters through its involvement in energy transfer, root development, nodulation, and metabolic activities. A comprehensive review of research findings across different agro-ecological regions reveals that increasing phosphorus application significantly improves growth attributes such as plant height, number of branches and leaves, leaf area index, leaf-to-stem ratio and dry matter production. Optimum phosphorus levels ranging from 60 to 80 kg P_2O_5/ha consistently recorded superior green and dry fodder yields across seasons and soil types, with higher doses showing marginal or at-par responses. Phosphorus application also influenced phenological stages, often reducing days to flowering and maturity. Quality parameters including crude protein content, crude fibre content, and ash content were significantly enhanced with adequate phosphorus nutrition. Overall, the reviewed studies indicate that balanced phosphorus fertilization is essential for maximizing productivity and improving fodder quality of cowpea, thereby contributing to sustainable fodder production and soil fertility management.

Key words: Cowpea, fodder yield, crude protein, sustainable fodder production and soil fertility management

Fodder cowpea (*Vigna unguiculata* L.) is a widely cultivated, drought-tolerant leguminous forage crop known for its rapid growth, high green biomass production and rich protein content. It plays a crucial role in supporting livestock nutrition, particularly in arid and semi-arid regions, due to its adaptability to dryland farming systems and its ability to fix atmospheric nitrogen, thereby improving soil health. Among the essential nutrients required for optimal fodder cowpea growth, phosphorus (P) and zinc(Zn) stand out due to their key physiological roles. Phosphorus is vital for energy metabolism (ATP formation), root proliferation, nodulation, and early plant vigor, all of which directly influence forage yield. On the other hand, zinc, though required in smaller quantities, is indispensable for the activation of various enzymes, synthesis of auxins (plant hormones), regulation of photosynthesis and enhancement of plant stress resistance mechanisms.

Growth Parameters

Plant Height

Application of 90 kg P_2O_5/ha had a substantial impact on plant height and was comparable to the application of 60 kg P_2O_5/ha in fodder cowpea on clay loam soils at Samastipur during the *kharif* season (Nanda *et al*., 2023). Neeraj *et al*. (2022) concluded that during *zaid* season on sandy loam soils in Prayagraj, Uttar Pradesh, the plant height of fodder cowpea was significantly higher when the phosphorus content increased from 50 to 70 kg P_2O_5/ha. Sanikommu *et al*. (2022) found that maximum plant height was obtained in Sadabahar variety with application of 100 % phosphorus which is significantly superior over rest of all treatments of cowpea during *zaid* season on sandy loam soils at Prayagraj, Uttar Pradesh. Bhagat *et al*. (2018) noticed that application of 80 kg P_2O_5/ha recorded maximum plant height followed by 60 kg P_2O_5/ha which was at par with each other, but found significantly superior over rest of the treatments at 60 DAS in fodder cowpea during *rabi* season on sandy clay loam soils at Dapoli, Maharashtra.

Number of branches/plant

Neeraj *et al*. (2022) observed that maximum number of branches/plant were recorded with the application of 70 kg P_2O_5/ha which was significantly

higher over rest of the treatments in fodder cowpea during *zaid* season on sandy loam soils at Prayagraj, Uttar Pradesh. Sanikommu *et al*. (2022) found that maximum number of branches was obtained in Sadabahar variety with the application of 100% phosphorus which is significantly superior over rest of the treatments in cowpea during *zaid* season on sandy loam soils at Prayagraj, Uttar Pradesh. Maximum number of branches plant^{-1} were recorded with application of 80 kg P_2O_5/ha followed by 60 kg P_2O_5/ ha in fodder cowpea during *rabi* season on sandy clay loam soils at Dapoli, Maharashtra (Bhagat *et al.*, 2018)

Number of leaves/plant

Maximum number of leaves/plant were recorded with the application of 80 kg P_2O_5/ha followed by 60 kg P_2O_5/ha in fodder cowpea during *rabi* season on sandy clay loam soils at Dapoli, Maharashtra (Bhagat *et al*., 2018). Kumar *et al*. (2016) opined that number of leaves/plant in fodder cowpea increased significantly with increase in P_2O_5 from 40 to 80 kg/ ha on sandy loam soils of Karnal, Haryana during *kharif* season. Meena and Chand (2014) reported that number of leaves/plant increased significantly in forage cowpea with the application of phosphorus @ 60 kg/ha over control and 20 kg P_2O_5/ha during *kharif* on sandy loam soils of Avikanagar, Rajasthan.

Leaf to stem ratio

Nanda *et al*. (2023) concluded that application of 90 kg P_2O_5/ha significantly influenced leaf to stem ratio and at par with 60 kg P_2O_5/ha in forage cowpea during *Kharif* season on clay loam soils at Samastipur, Bihar. Application of 60 kg P_2O_5/ha resulted in higher leaf to stem ratio when compared to other treatments in fodder cowpea during summer on sandy loam soils at Tirupati, Andhra Pradesh (Mobeena *et al*., 2020). Kumar *et al*. (2016) reported that increase in the phosphorus level from 40 to 80 kg/ha significantly increased the leaf to stem ratio of fodder cowpea on sandy loam soils of Karnal, Haryana.

Leaf area index

Sanikommu *et al*. (2022) found that maximum leaf area index was obtained in Sadabahar variety with application of 100 % phosphorus which is significantly superior over rest of the treatments of cowpea during *zaid* season on sandy loam soils at Prayagraj, Uttar Pradesh. Experiment conducted during *kharif* on sandy loam soils of Shivamogga, Karnataka revealed that leaf area index significantly increased with increasing levels of phosphorus from 20, 30 and 50 kg P_2O_5/ha in groundnut (Amruth *et al*., 2017)

Dry matter production

Dry matter/plant was significantly higher with the application of 80 kg P_2O_5/ha followed by 60 kg P_2O_5/ha in fodder cowpea during *rabi* season on sandy clay loam soils at Dapoli, Maharashtra (Bhagat *et al.*, 2018). Nadeem *et al*. (2017) reported that increase in phosphorus level from 0 to 40 kg/ha significantly enhanced the total dry matter production of summer cowpea on sandy loam soils of Pasighat, Arunachal Pradesh. The increase in level of phosphorus from 0 to 40 kg/ha during *kharif* season significantly increased dry matter production of cowpea on red loamy sand soils of Sardarkrushinagar, Gujarat (Jat *et al*., 2013)

Days to 50% flowering

Jamir *et al*. (2022) concluded that application of 60 kg P_2O_5/ha recorded minimum number of days for 50 % flowering than control during *kharif* season in blackgram on sandy loam soils of Nagaland. Mishra (2022) revealed that lower number of days to 50 % flowering was observed with the application of phosphorus @ 40 kg/ha over control in blackgram on sandy loam soils at Raushar, Madhya Pradesh**.** Kiran *et al*. (2018) noticed that maximum days to 50 % flowering was seen in cowpea supplied with phosphorus @ 60 kg/ha and minimum number of days to 50 % flowering resulted when no phosphorus was applied during spring-summer on sandy loam soils at Hisar, Haryana.

Days to maturity

Singh *et al*. (2025) reported that moderate P application (40 kg/ha) in cowpea altered phenological development, with slight changes in flowering and maturity compared with no phosphorus. Abdar *et al*. (2023) reported that cowpea plots receiving P @ 40 kg P, O… /ha had the shortest crop duration (earlier maturity) compared with higher P levels and control treatments. Mishra (2022) revealed that lower number of days to maturity observed with the application of phosphorus @ 40 kg/ha over control in blackgram on sandy loam soils at Raushar, Madhya Pradesh.

Yield and Yield attributes

Green fodder yield

Nanda *et al*. (2023) concluded that application of 90 kg P_2O_5 ha^{-1} significantly resulted in higher green fodder yield but was at par with 60 kg P_2O_5/ha in forage cowpea during *kharif* season on clay loam soils at Samastipur, Bihar. Neeraj *et al*. (2022) found that application of 70 kg P_2O_5/ha recorded significantly higher dry weight over all other treatments in fodder cowpea during *zaid* season on sandy loam soils at prayagraj, Uttar Pradesh. Application of 60 kg P_2O_5/ha resulted in higher green fodder yield when compared to other treatments in fodder cowpea during summer on sandy loam soils at Tirupati, Andhra Pradesh, (Mobeena, 2019). Bhagat *et al*. (2018) revealed that application of 80 kg P_2O_5/ha recorded significantly higher green forage yield when compared to other treatments in fodder cowpea during *rabi* season on sandy clay loam soils at Dapoli, Maharashtra.

Dry fodder yield

Nanda *et al*. (2023) concluded that application of 90 kg P_2O_5/ha significantly increased dry fodder yield and at par with 60 kg P_2O_5/ha in forage cowpea during *Kharif* season on clay loam soils at Samastipur, Bihar. Significantly higher green fodder yield was recorded with the treatment of 70 kg/ha when compared to all other treatments during *zaid* on sandy loam soils at Prayagraj, Uttar Pradesh (Neeraj *et al.*, 2022). Bhagat *et al*. (2018) noticed that application of 80 kg P_2O_5/ha recorded significantly higher dry forage yield when compared to other treatments in fodder cowpea during *rabi* season on sandy clay loam soils at Dapoli, Maharashtra.

Quality Parameters

Crude protein content

Nanda *et al*. (2023) concluded that application of 90 kg P_2O_5/ha significantly influenced crude protein yield but statistically at par with 60 kg P_2O_5 ha^{1} in forage cowpea during *Kharif* season on clay loam soils at Samastipur, Bihar. Crude protein of fodder cowpea was significantly higher with application of 60 kg P_2O_5/ha than that with other nutrient doses during summer on sandy loam soils at Tirupati, Andhra Pradesh (Mobeena *et al*., 2020). Kundu *et al.* (2015) revealed that application of 90 kg P_2O_5/ha resulted in maximum crude protein yield and followed by 60 kg P_2O_5/ha in fodder ricebean during *kharif* on sandy loam soils at Gayeshpur, West Bengal.

Crude fibre content

On sandy loam soils of Vellayani, Kerala, the crude fibre content increased significantly in the fodder rice bean genotypes with increase in phosphorus dose from 20 to 40 kg ha^{-1} during *kharif* season (Fayique and Thomas, 2018). Application of 75 kg P_2O_5/ha to *rabi* lucerne resulted in significantly higher crude fibre content compared to that of 50 and 25 kg P_2O_5/ha on clay soils of Navsari, Gujarat (Tandon and Patel, 2009).

Ash content

Total ash content of fodder cowpea was significantly higher with application of 60 kg P_2O_5/ha than that with other nutrient doses during summer on sandy loam soils at Tirupati, Andhra Pradesh, (Mobeena *et al*., 2020). Maximum ash content was obtained when the cowpea crop was supplied with 60 kg P_2O_5/ha during *kharif* which was however on par with that of 40 kg P_2O_5/ha on loamy sand soils of Hisar, Haryana (Kumar *et al*., 2012). Tandon and Patel (2009) recorded the highest ash content of *rabi* lucerne with the application of 75 kg P_2O_5/ha compared to that of 50 and 25 kg P_2O_5/ha on clay soils of Navsari, Gujarat.

CONCLUSION

The collective evidence from various studies clearly indicate the pivotal role of phosphorus nutrition in enhancing growth, yield, and quality parameters of fodder cowpea. Application of phosphorus significantly improved plant height, branching, leaf production, leaf area index, leaf-to-stem ratio, and dry matter accumulation, ultimately leading to higher green and dry fodder yields. Phosphorus levels in the range of 60–80 kg P_2O_5/ha were found to be optimum under most soil and climatic conditions, producing yields comparable to higher doses while ensuring efficient nutrient use. Adequate P supply also favourably influence crop phenology by promoting early flowering and maturity in several instances. Moreover, improvement in quality attributes such as crude protein, crude fibre, and ash content highlights the importance of phosphorus in enhancing the nutritive value of

fodder cowpea. Therefore, judicious phosphorus management is essential not only for achieving higher fodder productivity but also for improving forage quality and sustaining soil health in fodder-based cropping systems.

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