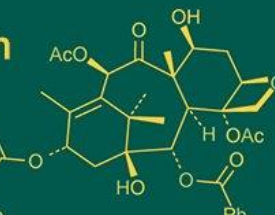


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Influence of phosphorus levels and foliar sprays on green fodder yield, quality and economics of cowpea [*Vigna unguiculata* (L.)]

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Abstract

A field experiment was conducted during *rabi*, 2025-26 on sandy loam soils of dryland farm at S.V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh to study the influence of integrated phosphorus management and foliar nutrition on green fodder yield, fodder quality and economics of cowpea. The experiment was laid out in randomized block design with factorial concept with three replications comprising three phosphorus levels (100% RDP through inorganics (P₁), 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha⁻¹ (P₂) and 50% RDP through inorganics + 50% RDP through FYM + PSB @ 1.25 l ha⁻¹ (P₃) and five foliar sprays (water spray (F₁), 2% urea (F₂), 10% cow urine (F₃), 1% KNO₃ (F₄) and 1% seaweed extract (F₅), applied twice at 30 and 45 days after sowing). Green fodder yield was significantly higher with the application of 100% RDP through inorganics (P₁) whereas the application of 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha⁻¹ (P₂) recorded significantly higher crude protein content, lower crude fibre content in green fodder, highest gross returns, net returns and benefit-cost ratio. Among foliar sprays, 1% KNO₃ (F₄) produced significantly the highest green fodder yield, gross and net returns. The results indicate that combining 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha⁻¹ (P₂), along with foliar spray of 1% KNO₃ (F₄), offers a favourable balance of fodder quality, yield and profitability in cowpea cultivation.

Keywords: Cowpea, integrated nutrient management, foliar nutrition, green fodder, crude protein, crude fibre, economics

Introduction

Leguminous crops occupy a pivotal position in sustainable agriculture owing to their ability to fix atmospheric nitrogen and enrich soil fertility. Among grain legumes, cowpea [*Vigna unguiculata* (L.)] is widely grown in tropical and subtropical regions for its adaptability, short duration and multiple uses as pulse, vegetable and fodder crop. Besides being a rich source of dietary protein for humans (Jayatilake *et al.*, 2018) [1], cowpea also provides nutritious green fodder containing 16-24 percent crude protein, making it a valuable feed resource for livestock and enhancing its utility as a dual-purpose crop in mixed crop-livestock farming systems.

Phosphorus is one of the most critical nutrients governing legume productivity, influencing nodulation, nitrogen fixation, root proliferation and biomass accumulation. However, its use efficiency from inorganic sources alone is often low due to fixation in soil. Integrated nutrient management (INM), which combines inorganic fertilizers with farmyard manure (FYM) and phosphorus solubilizing bacteria (PSB) offers a sustainable means of improving phosphorus availability while maintaining soil health. In addition to soil applied nutrients, foliar nutrition has emerged as an effective supplementary strategy for correcting nutrient deficiencies during critical growth stages, since foliar absorbed nutrients bypass soil related constraints such as fixation and leaching.

While the effects of phosphorus management and foliar nutrition on the growth and seed yield of cowpea have been documented, information on their combined influence on fodder quality traits such as crude protein and crude fibre content along with green fodder yield and profitability, remains limited. The present study was therefore undertaken to evaluate the effect of integrated phosphorus management and foliar nutrition on green fodder yield, crude protein content, crude fibre content and economics of cowpea.

Materials and Methods

A field experiment was conducted during *rabi* 2025-26 at dryland farm, S. V. Agricultural College, Tirupati campus of Acharya N. G. Ranga Agricultural University. The soil of the experimental site was sandy loam in texture, neutral in reaction (pH 6.51), low in organic carbon (0.4%) and available nitrogen (207 kg ha^{-1}), and medium in available phosphorus (24.3 kg ha^{-1}) and available potassium (213 kg ha^{-1}).

The experiment was laid out in randomized block design with factorial concept with three replications, comprising fifteen treatment combinations of three phosphorus levels: P_1 -100% recommended dose of phosphorus (RDP) through inorganics, P_2 -75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha^{-1} and P_3 -50% RDP through inorganics + 50% RDP through FYM + PSB @ 1.25 l ha^{-1} (RDP = $50 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$), and five foliar sprays: F_1 -control (water spray), F_2 -2% urea, F_3 -10% cow urine, F_4 -1% potassium nitrate (KNO_3) and F_5 -1% seaweed extract, applied twice at 30 and 45 days after sowing (DAS). The short-duration cowpea variety TPTC-29 was sown on 19th November 2025 at a spacing of $45 \text{ cm} \times 15 \text{ cm}$. A uniform basal dose of 20 kg N ha^{-1} and $25 \text{ kg K}_2\text{O ha}^{-1}$ was applied to all plots. All the other recommended practices were also adopted as per the crop requirement.

Results and Discussion

Green Fodder Yield

Green fodder yield of cowpea was significantly influenced by phosphorus levels and foliar sprays, while their interaction effect was non-significant (Table 1). Among phosphorus levels, significantly higher green fodder yield was recorded with 100% RDP through inorganics (P_1), while 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_2) and 50% RDP through inorganics + 50% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_3) were statistically at par with each other, both recording significantly lower yield than P_1 . The higher biomass accumulation under P_1 can be attributed to the immediate and complete availability of soluble inorganic phosphorus from early crop growth stages, which sustained active vegetative growth, whereas the slower mineralization of the organically sourced phosphorus fraction under P_2 and P_3 likely resulted in a transient nutrient deficit during the peak vegetative phase. Similar findings on higher fodder yield under fully inorganic phosphorus nutrition were reported by Joshi *et al.* (2018) [2], Mobeena *et al.* (2020) [3] and Sejal *et al.* (2024) [4].

Among foliar sprays, 1% KNO_3 (F_4) recorded significantly the highest green fodder yield, followed by 2% urea (F_2), while 10% cow urine (F_3) and 1% seaweed extract (F_5) were statistically comparable and occupied an intermediate position, and water spray (F_1) recorded significantly the lowest yield. The superiority of F_4 can be ascribed to the concurrent foliar supply of nitrogen and potassium during the critical vegetative growth stages, which enhanced turgor maintenance, chlorophyll biosynthesis and net photosynthetic rate, thereby promoting greater vegetative biomass accumulation. These results corroborate the findings of Dey *et al.* (2017) [5], Sakpal *et al.* (2021) [6] and Surender *et al.* (2024) [7] in cowpea.

Crude Protein Content in Green Fodder

Crude protein content in green fodder was significantly influenced by phosphorus levels and foliar sprays, with a

non-significant interaction effect (Table 1). Among phosphorus levels, significantly higher crude protein content was recorded with 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_2), while 100% RDP through inorganics (P_1) and 50% RDP through inorganics + 50% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_3) were statistically at par with each other and significantly lower than P_2 . The integrated supply of inorganic phosphorus, FYM and PSB under P_2 likely enhanced nodule activity and biological nitrogen fixation, leading to greater nitrogen accumulation in vegetative tissues and consequently higher crude protein content. These findings are in agreement with Rekha *et al.* (2018) [8], Mobeena *et al.* (2020) [3] and Dharani *et al.* (2025) [9].

Among foliar sprays, significantly the highest crude protein content was recorded with 2% urea (F_2) and was on par with 1% KNO_3 (F_4), 10% cow urine (F_3) and 1% seaweed extract (F_5) were statistically comparable at an intermediate level and water spray (F_1) recorded significantly the lowest crude protein content. The direct and concentrated foliar supply of nitrogen through urea, applied during active vegetative growth, appears to have maximized nitrogen incorporation into structural and storage proteins of the fodder. These results are in conformity with Ritika *et al.* (2019) [10], Mandalika *et al.* (2022) [11] and Dhar *et al.* (2025) [12].

Crude Fibre Content

Crude fibre content, being an inverse indicator of fodder quality, was significantly influenced by phosphorus levels and foliar sprays (Table 1). Significantly the highest crude fibre content was recorded with 50% RDP through inorganics + 50% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_3), followed by 100% RDP through inorganics (P_1), while 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_2) recorded significantly the lowest crude fibre content. The lower nutrient availability under P_3 during the active vegetative phase likely suppressed protein and chlorophyll synthesis and diverted a greater proportion of photosynthates towards structural cell wall carbohydrates, whereas the balanced integrated nutrition under P_2 favoured metabolically active tissue over structural biomass. These results support the findings of Mobeena *et al.* (2020) [3] and Dharani *et al.* (2025) [9].

Among foliar sprays, significantly the highest crude fibre content was recorded under water spray (F_1), while 2% urea (F_2) and 1% KNO_3 (F_4) were on par recorded lower crude fibre content, consistent with the higher crude protein performance. The absence of exogenous nitrogen under F_1 appears to have shifted plant metabolism towards structural carbohydrate synthesis, whereas the concentrated nitrogen supply from urea enhanced protein and chlorophyll biosynthesis at the expense of cell-wall fibre deposition. Similar trends were reported by Mandalika *et al.* (2022) [11] and Uttamrao *et al.* (2022) [13].

Economics

Gross returns, net returns and benefit-cost ratio of cowpea were significantly influenced by phosphorus levels and foliar sprays, with a non-significant interaction effect (Table 2). Among phosphorus levels, 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_2) recorded significantly the highest gross returns, net returns and benefit-cost ratio, followed by 100% RDP through

inorganics (P_1), while 50% RDP through inorganics + 50% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_3) recorded the lowest values for all three economic parameters. Although P_2 involved additional expenditure on FYM and PSB, the substantial improvement in seed and fodder yield realized through the synergism of inorganic, organic and biological phosphorus sources was sufficient to outweigh this marginal cost increase, resulting in the highest profitability. These findings were in line with Rathour *et al.* (2015) [14], Jangir *et al.* (2016) [15] and Sejal *et al.* (2024) [4].

Among foliar sprays, F_4 1% KNO_3 (F_4) recorded the highest gross and net returns, followed by 2% urea (F_2), while F_4 and F_2 were statistically at par for benefit-cost ratio. Water spray (F_1) recorded the lowest values for all three economic parameters. The higher gross and net returns under F_4 reflect its superior seed and fodder yield performance, which, combined with the relatively low material cost of foliar sprays, translated into the greatest monetary and efficiency advantage among the foliar treatments. Similar results were reported by Sonal *et al.* (2021) [16], Mandaliya *et al.* (2022) [11] and Rathod *et al.* (2023) [17].

Table 1: Green fodder yield, crude protein content and crude fibre content of cowpea as influenced by phosphorus levels and foliar sprays

Treatments	Green fodder yield (kg ha^{-1})	Crude protein content (%)	Crude fibre content (%)
Phosphorus levels (P)			
P_1 : 100% RDP through inorganics	14588	16.2	20.9
P_2 : 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha^{-1}	13392	17.1	19.8
P_3 : 50% RDP through inorganics + 50% RDP through FYM + PSB @ 1.25 l ha^{-1}	12775	15.8	22.1
SEm $\pm$	368.8	0.26	0.33
CD (P = 0.05)	1033	0.7	0.9
Foliar sprays (F)			
F_1 : Control (Water spray)	11267	14.4	24.3
F_2 : 2% Urea	14608	18.6	18.1
F_3 : 10% Cow urine	13333	16.3	20.8
F_4 : 1% KNO_3	15856	17.8	19.2
F_5 : 1% Seaweed extract	12528	15.8	21.8
SEm $\pm$	408.7	0.33	0.43
CD (P = 0.05)	1218	0.9	1.2
Interaction (P $\times$ F)			
SEm $\pm$	789.3	0.58	0.74
CD (P = 0.05)	NS	NS	NS

Table 2: Economics of cowpea cultivation as influenced by phosphorus levels and foliar sprays

Treatments	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	Benefit-cost ratio
Phosphorus levels (P)			
P_1 : 100% RDP through inorganics	129509	88760	3.19
P_2 : 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha^{-1}	139856	98244	3.37
P_3 : 50% RDP through inorganics + 50% RDP through FYM + PSB @ 1.25 l ha^{-1}	118232	76133	2.82
SEm $\pm$	2059.9	1417.6	0.050
CD (P = 0.05)	5967	4106	0.14
Foliar sprays (F)			
F_1 : Control (Water spray)	109514	69632	2.64
F_2 : 2% Urea	139448	96446	3.41
F_3 : 10% Cow urine	131066	90184	3.20
F_4 : 1% KNO_3	147344	101961	3.42
F_5 : 1% Seaweed extract	122622	82339	2.87
SEm $\pm$	2659.4	1830.2	0.065
CD (P = 0.05)	7704	5301	0.18
Interaction (P $\times$ F)			
SEm $\pm$	4606.2	3170	0.11
CD (P = 0.05)	NS	NS	NS

Conclusion

Based on the results of the present investigation, it can be concluded that among phosphorus levels, application of 75% RDP through inorganics + 25% RDP through FYM + PSB @ 1.25 l ha^{-1} (P_2) recorded the best combination of fodder quality (higher crude protein, lower crude fibre) and profitability (highest gross returns, net returns and benefit-cost ratio), although 100% RDP through inorganics (P_1) produced the highest green fodder yield. Among foliar sprays, foliar application of 1% KNO_3 (F_4) at 30 and 45 DAS proved superior in terms of green fodder yield, fodder quality (higher crude protein, lower crude fibre) and

economic returns (highest gross returns, net returns and benefit-cost ratio). Therefore, integration of 75% RDP through inorganics with FYM and PSB, combined with foliar spray of 1% KNO_3 can be recommended for improving the productivity, quality and profitability of fodder cowpea under similar agro-climatic conditions.

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