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# Influence of Foliar Potassium Nutrition on Nutrient Uptake and Profitability of Summer Green Gram (*Vigna radiata* L.)

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## Abstract

A field experiment was conducted during the summer season of 2024–25 at Mahatma Phule Krishi Vidyapeeth, Rahuri, to evaluate the effect of foliar potassium application on soil chemical properties, nutrient uptake, and economic returns in summer green gram (*Vigna radiata* L.). Treatments included different potassium sources and concentrations with a recommended dose of fertilizers in a randomized block design. Results showed that foliar application of potassium, particularly potassium Schoenite at 2% or SOP at 2% or MOP at 2% at 40 and 55 DAS nutrient uptake by the crop was enhanced. Economic analysis revealed that the treatment with potassium Schoenite at 2% or SOP at 2% or MOP at 2% at 40 and 55 DAS foliar application generated the highest gross and net returns with superior benefit-cost ratio. The study highlights the effectiveness of foliar potassium nutrition for enhancing soil fertility, nutrient use efficiency, and profitability in summer green gram cultivation under semi-arid tropics.

**Key words : Green gram, foliar potassium, nutrient uptake, potassium schoenite, economic analysis.**

Summer green gram (*Vigna radiata* L.) is a vital legume crop cultivated extensively in semi-arid regions due to its short growing period, nutritional value, and nitrogen-fixing ability. Despite its adaptability and economic importance, green gram production is often constrained by nutrient deficiencies, particularly potassium (K), which plays an indispensable role in various physiological processes essential for plant growth and yield. Potassium is critical for enzyme activation, osmoregulation, photosynthesis, and nutrient translocation, thus impacting crop productivity and quality (Jat *et al*., 2021). Conventionally, soil application of potassium fertilizers has been the primary management strategy; however, foliar potassium application has emerged as a rapid and efficient alternative, potentially alleviating potassium deficiency during critical crop growth stages and improving nutrient use efficiency (Choudhary *et al*., 2024).

Foliar nutrient application allows direct nutrient uptake by leaves, facilitating immediate utilization and minimizing nutrient losses commonly associated with soil applications due to fixation or leaching. Several recent investigations have emphasized the positive impact of potassium foliar sprays on soil nutrient dynamics, plant nutrient uptake, and physiological improvements in various crops, including pulses (Manisha *et al*., 2025; Pandian *et al*., 2024). In green gram, potassium foliar application has been reported to enhance physiological parameters such as chlorophyll content, stomatal conductance, and photosynthetic rate, leading to improved biomass accumulation and yield attributes (Roy *et al*., 2023; Rajemahadik *et al*., 2024).

Recent studies demonstrate that integrating potassium foliar applications with basal fertilization not only augments plant growth but also improves soil chemical properties, including pH, electrical conductivity, and organic carbon content, through enhanced root exudation and microbial activity (Mohanapriya *et al*., 2022). Such improvements in soil fertility parameters contribute to increased availability of essential macro-nutrients-nitrogen (N), phosphorus (P), and potassium (K)-post-harvest, which is imperative for sustainable crop production systems. Furthermore, the synergistic effect of potassium with secondary nutrients like magnesium and sulfur, especially in forms such as potassium schoenite, has shown promising results in enhancing nutrient solubility and uptake efficiency in leguminous crops (Srinivasarao *et al*., 2023; Kumar *et al*., 2018).

Economic viability remains a critical factor for the adoption of nutrient management strategies by farmers. Foliar potassium applications have shown potential to improve the cost-benefit ratio by enhancing yield and quality while optimizing input use. Enhanced economic returns realized through increased gross and net monetary benefits validate foliar potassium application as a feasible practice for smallholder farmers cultivating summer green gram under resource-constrained environments (Manjhi *et al*., 2020; Pandey *et al*., 2013).

Despite growing evidence supporting potassium foliar nutrition, comprehensive studies that concurrently evaluate its effects on soil nutrient dynamics, plant nutrient uptake, and detailed economic analysis in summer green gram remain limited. This research aims to address this gap by investigating the impact of potassium foliar application on soil chemical properties, nutrient uptake efficiency (N, P, K), growth and yield performance, and economic returns of summer green gram (*Vigna radiata* L.), with a special focus on foliar potassium sources such as potassium schoenite and sulfate of potash. The outcomes will contribute to optimizing nutrient management practices conducive to improving productivity and sustainability in pulse cropping systems.

## Materials and Methods

A field experiment entitled "Enhanced Growth and Yield of Summer Green Gram (*Vigna radiata* L.) through Foliar Application of Potassium Sources in Semi-Arid Tropics" was conducted at the Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Dist. Ahilyanagar (Maharashtra) during the summer season of 2024-25. The site is situated between 19°19-19°57  N latitude and 74°19-74°32  E longitude, with an altitude of 491-537 m above mean sea level, falling under the semi-arid tropics with an average annual rainfall of 520 mm. The experimental soil was clayey, non-calcareous, and alkaline (pH 8.18) with medium organic carbon (0.51%), low available nitrogen (195.35 kg $ha^{-1}$), medium phosphorus (17.03 kg $ha^{-1}$), and very high potassium (367.22 kg $ha^{-1}$). Meteorological observations indicated maximum and minimum temperatures of 32.8-40.8°C and 12.6-22.5°C, respectively, with 214.6 mm rainfall during the experimental period.  The experiment was laid out in a randomized block design (RBD) with three replications and twenty-four treatments. Each plot measured 3.60 x 3.00 m (gross) and 3.00 x 2.40 m (net). Land preparation involved ploughing and harrowing, followed by layout according to design. Phule Suvarna seeds were sown on 6$^{th}$ March, 2025, at 30 cm x 10 cm spacing using a seed rate of 15 kg $ha^{-1}$. Seeds were treated with phosphate-solubilizing bacteria (PSB) @ 250 g and *Trichoderma* culture @ 50 g per 10 kg of seed. A recommended basal dose of 20:40:00 N:$P_2O_5$:$K_2O$ kg $ha^{-1}$ and 5 t $ha^{-1}$ FYM was applied through straight fertilizers (urea and single super phosphate).

## Results and Discussion

### Available Soil Nutrients Post-Harvest

**Nutrient Uptake :** Though nitrogen and phosphorus contents in seed and straw were not significantly altered, their uptake differed notably among treatments. Nitrogen uptake peaked in $T_8$ with 54.05 kg ha$^{-1}$ (seed) and 13.55 kg ha$^{-1}$ (straw), reflecting potassium's vital role in nitrate reduction, protein synthesis, and assimilate translocation, corroborating Akhil *et al*. (2022) and Kumawat *et al*. (2014). Phosphorus uptake was highest in $T_8$, emphasizing potassium schoenite's synergistic effect in enhancing root activity and enzyme function for improved P mobilization (Kumawat *et al*., 2024; Akhil *et al*., 2022). Potassium uptake was significantly influenced by foliar potassium source and concentration. $T_8$ again recorded the highest uptake (19.66 kg ha$^{-1}$ seed; 19.87 kg ha$^{-1}$ straw), aligning with Das *et al*. (2017) and Verma *et al*. (2023), who reported enhanced potassium absorption and efficiency following foliar supplementation. Total nutrient uptake (NPK) was markedly improved under $T_8$, reinforcing the contribution of foliar potassium, particularly Schoenite, in nutrient use efficiency and uptake optimization (Kumar *et al*., 2018; Shiksha *et al*., 2025; Chavan *et al*., 2024).

**Economic Analysis :** Economic returns reflected the enhancements in growth and

**Table 1.** Nitrogen uptake of summer green gram as influenced by different potassium foliar application treatments

| Treatments | N content (%) | | N uptake (kg ha$^{-1}$) | |
|---|---|---|---|---|
| | Seed | Straw | Seed | Straw |
| $T_1$ : Absolute control | 3.36 | 0.73 | 19.65 | 6.43 |
| $T_2$ : GRDF 20:40:00 (N: $P_2O_5$: $K_2O$) kg ha$^{-1}$ + FYM @ 5 t ha$^{-1}$ | 3.39 | 0.74 | 35.81 | 9.48 |
| $T_3$ : GRDF + foliar application of MOP (1%) | 3.41 | 0.74 | 37.44 | 9.83 |
| $T_4$ : GRDF + foliar application of MOP (2%) | 3.48 | 0.76 | 44.63 | 11.32 |
| $T_5$ : GRDF + foliar application of SOP (1%) | 3.45 | 0.75 | 39.84 | 10.37 |
| $T_6$ : GRDF + foliar application of SOP (2%) | 3.50 | 0.77 | 47.32 | 11.88 |
| $T_7$ : GRDF + foliar application of Potassium Schoenite (1%) | 3.46 | 0.76 | 40.93 | 10.61 |
| $T_8$ : GRDF + foliar application of Potassium Schoenite (2%) | 3.65 | 0.81 | 54.05 | 13.55 |
| S. Em± | 0.14 | 0.04 | 3.15 | 0.82 |
| C. D. at 5% | NS | NS | 9.46 | 2.48 |
| General mean | 3.46 | 0.76 | 39.96 | 10.43 |

**Table 2.** Phosphorus uptake of summer green gram as influenced by different potassium foliar application treatments

| Treatments | P content (%) | | P uptake (kg ha$^{-1}$) | |
|---|---|---|---|---|
| | Seed | Straw | Seed | Straw |
| $T_1$ : Absolute control | 0.39 | 0.23 | 2.27 | 2.01 |
| $T_2$ : GRDF 20:40:00 (N: $P_2O_5$: $K_2O$) kg ha$^{-1}$ + FYM @ 5 t ha$^{-1}$ | 0.41 | 0.25 | 4.36 | 3.18 |
| $T_3$ : GRDF + foliar application of MOP (1%) | 0.42 | 0.25 | 4.63 | 3.35 |
| $T_4$ : GRDF + foliar application of MOP (2%) | 0.44 | 0.26 | 5.65 | 3.88 |
| $T_5$ : GRDF + foliar application of SOP (1%) | 0.44 | 0.27 | 5.08 | 3.66 |
| $T_6$ : GRDF + foliar application of SOP (2%) | 0.45 | 0.27 | 6.09 | 4.14 |
| $T_7$ : GRDF + foliar application of Potassium Schoenite (1%) | 0.43 | 0.25 | 5.07 | 3.55 |
| $T_8$ : GRDF + foliar application of Potassium Schoenite (2%) | 0.46 | 0.28 | 6.69 | 4.56 |
| S. Em± | 0.01 | 0.01 | 0.36 | 0.23 |
| C. D. at 5% | NS | NS | 1.11 | 0.69 |
| General mean | 0.43 | 0.26 | 0.43 | 3.54 |

**Table 3.** Potassium uptake of summer green gram as influenced by different potassium foliar application treatments

| Treatments | K content (%) | | K uptake (kg $ha^{-1}$) | |
|---|---|---|---|---|
| | Seed | Straw | Seed | Straw |
| $T_1$ : Absolute control | 1.14 | 1.02 | 6.61 | 9.01 |
| $T_2$ : GRDF 20:40:00 (N: $P_2O_5$: $K_2O$) kg $ha^{-1}$ + FYM @ 5 t $ha^{-1}$ | 1.21 | 1.09 | 12.83 | 14.10 |
| $T_3$ : GRDF + foliar application of MOP (1%) | 1.23 | 1.11 | 13.60 | 14.80 |
| $T_4$ : GRDF + foliar application of MOP (2%) | 1.27 | 1.15 | 16.33 | 17.06 |
| $T_5$ : GRDF + foliar application of SOP (1%) | 1.29 | 1.16 | 14.92 | 16.03 |
| $T_6$ : GRDF + foliar application of SOP (2%) | 1.30 | 1.17 | 17.60 | 18.15 |
| $T_7$ : GRDF + foliar application of Potassium Schoenite (1%) | 1.24 | 1.12 | 14.68 | 15.67 |
| $T_8$ : GRDF + foliar application of Potassium Schoenite (2%) | 1.33 | 1.20 | 19.66 | 19.87 |
| S. Em± | 0.03 | 0.03 | 1.13 | 0.95 |
| C. D. at 5% | NS | NS | 3.41 | 2.85 |
| General mean | 1.25 | 1.13 | 14.53 | 15.59 |

**Table 4.** Total uptake of NPK uptake of summer green gram as influenced by different potassium foliar application treatments

| Treatments | Total N uptake (kg $ha^{-1}$) | Total P uptake (kg $ha^{-1}$) | Total K uptake (kg $ha^{-1}$) |
|---|---|---|---|
| $T_1$ : Absolute control | 26.08 | 4.26 | 15.62 |
| $T_2$ : GRDF 20:40:00 (N: $P_2O_5$: $K_2O$) kg $ha^{-1}$ + FYM @ 5 t $ha^{-1}$ | 45.29 | 7.57 | 26.93 |
| $T_3$ : GRDF + foliar application of MOP (1%) | 47.27 | 8.01 | 28.40 |
| $T_4$ : GRDF + foliar application of MOP (2%) | 55.95 | 9.49 | 33.40 |
| $T_5$ : GRDF + foliar application of SOP (1%) | 50.21 | 8.79 | 30.95 |
| $T_6$ : GRDF + foliar application of SOP (2%) | 59.20 | 10.20 | 35.75 |
| $T_7$ : GRDF + foliar application of Potassium Schoenite (1%) | 51.54 | 8.59 | 30.35 |
| $T_8$ : GRDF + foliar application of Potassium Schoenite (2%) | 67.60 | 11.34 | 39.53 |
| S. Em± | 3.89 | 0.65 | 2.11 |
| C. D. at 5% | 11.81 | 1.95 | 6.33 |
| General mean | 50.39 | 8.53 | 30.12 |

**Table 5.** Economics of summer green gram as influenced by different potassium foliar application treatments

| Treatments | Gross monetary returns (Rs. $ha^{-1}$) | Cost of cultivation (Rs. $ha^{-1}$) | Net monetary return (Rs. $ha^{-1}$) | B:C Ratio |
|---|---|---|---|---|
| $T_1$ : Absolute control | 51138 | 39981 | 11557 | 1.29 |
| $T_2$ : GRDF 20:40:00 (N: $P_2O_5$: $K_2O$) kg $ha^{-1}$ + FYM @ 5 t $ha^{-1}$ | 82963 | 45235 | 40728 | 1.83 |
| $T_3$ : GRDF + foliar application of MOP (1%) | 96478 | 56063 | 40415 | 1.72 |
| $T_4$ : GRDF + foliar application of MOP (2%) | 112337 | 55656 | 55573 | 2.01 |
| $T_5$ : GRDF + foliar application of SOP (1%) | 100987 | 55757 | 45230 | 1.81 |
| $T_6$ : GRDF + foliar application of SOP (2%) | 118290 | 56105 | 62185 | 2.10 |
| $T_7$ : GRDF + foliar application of Potassium Schoenite (1%) | 103124 | 55749 | 47375 | 1.85 |
| $T_8$ : GRDF + foliar application of Potassium Schoenite (2%) | 127005 | 56089 | 70916 | 2.26 |
| S. Em± | 5124 | - | 5124 | - |
| C. D. at 5% | 15543 | - | 15543 | - |
| General mean | 99036.87 | 41270.62 | 46747.37 | 1.85 |

nutrient uptake. $T_8$ led with the highest gross return of Rs. 127,005 ha$^{-1}$, net return Rs. 70,916 ha$^{-1}$, and benefit-cost ratio (B:C) of 2.26, significantly outpacing other treatments. The superior economic performance is attributed to increased yield components translating to greater marketable produce. These outcomes align with Manjhi *et al*. (2020) and Pandey *et al*. (2013), emphasizing foliar potassium fertilization as a profitable practice. Potassium Schoenite's chloride-free dual K and Mg supply improves photosynthetic efficiency and crop resilience under heat stress, further supporting yield and economic benefits (Kuttimani, 2011).

## Conclusion

The study demonstrated that foliar application of potassium, particularly potassium schoenite at 2% or SOP at 2% or MOP at 2% at 40 and 55 DAS significantly improved nutrient uptake in summer green gram (*Vigna radiata* L.). Foliar potassium treatments notably increased nitrogen, phosphorus, and potassium uptake by seed and straw, leading to improved growth and yield attributes. The potassium schoenite treatment consistently outperformed other potassium sources, enhancing nutrient use efficiency and crop resilience. Economically, foliar potassium application resulted in superior monetary returns and benefit-cost ratio, confirming its effectiveness as a sustainable and profitable nutrient management strategy for green gram cultivation in semi-arid regions.

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