

## Impact of fertilizing with potassium and phosphorus on summer greengram (*Vigna radiata*) cultivars

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### Abstract

In order to solve the problem of global food security and advance sustainable farming techniques, pulses are crucial. Greengram (*Vigna radiata* L.) stands out among the other alternatives because of its nutritional makeup, short growing time, and ability to improve soil fertility via nitrogen fixation. Greengram is grown on an estimated 46 lakh hectares of land in India, of which only 0.002 lakh hectares are in Nagaland (DPD 2021). To meet the increasing demand for foods high in protein and to provide stability in the agricultural environment, greengram production must be increased. Achieving maximum agricultural production and improving crop quality depend heavily on the efficient management of nutrients, particularly potassium (K) and phosphorus (P) (Singh 2017, Sahu et al. 2020). Potassium controls water absorption, enzyme activity, and the general health of plants (Kumar et al. 2022), whereas phosphorus is essential for energy transmission, photosynthesis, and root growth (Sahu et al. 2021). Plant growth, development, and production are greatly impacted by the intricate interactions between various crop cultivars and vital nutrients. When one considers how various types respond to varied nutrient levels, it becomes clear how important customised management techniques are to maximising their potential.

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### Introduction

With the dual goals of assessing the performance of various summer greengram varieties and examining the effects of phosphorus and potassium levels on their growth and yield, the current study was conducted in the summer of 2021 at Nagaland University's School of Agricultural Sciences, Medziphema Campus, Nagaland. Furthermore, the financial viability of the different therapies were evaluated. The study was conducted between April and July of 2021. The field was divided into 36 plots, each measuring 4 m by 3 m, using a factorial randomised block design. Over the course of the experiment, the average maximum, minimum, rainfall, and relative humidity were 33.1°C, 21.6°C, 22.26 mm, and 71.95%, respectively. The initial soil status shows high carbon (1.05%), acidic soil, and medium accessible nitrogen (250.88 kg/ha), P<sub>2</sub>O<sub>5</sub> (32.81 kg/ha), and K<sub>2</sub>O (144.64 kg/ha). Three greengram varieties—G1: IPM 02-3, G2: SGC-20, and G3: SGC-16—were used in the experiment. They were given four different dosages of potassium and phosphorus: F0, control; F1, 40 kg P<sub>2</sub>O<sub>5</sub> + 40 kg K<sub>2</sub>O; F2, 50 kg P<sub>2</sub>O<sub>5</sub> + 50 kg K<sub>2</sub>O; and F3, 60 kg P<sub>2</sub>O<sub>5</sub> + 60 kg K<sub>2</sub>O per hectare. At the time of sowing, a single dosage of each fertiliser was administered in furrows. Every plot received 20 kg/ha of urea. The process outlined by Gomez and Gomez (1984) was used to submit the data to statistical analysis suitable for the design.

Growth characteristics: As the crop developed, a steady rise in plant height was seen (Table 1). The tallest plants among the cultivars were IPM 02-3 (28.98 cm at 45 DAS and 53.09 cm at harvest), followed by SGC-20 (28.21 cm and 51.93 cm) and SGC-16 (27.64 cm and 51.79 cm). Plant height was positively impacted by fertiliser application, with all treatments exhibiting greater heights than the control. Notably, the 60 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O treatment produced the maximum height (30.73 cm at 45 DAS and 54.87 cm at harvest), which was statistically equivalent to the 50 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O treatment at 45 DAS. It's interesting to note that, apart from the control, all fertiliser treatments produced plants with comparable heights at harvest. The leaf area index (LAI) showed varying patterns. Variety or phosphorus and potassium levels did not significantly affect LAI at 45 DAS. All phosphorus and potassium treatments showed significant differences, although IPM 02-3 outperformed the other kinds by 60 DAS. Applying 60 kg/ha of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O resulted in the greatest LAI. A steady rise in dry matter was

Table 1 Effect of variety and different doses of phosphorus and potassium on growth and yield

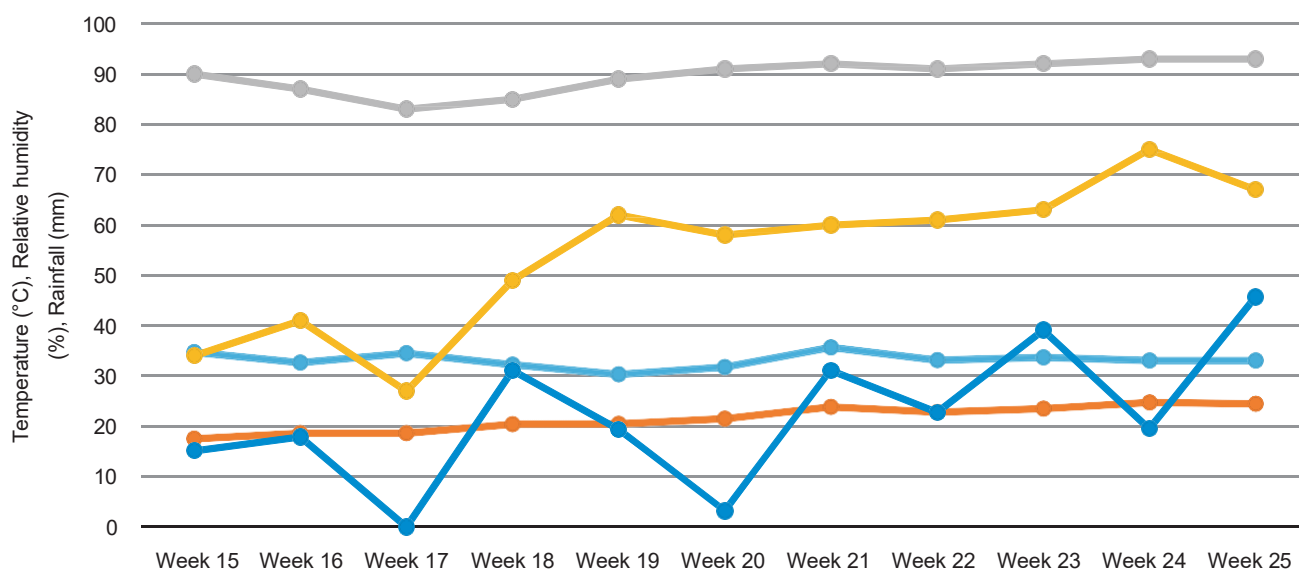
| Treatment      | Plant height       |                    | Left area index   |                   | Dry matter production (g) |                     | Branches/<br>plant | Seeds/<br>pod     | Test weight (g)    | Seed yield (q/ha) | Stover yield (q/ha) | Harvest index (%)  |
|----------------|--------------------|--------------------|-------------------|-------------------|---------------------------|---------------------|--------------------|-------------------|--------------------|-------------------|---------------------|--------------------|
|                | 40 DAS             | Harvest            | 45 DAS            | 60 DAS            | 45 DAS                    | 60 DAS              |                    |                   |                    |                   |                     |                    |
| G <sub>1</sub> | 28.98 <sup>a</sup> | 53.09 <sup>a</sup> | 1.10 <sup>a</sup> | 2.73 <sup>a</sup> | 94.64 <sup>a</sup>        | 137.98 <sup>a</sup> | 4.64 <sup>a</sup>  | 8.85              | 28.00 <sup>a</sup> | 5.48 <sup>a</sup> | 13.43 <sup>a</sup>  | 28.82 <sup>a</sup> |
| G <sub>2</sub> | 28.21 <sup>b</sup> | 51.93 <sup>a</sup> | 1.05 <sup>a</sup> | 2.64 <sup>b</sup> | 93.68 <sup>a</sup>        | 136.93 <sup>b</sup> | 4.17 <sup>a</sup>  | 7.92              | 27.01 <sup>b</sup> | 5.08 <sup>b</sup> | 12.87 <sup>ab</sup> | 28.14 <sup>a</sup> |
| G <sub>3</sub> | 27.64 <sup>b</sup> | 51.79 <sup>a</sup> | 1.02 <sup>a</sup> | 2.59 <sup>c</sup> | 93.04 <sup>a</sup>        | 136.14 <sup>b</sup> | 4.05 <sup>a</sup>  | 7.91              | 26.60 <sup>b</sup> | 4.37 <sup>c</sup> | 12.80 <sup>b</sup>  | 25.42 <sup>b</sup> |
| F <sub>0</sub> | 25.01 <sup>c</sup> | 44.56 <sup>b</sup> | 0.96 <sup>a</sup> | 2.22 <sup>d</sup> | 85.44 <sup>b</sup>        | 120.38 <sup>b</sup> | 3.56 <sup>a</sup>  | 7.41              | 25.26 <sup>d</sup> | 3.86 <sup>c</sup> | 10.99 <sup>c</sup>  | 26.03 <sup>b</sup> |
| F <sub>1</sub> | 27.57 <sup>b</sup> | 53.08 <sup>a</sup> | 0.99 <sup>a</sup> | 2.46 <sup>c</sup> | 96.01 <sup>a</sup>        | 140.42 <sup>c</sup> | 4.17 <sup>a</sup>  | 7.98 <sup>a</sup> | 26.47 <sup>c</sup> | 4.47 <sup>b</sup> | 12.37 <sup>b</sup>  | 26.51 <sup>b</sup> |
| F <sub>2</sub> | 29.79 <sup>a</sup> | 54.37 <sup>a</sup> | 1.07 <sup>a</sup> | 2.74 <sup>b</sup> | 96.90 <sup>a</sup>        | 143.82 <sup>a</sup> | 4.40 <sup>a</sup>  | 8.40 <sup>a</sup> | 27.61 <sup>b</sup> | 5.74 <sup>a</sup> | 14.25 <sup>a</sup>  | 28.65 <sup>a</sup> |
| F <sub>3</sub> | 30.73 <sup>a</sup> | 54.87 <sup>a</sup> | 1.21 <sup>a</sup> | 3.21 <sup>a</sup> | 96.80 <sup>a</sup>        | 143.46 <sup>a</sup> | 5.02 <sup>a</sup>  | 9.14 <sup>a</sup> | 29.47 <sup>a</sup> | 5.84 <sup>a</sup> | 14.51 <sup>a</sup>  | 28.68 <sup>a</sup> |

Means with the same letters in column are not significantly different as per Duncan's multiple range test.

Refer to the methodology for treatment details.

noticed at the first stage of growth, becoming more intense when the crop entered the reproductive stage. With the exception of the control, all phosphorus and potassium treatments were similar at 45 DAS, and variation had no discernible impact on dry matter. IPM 02-3 performed better by 60 DAS, and the 50 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O treatment showed much more dry matter accumulation than F<sub>0</sub> and F<sub>1</sub>, but it was comparable to F<sub>3</sub>. Fertiliser treatment or variety did not significantly affect the number of branches per plant. The genetic characteristics of each genotype, together with the combined effects of phosphorus and potassium, may be responsible for the different responses in plant height, LAI, dry matter accumulation, and branches per plant. These elements are essential for activities including photosynthesis, cell division, cell expansion, sugar buildup, and energy storage. Awomi et al. (2012), Gadi et al. (2018), Bagadkar et al. (2020), and Kharkongor and Dhamak (2020) all found similar results.

**Yield characteristics:** The data in Table 1 demonstrated how variety and fertilisation with potassium and phosphorus affected yield and yield attributes. In terms of seeds/pod, test weight, seed yield, stover yield, and harvest index, variety IPM 02-3 showed the greatest results compared to other varieties. In terms of harvest index and stover yield, it was shown to be comparable to SGC-20. There was no discernible variation in the number of seeds per pod across the cultivars. With the exception of seeds per pod, where there was no discernible variation as a result of P and K fertilisation, all phosphorus and potassium treatments showed considerably greater yield characteristics when compared to the control. The greatest seed/pod (9.14), test weight (29.47 g), seed yield (5.84 q/ha), stover yield (14.51 q/ha), and harvest index (28.64%) were reported when 60 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were applied. However, in terms of qualities like seed yield, stover output, and harvest index, this was statistically comparable to applying 50 kg/ha P<sub>2</sub>O<sub>5</sub> and



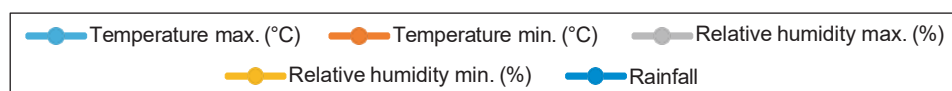


Fig 1 Meteorological observations during the period of experiment (April to July).

The genetic superiority and adaptability of the kinds to the local environment, as well as the function of phosphorus and potassium in early seed germination, seedling establishment,  $F_2$  (Since the level of  $P_2O_5$  and  $K_2O$  is same, a separated table is not provided and the value is the individual effect of each fertilizer rate and not a combined effect of P and K). This was followed by  $F_1$  and  $F_3$ . This suggests that optimal

development of the stalk, bloom, and seed. The results of Ranpariya et al. (2017), Singh et al. (2018), and Bhabai et al. (2019) corroborated this.

Soil nutrient status and yield: Figure 2 shows the data on soil nutrient levels as affected by phosphorus and potassium dosages and types. Furthermore, Fig. 3 provides a visual depiction of the complex connection between the yield of greengram cultivars and the nutrients available in the soil. During the experiment, no discernible impact of diversity on the overall nutritional status was found. In the meanwhile, soil nitrogen, phosphorus, and potassium concentrations were significantly impacted by P and K levels compared to control. With the exception of organic carbon, which exhibits a decrease curve, it is clear that a rise in P and K levels causes the soil nutrient curve to steadily slope (Fig 2). Significantly, when soil accessible nitrogen and potassium levels rise, a discernible pattern appears (Fig. 3), marked by a steady rising trajectory in the seed yield curve.

Nutrient usage efficiency: Table 2's partial factor productivity data shows that treatment produces the maximum seed production per kilogram of applied nutrients (11.49 seed yield/kg each of  $P_2O_5$  and  $K_2O$ ).

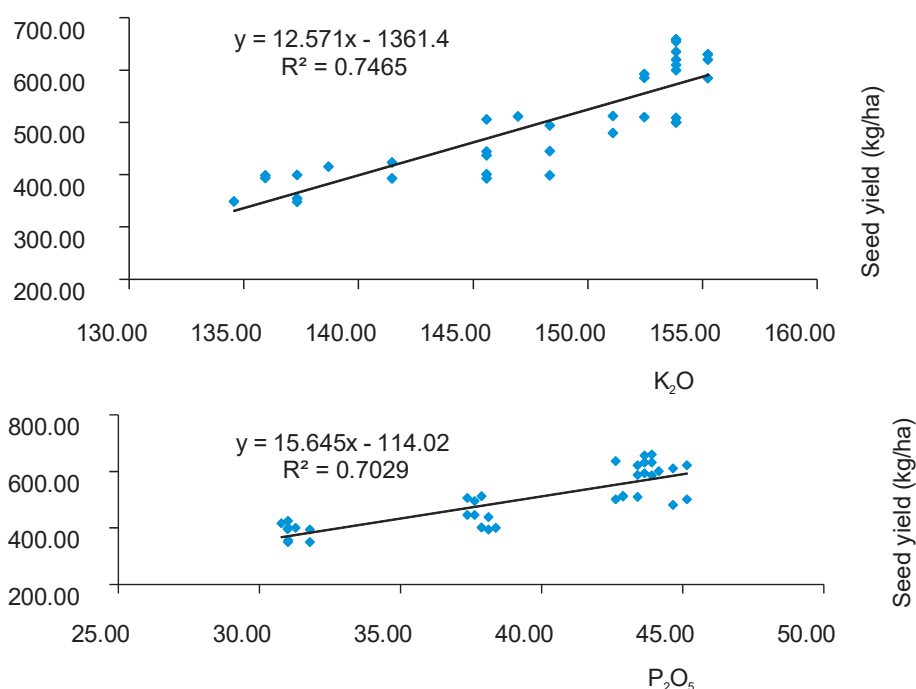


Fig 2 Relation between soil available nutrient and seed yield of green gram.

Table 2 Partial factor productivity (PFP) and economics of treatments

| Partial factor productivity (kg yield/kg nutrient applied) |                |                |                |          | Net return (₹/ha)  |                    |                    |                    | B:C ratio          |                    |                   |                   |                   |                   |
|------------------------------------------------------------|----------------|----------------|----------------|----------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|-------------------|-------------------|-------------------|
| Nutrient × Variety                                         | G <sub>1</sub> | G <sub>2</sub> | G <sub>3</sub> | Mean PFP | Nutrient × Variety | G <sub>1</sub>     | G <sub>2</sub>     | G <sub>3</sub>     | Mean net return    | Nutrient × Variety | G <sub>1</sub>    | G <sub>2</sub>    | G <sub>3</sub>    | Mean B:C ratio    |
| F <sub>0</sub>                                             | 0.00           | 0.00           | 0.00           | 0.00     | F <sub>0</sub>     | 21597              | 19712              | 14785              | 18698 <sup>c</sup> | F <sub>0</sub>     | 0.89              | 0.82              | 0.61              | 0.77 <sup>c</sup> |
| F <sub>1</sub>                                             | 12.59          | 11.05          | 9.93           | 11.19    | F <sub>1</sub>     | 30848              | 24075              | 19117              | 24680 <sup>b</sup> | F <sub>1</sub>     | 1.23              | 0.96              | 0.76              | 0.98 <sup>b</sup> |
| F <sub>2</sub>                                             | 12.76          | 11.75          | 9.95           | 11.49    | F <sub>2</sub>     | 45466              | 39908              | 29982              | 38452 <sup>a</sup> | F <sub>2</sub>     | 1.80              | 1.58              | 1.19              | 1.52 <sup>a</sup> |
| F <sub>3</sub>                                             | 10.64          | 10.17          | 8.44           | 9.75     | F <sub>3</sub>     | 45317              | 42164              | 30788              | 39423 <sup>a</sup> | F <sub>3</sub>     | 1.78              | 1.66              | 1.21              | 1.55 <sup>a</sup> |
| Mean PFP                                                   | 9.00           | 8.24           | 7.08           |          | Mean net return    | 35807 <sup>a</sup> | 31465 <sup>b</sup> | 23669 <sup>c</sup> |                    | Mean B:C ratio     | 1.42 <sup>a</sup> | 1.25 <sup>b</sup> | 0.94 <sup>c</sup> |                   |

Means with same letters in column and in row, indicate not significantly different as per Duncan's multiple range test. Refer to the methodology for treatment details.

Its effectiveness is shown by the achievement of nutrient utilisation with 50 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. Economics of therapy: Table 2 provides information on the economics of treatment. With the greatest net return of ₹35807.00 and B:C ratio of 1.43, IPM 02-3 clearly stands out among the several kinds evaluated. SGC-16 shows net returns of ₹23668 and a B:C ratio of 0.94, while SGC-20 displays net returns of ₹31464 and a B:C ratio of 1.25. The application of 60 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O produces the greatest net return of ₹39423 and an increased B:C ratio of 1.55 when assessing the effects of various phosphorus and potassium levels. It's interesting to note that applying 50 kg/ha of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O yields comparable financial results. The 50 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O application produced parity in net return and B:C ratio, indicating that an ideal balance may be reached without the larger nutrient dose.

## SUMMARY

This experiment indicates that using the greengram variety IPM 02-3 is beneficial since it performs better and is more adaptable than the other kinds examined. Furthermore, 50 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O application shows similar performance and profitability to 60 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O application, making it an economically advantageous choice. Analysis of soil fertility showed how P and K improve nutrient dynamics. The complex link is shown by the connection between soil nitrogen levels and greengram production. In conclusion, genetic variables and ideal nutrition management work together to influence greengram development and production.

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