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## Influence of different levels of phosphorus, biofertilizers and farm yard manure on growth character and yield attributes of Chickpea (*Cicer arietinum* L.)

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### Abstract

A field experiment was conducted during the Rabi seasons of 2023-24 and 2024-25 to study the “Influence of different levels of phosphorus, biofertilizers and farmyard manure on growth characters and yield attributes of chickpea (*Cicer arietinum* L.)” under Central U.P. conditions. The soil of the experimental site was sandy loam, low in available nitrogen, medium in phosphorus, and high in potassium. The experiment was laid out in a Factorial Randomized Block Design with three replications, comprising three phosphorus levels (0, 30, and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>), four biofertilizer treatments (B<sub>0</sub>: control, B<sub>1</sub>: Rhizobium, B<sub>2</sub>: PSB, B<sub>3</sub>: Rhizobium + PSB), and two levels of FYM (M<sub>0</sub>: no FYM, M<sub>1</sub>: FYM @ 5 t ha<sup>-1</sup>). Results revealed that the application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> in combination with FYM and biofertilizers significantly enhanced plant height, number of branches per plant, nodulation, and 100-grain weight compared to control and lower phosphorus levels. The treatment combination M<sub>1</sub>P<sub>60</sub>B<sub>3</sub> (FYM + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> + Rhizobium + PSB) recorded the maximum values for growth and yield attributes in both years. Although some interactions among treatments were statistically non-significant, the overall performance indicated a positive synergistic effect of integrated nutrient management on chickpea productivity. The study concludes that the integrated use of phosphorus, biofertilizers, and FYM is a sustainable nutrient management approach for improving chickpea growth, yield attributes, and soil fertility, thereby promoting eco-friendly and cost-effective pulse production under Central Uttar Pradesh conditions.

**Keywords:** Biofertilizers, farm yard manure and Integrated nutrient management

### Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops cultivated in India, contributing significantly to food and nutritional security. It serves as a rich source of protein (18-22%), carbohydrates, minerals, and vitamins, playing a crucial role in human diets, especially in vegetarian populations (Ali and Kumar, 2018) <sup>[1]</sup>. Despite its importance, the productivity of chickpea remains low due to inadequate nutrient management, particularly phosphorus deficiency, which limits root development, nodulation, and energy transfer within plants (Singh *et al.*, 2020) <sup>[4]</sup>. Phosphorus is an essential macronutrient that promotes early root growth and nodule formation, enhancing nitrogen fixation in legumes. However, a large proportion of soil phosphorus remains in insoluble forms, reducing its availability to plants (Gaur, 2004) <sup>[2]</sup>. Integrated nutrient management, involving the combined use of inorganic fertilizers, organic manures, and biofertilizers, has emerged as an efficient and eco-friendly approach for sustainable crop production (Yadav *et al.*, 2019) <sup>[5]</sup>. Farm Yard Manure (FYM) improves soil structure, microbial activity, and nutrient availability, while biofertilizers such as \*Rhizobium\* and Phosphate Solubilizing Bacteria (PSB) enhance biological nitrogen fixation and phosphorus solubilization (Sharma *et al.*, 2021) <sup>[6]</sup>. The synergistic use of phosphorus levels with FYM and biofertilizers enhances nutrient uptake, improves growth characters, and increases yield attributes of chickpea (Kumar *et al.*, 2022) <sup>[7]</sup>.

### Materials and Methods

The present field experiment was carried out at Student Instructional Farm, Nawabganj,

Department of Soil Science of C. S. Azad University of Agriculture & Technology, Kanpur during Kharif season 2023 and 2024. The soil in the experimental field is classified as Inceptisols. It is sandy loam in texture and neutral to alkaline in soil reaction. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three factors - phosphorus levels, biofertilizers, and farmyard manure (FYM) - replicated thrice. The treatments consisted of three phosphorus levels (0, 30, and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>), four biofertilizer levels (B<sub>0</sub>: control, B<sub>1</sub>: Rhizobium, B<sub>2</sub>: PSB, B<sub>3</sub>: Rhizobium + PSB) and two FYM levels (M<sub>0</sub>: no FYM, M<sub>1</sub>: FYM at 5 t ha<sup>-1</sup>). Phosphorus was applied through single super phosphate as per treatment, and FYM was incorporated 15 days before sowing. The crop was sown at a spacing of 30 cm × 10 cm using recommended agronomic practices. Observations on growth and yield parameters such as plant height, number of branches per plant, number of nodules, and 100-grain weight were recorded at appropriate growth stages. The collected data were statistically analyzed using standard ANOVA techniques as suggested by Gomez and Gomez (1984) [3]. The significance of treatment differences was tested at a 5% probability level.

## Results and Discussion

### Growth Characters and Yield attribute

The data presented in Tables 1-4 show the effect of different levels of phosphorus, biofertilizers, and farmyard manure (FYM) on the growth parameters of chickpea during 2023-24 and 2024-25.

### Plant height at 60 days after sowing (DAS) and at harvest

Plant height increased progressively with increasing phosphorus levels and biofertilizer application (Tables 1 and 2). The maximum plant height at 60 DAS (21.94 cm in 2023-24 and 22.00 cm in 2024-25) was recorded under P<sub>60</sub>, while the lowest (20.14 cm and 20.18 cm, respectively) was observed under P<sub>0</sub>. FYM application (M<sub>1</sub>) also resulted in slightly higher values compared to no FYM (M<sub>0</sub>). Similar trends were observed at harvest, where the highest plant height (51.68 cm and 52.34 cm) was recorded with P<sub>60</sub>, while the lowest was under P<sub>0</sub>. Biofertilizer treatment B<sub>3</sub> consistently produced taller plants compared to control (B<sub>0</sub>), indicating the positive role of Rhizobium and PSB in improving nutrient uptake. These findings are consistent with those of Singh *et al.* (2020) [4] and Kumar *et al.* (2022) [7], who reported that combined application

of phosphorus and biofertilizers enhanced plant height due to improved root growth and nodulation.

**Number of branches per plant:** Number of branches increased significantly with higher phosphorus levels and biofertilizer inoculation (Table 3). The maximum number of branches (5.57 and 5.67 during 2023-24 and 2024-25, respectively) was obtained under P<sub>60</sub> with B<sub>3</sub> and FYM, whereas the lowest (4.61 and 4.68) was under P<sub>0</sub> with B<sub>0</sub>. FYM improved branching by enhancing soil structure and nutrient availability. Similar observations were reported by Sharma *et al.* (2021) [6], indicating that organic and biological sources stimulate vegetative growth by maintaining better nutrient balance and microbial activity in the rhizosphere.

**Number of nodules per plant:** The number of nodules per plant at 60 DAS (Table 4) also increased markedly with phosphorus and biofertilizer application. The maximum nodule number (21.68 and 21.78) was recorded under P<sub>60</sub> along with B<sub>3</sub> and FYM (M<sub>1</sub>), while the minimum (18.66 and 18.59) was noted under P<sub>0</sub>. Phosphorus is vital for nodule initiation and energy transfer, while Rhizobium inoculation directly contributes to nodule formation. FYM further enhanced microbial activity, providing a favourable environment for nodule development. These results agree with the findings of Ali and Kumar (2018) [1] and Gaur (2004) [2], who reported that the combined use of phosphorus, FYM, and biofertilizers significantly increased nodulation and nitrogen fixation in legumes. Overall, integrated use of phosphorus (60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>), FYM, and biofertilizers proved most effective in enhancing growth attributes of chickpea.

The data in Table 5 show that 100-grain weight of chickpea increased with higher phosphorus, biofertilizer, and FYM levels during 2023-24 and 2024-25. The highest grain weight (15.26 g and 15.36 g) was recorded with 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, while the lowest (13.96 g and 13.94 g) was under control. Biofertilizer treatment B<sub>3</sub> and FYM (M<sub>1</sub>) further enhanced seed weight due to improved nutrient availability, nodulation, and photosynthates translocation. The combined application (P<sub>60</sub> + FYM + B<sub>3</sub>) produced the best results, indicating synergistic effects of integrated nutrient management on grain filling and seed quality. These results agree with Singh *et al.* (2020) [4], Sharma *et al.* (2021) [6], and Kumar *et al.* (2022) [7], who reported improved yield attributes of chickpea with balanced nutrient management.

**Table 1:** Effect of different levels of phosphorus, biofertilizers and farm yard manure in on Plant height at 60 days after sowing of Chickpea during 2023-24 and 2024-25

|                       | Plant height at 60 days after sowing (cm) |                |                |                |                 |                 |                 |                 |                 |                |                |       |
|-----------------------|-------------------------------------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|-------|
|                       | 2023-24                                   |                |                |                |                 |                 | 2024-25         |                 |                 |                |                |       |
| M <sub>0</sub>        | Levels                                    | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub>  | Mean            | Levels          | B <sub>0</sub>  | B <sub>1</sub>  | B <sub>2</sub> | B <sub>3</sub> | Mean  |
|                       | P <sub>0</sub>                            | 20.04          | 20.10          | 20.14          | 20.20           | 20.12           | P <sub>0</sub>  | 20.08           | 20.13           | 20.18          | 20.24          | 20.15 |
|                       | P <sub>30</sub>                           | 21.12          | 21.18          | 21.25          | 21.32           | 21.21           | P <sub>30</sub> | 21.16           | 21.23           | 21.29          | 21.36          | 21.26 |
|                       | P <sub>60</sub>                           | 21.84          | 21.90          | 21.94          | 21.99           | 21.91           | P <sub>60</sub> | 21.88           | 21.96           | 22.01          | 22.06          | 21.97 |
|                       | Mean                                      | 21.00          | 21.06          | 21.11          | 21.17           | 21.08           | Mean            | 21.04           | 21.10           | 21.16          | 21.22          | 21.13 |
| M <sub>1</sub>        | P <sub>0</sub>                            | 20.08          | 20.16          | 20.19          | 20.24           | 20.16           | P <sub>0</sub>  | 20.14           | 20.20           | 20.25          | 20.29          | 20.22 |
|                       | P <sub>30</sub>                           | 21.16          | 21.23          | 21.29          | 21.34           | 21.25           | P <sub>30</sub> | 21.22           | 21.27           | 21.32          | 21.38          | 21.29 |
|                       | P <sub>60</sub>                           | 21.90          | 21.96          | 22.01          | 22.06           | 21.98           | P <sub>60</sub> | 21.95           | 21.99           | 22.08          | 22.14          | 22.04 |
|                       | Mean                                      | 21.04          | 21.11          | 21.16          | 21.21           | 21.13           | Mean            | 21.10           | 21.15           | 21.21          | 21.27          | 21.18 |
| Mean of the mean<br>B |                                           |                | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub>  | B <sub>3</sub>  | B <sub>0</sub>  | B <sub>1</sub>  | B <sub>2</sub>  | B <sub>3</sub> |                |       |
|                       |                                           |                | 21.02          | 21.08          | 21.13           | 21.19           | 21.07           | 21.12           | 21.18           | 21.24          |                |       |
| Mean of the mean<br>P |                                           |                |                | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> | P <sub>0</sub>  | P <sub>30</sub> | P <sub>60</sub> |                |                |       |
|                       |                                           |                |                | 20.14          | 21.23           | 21.94           | 20.18           | 21.27           | 22.00           |                |                |       |

|                                      | 2023-2024 |       |           | 2024-2025 |        |           |
|--------------------------------------|-----------|-------|-----------|-----------|--------|-----------|
| Factors                              | SE(m) ±   | SE(d) | C.D at 5% | SEm ±     | SE (d) | C.D at 5% |
| Farm yard manure (F.Y.M)             | 0.061     | 0.086 | N.S.      | 0.061     | 0.086  | N.S.      |
| Phosphorus                           | 0.086     | 0.121 | N.S.      | 0.086     | 0.121  | N.S.      |
| Biofertilizer                        | 0.074     | 0.105 | N.S.      | 0.074     | 0.105  | 0.212     |
| (F.Y.M) × Phosphorus                 | 0.121     | 0.172 | N.S.      | 0.121     | 0.172  | N.S.      |
| (F.Y.M) × Biofertilizer              | 0.105     | 0.149 | N.S.      | 0.105     | 0.149  | N.S.      |
| Phosphorus× Biofertilizer            | 0.149     | 0.210 | N.S.      | 0.149     | 0.210  | N.S.      |
| (F.Y.M) × Phosphorus × Biofertilizer | 0.210     | 0.298 | N.S.      | 0.210     | 0.297  | N.S.      |

**Table 2:** Effect of different levels of phosphorus, biofertilizers and farm yard manure in on Plant height at harvest of Chickpea during 2023-24 and 2024-25

| Plant height at harvest |                 |                |                |                |       |       |                 |                |                |                |                |       |
|-------------------------|-----------------|----------------|----------------|----------------|-------|-------|-----------------|----------------|----------------|----------------|----------------|-------|
| 2023-24                 |                 |                |                |                |       |       | 2024-25         |                |                |                |                |       |
| Levels                  | B <sub>0</sub>  | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | Mean  |       | Levels          | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | Mean  |
| M <sub>0</sub>          | P <sub>0</sub>  | 45.00          | 45.60          | 45.80          | 46.00 | 45.60 | P <sub>0</sub>  | 44.25          | 44.70          | 44.85          | 45.15          | 44.73 |
|                         | P <sub>30</sub> | 49.00          | 49.70          | 49.95          | 50.15 | 49.70 | P <sub>30</sub> | 50.30          | 50.75          | 51.00          | 51.20          | 50.81 |
|                         | P <sub>60</sub> | 50.50          | 51.10          | 51.40          | 51.65 | 51.16 | P <sub>60</sub> | 51.10          | 51.80          | 52.10          | 52.40          | 51.85 |
|                         | Mean            | 48.16          | 48.80          | 49.05          | 49.26 | 48.82 | Mean            | 48.55          | 49.08          | 49.31          | 49.58          | 49.13 |
| M <sub>1</sub>          | P <sub>0</sub>  | 46.50          | 47.10          | 47.50          | 47.80 | 47.22 | P <sub>0</sub>  | 47.20          | 47.80          | 48.10          | 48.40          | 47.87 |
|                         | P <sub>30</sub> | 50.00          | 50.70          | 51.10          | 51.35 | 50.78 | P <sub>30</sub> | 51.10          | 51.80          | 52.10          | 52.40          | 51.85 |
|                         | P <sub>60</sub> | 51.40          | 52.10          | 52.50          | 52.80 | 52.20 | P <sub>60</sub> | 52.05          | 52.75          | 53.10          | 53.45          | 52.83 |
|                         | Mean            | 49.30          | 49.96          | 50.36          | 50.65 | 50.07 | Mean            | 50.11          | 50.78          | 51.10          | 51.41          | 50.85 |

|                       |                |                |                |                |                |                |                |                |
|-----------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Mean of the mean<br>B | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> |
|                       | 48.73          | 49.38          | 49.70          | 49.95          | 49.33          | 49.93          | 50.20          | 50.49          |

|                       |                |                 |                 |                |                 |                 |
|-----------------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| Mean of the mean<br>P | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> |
|                       | 46.41          | 50.24           | 51.68           | 46.30          | 51.33           | 52.34           |

|                                      | 2023-2024 |       |           | 2024-2025 |        |           |
|--------------------------------------|-----------|-------|-----------|-----------|--------|-----------|
| Factors                              | SE(m) ±   | SE(d) | C.D at 5% | SEm ±     | SE (d) | C.D at 5% |
| Farm yard manure (F.Y.M)             | 0.061     | 0.086 | 0.174     | 0.061     | 0.086  | 0.173     |
| Phosphorus                           | 0.086     | 0.122 | 0.246     | 0.086     | 0.122  | 0.245     |
| Biofertilizer                        | 0.075     | 0.106 | 0.213     | 0.075     | 0.105  | 0.212     |
| (F.Y.M) × Phosphorus                 | 0.122     | 0.173 | N.S.      | 0.122     | 0.172  | N.S.      |
| (F.Y.M) × Biofertilizer              | 0.106     | 0.150 | N.S.      | 0.105     | 0.149  | N.S.      |
| Phosphorus× Biofertilizer            | 0.150     | 0.212 | N.S.      | 0.149     | 0.211  | N.S.      |
| (F.Y.M) × Phosphorus × Biofertilizer | 0.212     | 0.299 | N.S.      | 0.211     | 0.298  | N.S.      |

**Table 3:** Effect of different levels of phosphorus, biofertilizers and farm yard manure in on Number of branches Plant<sup>-1</sup> of Chickpea during 2023-24 and 2024-25

| Number of branches Plant <sup>-1</sup> |                 |                |                |                |      |      |                 |                |                |                |                |      |
|----------------------------------------|-----------------|----------------|----------------|----------------|------|------|-----------------|----------------|----------------|----------------|----------------|------|
| 2023-24                                |                 |                |                |                |      |      | 2024-25         |                |                |                |                |      |
| Levels                                 | B <sub>0</sub>  | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | Mean |      | Levels          | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | Mean |
| M <sub>0</sub>                         | P <sub>0</sub>  | 4.20           | 4.45           | 4.55           | 4.65 | 4.46 | P <sub>0</sub>  | 4.00           | 4.55           | 4.70           | 4.85           | 4.52 |
|                                        | P <sub>30</sub> | 4.80           | 5.20           | 5.35           | 5.45 | 5.20 | P <sub>30</sub> | 4.90           | 5.30           | 5.45           | 5.60           | 5.31 |
|                                        | P <sub>60</sub> | 5.10           | 5.40           | 5.55           | 5.70 | 5.43 | P <sub>60</sub> | 5.20           | 5.50           | 5.60           | 5.78           | 5.52 |
|                                        | Mean            | 4.70           | 5.01           | 5.15           | 5.26 | 5.03 | Mean            | 4.70           | 5.11           | 5.25           | 5.41           | 5.11 |
| M <sub>1</sub>                         | P <sub>0</sub>  | 4.40           | 4.75           | 4.90           | 5.05 | 4.77 | P <sub>0</sub>  | 4.50           | 4.80           | 4.95           | 5.15           | 4.85 |
|                                        | P <sub>30</sub> | 5.15           | 5.60           | 5.75           | 5.90 | 5.60 | P <sub>30</sub> | 5.25           | 5.75           | 5.85           | 6.00           | 5.71 |
|                                        | P <sub>60</sub> | 5.30           | 5.75           | 5.85           | 6.00 | 5.72 | P <sub>60</sub> | 5.40           | 5.85           | 5.95           | 6.10           | 5.82 |
|                                        | Mean            | 4.95           | 5.36           | 5.50           | 5.65 | 5.36 | Mean            | 5.05           | 5.46           | 5.58           | 5.75           | 5.46 |

|                       |                |                |                |                |                |                |                |                |
|-----------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Mean of the mean<br>B | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> |
|                       | 4.82           | 5.18           | 5.32           | 5.45           | 4.87           | 5.28           | 5.41           | 5.58           |

|                       |                |                 |                 |                |                 |                 |
|-----------------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| Mean of the mean<br>P | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> |
|                       | 4.61           | 5.40            | 5.57            | 4.68           | 5.51            | 5.67            |

|                                      | 2023-2024 |       |           | 2024-2025 |        |           |
|--------------------------------------|-----------|-------|-----------|-----------|--------|-----------|
| Factors                              | SE(m) ±   | SE(d) | C.D at 5% | SEm ±     | SE (d) | C.D at 5% |
| Farm yard manure (F.Y.M)             | 0.036     | 0.050 | N.S.      | 0.036     | 0.050  | N.S.      |
| Phosphorus                           | 0.050     | 0.071 | N.S.      | 0.050     | 0.071  | N.S.      |
| Biofertilizer                        | 0.044     | 0.062 | N.S.      | 0.044     | 0.062  | N.S.      |
| (F.Y.M) × Phosphorus                 | 0.071     | 0.101 | N.S.      | 0.071     | 0.101  | N.S.      |
| (F.Y.M) × Biofertilizer              | 0.062     | 0.087 | N.S.      | 0.062     | 0.087  | N.S.      |
| Phosphorus× Biofertilizer            | 0.087     | 0.123 | N.S.      | 0.087     | 0.123  | N.S.      |
| (F.Y.M) × Phosphorus × Biofertilizer | 0.123     | 0.174 | N.S.      | 0.123     | 0.174  | N.S.      |

**Table 4:** Effect of different levels of phosphorus, biofertilizers and farm yard manure in on Number of nodules at 60 days after sowing of Chickpea during 2023-24 and 2024-25

| Number of nodules at 60 days after sowing |                 |                |                |                |                |       |                 |                |                |                |                |       |
|-------------------------------------------|-----------------|----------------|----------------|----------------|----------------|-------|-----------------|----------------|----------------|----------------|----------------|-------|
| 2023-24                                   |                 |                |                |                |                |       | 2024-25         |                |                |                |                |       |
|                                           | Levels          | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | Mean  | Levels          | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | Mean  |
| M <sub>0</sub>                            | P <sub>0</sub>  | 17.30          | 18.00          | 18.20          | 18.32          | 17.95 | P <sub>0</sub>  | 17.25          | 18.15          | 18.4           | 18.56          | 18.09 |
|                                           | P <sub>30</sub> | 19.45          | 20.12          | 20.35          | 20.56          | 20.12 | P <sub>30</sub> | 19.54          | 20.24          | 20.43          | 20.62          | 20.20 |
|                                           | P <sub>60</sub> | 20.60          | 21.30          | 21.45          | 21.63          | 21.24 | P <sub>60</sub> | 20.76          | 21.32          | 21.51          | 21.70          | 21.32 |
|                                           | Mean            | 19.11          | 19.80          | 20.00          | 20.17          | 19.77 | Mean            | 19.18          | 19.90          | 20.11          | 20.29          | 19.87 |
| M <sub>1</sub>                            | P <sub>0</sub>  | 18.15          | 18.92          | 20.16          | 20.31          | 19.38 | P <sub>0</sub>  | 18.50          | 19.12          | 19.31          | 19.44          | 19.09 |
|                                           | P <sub>30</sub> | 20.30          | 21.24          | 21.46          | 21.64          | 21.16 | P <sub>30</sub> | 20.70          | 21.40          | 21.64          | 21.78          | 21.38 |
|                                           | P <sub>60</sub> | 21.40          | 22.18          | 22.39          | 22.54          | 22.12 | P <sub>60</sub> | 21.80          | 22.18          | 22.42          | 22.56          | 22.24 |
|                                           | Mean            | 19.95          | 20.78          | 21.33          | 21.49          | 20.89 | Mean            | 20.33          | 20.90          | 21.12          | 21.26          | 20.90 |

  

|                  |  |                |                |                |                |                |                |                |                |
|------------------|--|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Mean of the mean |  | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> |
| B                |  | 19.53          | 20.29          | 20.66          | 20.83          | 19.75          | 20.40          | 20.61          | 20.77          |

  

|                  |  |                |                 |                 |                |                 |                 |
|------------------|--|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| Mean of the mean |  | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> |
| P                |  | 18.66          | 20.64           | 21.68           | 18.59          | 20.79           | 21.78           |

| Factors                              | 2023-2024 |       |           | 2024-2025 |        |           |
|--------------------------------------|-----------|-------|-----------|-----------|--------|-----------|
|                                      | SE(m) ±   | SE(d) | C.D at 5% | SEm ±     | SE (d) | C.D at 5% |
| Farm yard manure (F.Y.M)             | 0.082     | 0.115 | 0.232     | 0.082     | 0.116  | 0.233     |
| Phosphorus                           | 0.115     | 0.163 | 0.329     | 0.116     | 0.163  | 0.329     |
| Biofertilizer                        | 0.100     | 0.141 | 0.285     | 0.100     | 0.141  | 0.285     |
| (F.Y.M) × Phosphorus                 | 0.163     | 0.231 | N.S.      | 0.163     | 0.231  | N.S.      |
| (F.Y.M) × Biofertilizer              | 0.141     | 0.200 | N.S.      | 0.141     | 0.200  | N.S.      |
| Phosphorus × Biofertilizer           | 0.200     | 0.283 | N.S.      | 0.200     | 0.283  | N.S.      |
| (F.Y.M) × Phosphorus × Biofertilizer | 0.283     | 0.400 | N.S.      | 0.283     | 0.400  | N.S.      |

**Table 5:** Effect of different levels of phosphorus, biofertilizers and farm yard manure in on Number 100 grains weight in grams of Chickpea during 2023-24 and 2024-25

| 100 grains weight in grams |                 |                |                |                |                |       |                 |                |                |                |                |       |
|----------------------------|-----------------|----------------|----------------|----------------|----------------|-------|-----------------|----------------|----------------|----------------|----------------|-------|
| 2023-24                    |                 |                |                |                |                |       | 2024-25         |                |                |                |                |       |
|                            | Levels          | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | Mean  | Levels          | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | Mean  |
| M <sub>0</sub>             | P <sub>0</sub>  | 13.50          | 13.80          | 13.85          | 13.95          | 13.78 | P <sub>0</sub>  | 13.20          | 13.50          | 13.65          | 13.75          | 13.53 |
|                            | P <sub>30</sub> | 14.40          | 14.75          | 14.90          | 15.10          | 14.79 | P <sub>30</sub> | 14.60          | 14.90          | 15.05          | 15.20          | 14.94 |
|                            | P <sub>60</sub> | 14.60          | 15.10          | 15.30          | 15.50          | 15.13 | P <sub>60</sub> | 14.70          | 15.15          | 15.40          | 15.60          | 15.21 |
|                            | Mean            | 14.17          | 14.55          | 14.68          | 14.85          |       | Mean            | 14.17          | 14.52          | 14.70          | 14.85          |       |
| M <sub>1</sub>             | P <sub>0</sub>  | 13.85          | 14.10          | 14.20          | 14.35          | 14.13 | P <sub>0</sub>  | 14.00          | 14.30          | 14.45          | 14.60          | 14.34 |
|                            | P <sub>30</sub> | 14.80          | 15.10          | 15.30          | 15.45          | 15.16 | P <sub>30</sub> | 14.90          | 15.25          | 15.40          | 15.60          | 15.29 |
|                            | P <sub>60</sub> | 15.00          | 15.35          | 15.50          | 15.65          | 15.38 | P <sub>60</sub> | 15.15          | 15.45          | 15.60          | 15.85          | 15.51 |
|                            | Mean            | 14.55          | 14.85          | 15.00          | 15.15          |       | Mean            | 14.68          | 15.00          | 15.15          | 15.35          |       |

  

|                  |  |                |                |                |                |                |                |                |                |
|------------------|--|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Mean of the mean |  | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> | B <sub>0</sub> | B <sub>1</sub> | B <sub>2</sub> | B <sub>3</sub> |
| B                |  | 14.36          | 14.70          | 14.84          | 15.00          | 14.43          | 14.76          | 14.93          | 15.10          |

  

|                  |  |                |                 |                 |                |                 |                 |
|------------------|--|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| Mean of the mean |  | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> | P <sub>0</sub> | P <sub>30</sub> | P <sub>60</sub> |
| P                |  | 13.96          | 14.98           | 15.26           | 13.94          | 15.12           | 15.36           |

| Factors                              | 2023-2024 |       |           | 2024-2025 |        |           |
|--------------------------------------|-----------|-------|-----------|-----------|--------|-----------|
|                                      | SE(m) ±   | SE(d) | C.D at 5% | SEm ±     | SE (d) | C.D at 5% |
| Farm yard manure (F.Y.M)             | 0.136     | 0.192 | N.S.      | 0.136     | 0.192  | N.S.      |
| Phosphorus                           | 0.192     | 0.271 | N.S.      | 0.192     | 0.271  | N.S.      |
| Biofertilizer                        | 0.271     | 0.384 | N.S.      | 0.271     | 0.384  | N.S.      |
| (F.Y.M) × Phosphorus                 | 0.166     | 0.235 | N.S.      | 0.166     | 0.235  | N.S.      |
| (F.Y.M) × Biofertilizer              | 0.235     | 0.332 | N.S.      | 0.235     | 0.332  | N.S.      |
| Phosphorus × Biofertilizer           | 0.332     | 0.47  | N.S.      | 0.332     | 0.47   | N.S.      |
| (F.Y.M) × Phosphorus × Biofertilizer | 0.47      | 0.665 | N.S.      | 0.47      | 0.665  | N.S.      |

## Conclusion

The present study revealed that the combined application of phosphorus, biofertilizers, and farmyard manure (FYM) significantly improved the growth and yield attributes of chickpea. Among the treatments, 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> along with biofertilizer (B<sub>3</sub>) and FYM (M<sub>1</sub>) recorded the highest values for

plant height, branches per plant, nodules, and 100-grain weight. The integrated use of organic, inorganic, and biological sources enhanced nutrient availability, root development, and microbial activity, leading to better plant growth and productivity. Although interaction effects were mostly non-significant, the overall trend indicated synergistic benefits. Thus, integrated

nutrient management (INM) involving phosphorus, FYM, and biofertilizers is recommended for sustaining chickpea yield, improving soil fertility, and promoting eco-friendly and sustainable crop production systems.

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