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## Effect of integrated nutrient management on growth, yield attributes and yield of Field Pea (*Pisum sativum* L.) under Bundelkhand Region

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### Abstract

A field experiment was conducted during the rabi season of 2025-26 in the Bundelkhand region at Lalitpur, district of Uttar Pradesh to evaluate the effect of integrated nutrient management (INM) on growth, yield attributes and yield of field pea (*Pisum sativum* L.). The experiment was laid out in Randomized Block Design with nine treatments and three replications. Treatments consisted of different combinations of recommended dose of fertilizers (RDF), farmyard manure (FYM), biofertilizers (Rhizobium + phosphate solubilizing bacteria) and foliar nitrogen spray. Results revealed that INM significantly improved growth, yield attributes and yield over sole fertilizer application and control. Among the treatments, 75% RDF + Rhizobium + PSB (T<sub>4</sub>) recorded the highest plant height (60.3 cm), branches plant<sup>-1</sup> (7.4), dry matter accumulation (644 g m<sup>-2</sup>), pods plant<sup>-1</sup> (17.2), seeds pod<sup>-1</sup> (8.0), test weight (22.5 g), seed yield (2560 kg ha<sup>-1</sup>), straw yield (3880 kg ha<sup>-1</sup>), biological yield (6440 kg ha<sup>-1</sup>) and harvest index (39.75%). The results indicate that partial substitution of chemical fertilizers with biofertilizers can enhance productivity and sustainability of field pea under Bundelkhand conditions.

**Keywords:** Field pea, integrated nutrient management, rhizobium, PSB, yield, legume, Bundelkhand

### 1. Introduction

Field pea (*Pisum sativum* L.) is one of the most important winter season pulse and vegetable legume crops cultivated in temperate and subtropical regions of the world. It is valued for its high nutritive quality, digestible protein, carbohydrates, vitamins and minerals, making it an important component of human diet and nutritional security (Fatima *et al.*, 2020) <sup>[1]</sup>. Green peas are consumed fresh, frozen, canned and dehydrated, while dry peas are used as pulse and feed. Pea plays a vital role in sustainable agriculture due to its ability to fix atmospheric nitrogen through symbiosis with *Rhizobium leguminosarum*, thereby reducing dependence on synthetic nitrogen fertilizers and improving soil fertility for succeeding crops (Mankar *et al.*, 2019) <sup>[8]</sup>. Inclusion of legumes in cropping systems improves soil aggregation, microbial activity and nutrient cycling (Peoples *et al.*, 2009) <sup>[10]</sup>.

Globally, pea is cultivated on millions of hectares and contributes substantially to food systems. In India, pea is grown widely in Uttar Pradesh, Madhya Pradesh, Bihar, Punjab and West Bengal. However, yield levels in semi-arid regions such as Bundelkhand remain below potential because of poor soil fertility, low organic carbon, moisture stress and imbalanced fertilizer use. Continuous dependence on chemical fertilizers alone often results in nutrient mining, declining soil organic matter, low nutrient use efficiency and environmental concerns (Ladha *et al.*, 2005) <sup>[6]</sup>. Therefore, integrated nutrient management (INM) has emerged as a sustainable strategy for maintaining productivity while preserving soil health. INM involves the combined use of inorganic fertilizers, organic manures and biofertilizers to optimize nutrient supply and improve crop response (Mahajan *et al.*, 2008) <sup>[7]</sup>.

Farmyard manure improves soil structure, moisture retention, cation exchange capacity and micronutrient availability. Biofertilizers such as *Rhizobium* and phosphate solubilizing bacteria (PSB) improve nitrogen fixation and phosphorus availability, respectively (Richardson *et al.*,

2009) [14]. Foliar nutrition at critical growth stages may further enhance reproductive efficiency and sink strength. Several studies have shown that integrated application of fertilizers, FYM and biofertilizers significantly improves growth, nodulation, yield attributes and seed yield in pea and other legumes (Qureshi *et al.*, 2015; Sharma *et al.*, 2018; Kimi *et al.*, 2021; Ghosh *et al.*, 2022) [13, 15, 3, 2]. Under Bundelkhand conditions, such nutrient management options require location-specific evaluation. Therefore, the present investigation was undertaken to study the effect of integrated nutrient management on growth, yield attributes and yield of field pea.

## 2. Materials and Methods

The field experiment was conducted during Rabi 2025–26 in Bundelkhand region, Lalitpur district of, Uttar Pradesh, India. The soil was sandy loam with pH 7.40, organic carbon 0.48%, available nitrogen 222.51 kg ha<sup>-1</sup>, phosphorus 18.5 kg ha<sup>-1</sup> and potassium 212.06 kg ha<sup>-1</sup>.

The experiment was laid out in Randomized Block Design with three replications and nine treatments:

| Treatment Details |                                                           |
|-------------------|-----------------------------------------------------------|
| T <sub>1</sub>    | 100% RDF                                                  |
| T <sub>2</sub>    | 125% RDF                                                  |
| T <sub>3</sub>    | 100% RDF + 1% N spray at pod formation                    |
| T <sub>4</sub>    | 75% RDF + Rhizobium + PSB                                 |
| T <sub>5</sub>    | 75% RDF + 1% N spray at flower initiation & pod formation |
| T <sub>6</sub>    | 50% RDF + 2.5 t FYM ha <sup>-1</sup>                      |
| T <sub>7</sub>    | 50% RDF + Rhizobium + PSB                                 |
| T <sub>8</sub>    | 50% RDF + 1% N spray at flower initiation & pod formation |
| T <sub>9</sub>    | Control                                                   |

Recommended fertilizer dose for pea was 25:60:40 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>. Standard agronomic practices were followed. Data were statistically analysis of variance ANOVA appropriate for Randomized Block Design as described by Panse and Sukhatme (1985) [11].

## 2.1 Observations Recorded

To evaluate the effect of integrated nutrient management treatments on growth, yield attributes and yield of field pea, observations were recorded at different crop growth stages following standard procedures. Five representative plants were randomly selected from each net plot for biometric observations, and final yield observations were recorded on plot basis.

### 2.1.1 Growth Parameters

#### 2.1.1.1 Plant Height (cm)

Plant height was measured from the base of the plant to the tip of the main shoot using a meter scale at 30 DAS, 60 DAS and at harvest. The mean value was expressed in centimetres.

#### 2.1.1.2 Number of Branches Plant<sup>-1</sup>

The number of primary branches arising from the main stem was counted from five tagged plants at harvest stage, and the average was calculated.

#### 2.1.1.3 Dry Matter Accumulation (g m<sup>-2</sup>)

Five plants were uprooted randomly from each plot at 30 DAS, 60 DAS and harvest. Plant samples were oven dried at 65 ± 2 °C until constant weight and expressed as dry matter accumulation in g m<sup>-2</sup>.

## 2.1.2 Yield Attributes

### 2.1.2.1 Number of Pods Plant<sup>-1</sup>

At harvest, pods from five randomly selected plants were counted and the average number of pods per plant was computed.

### 2.1.2.2 Number of Seeds Pod<sup>-1</sup>

Ten pods were randomly selected from each plot, seeds were counted and average seeds per pod were calculated.

### 2.1.2.3 Test Weight (g)

One hundred seeds from each treatment were counted and weighed using an electronic balance. The weight was expressed in grams.

## 2.1.3 Yield Parameters

### 2.1.3.1 Seed Yield (kg ha<sup>-1</sup>)

The crop from net plot area was harvested separately, dried, threshed and cleaned. Seed yield from each plot was recorded and converted into kg ha<sup>-1</sup>.

### 2.1.3.2 Straw Yield (kg ha<sup>-1</sup>)

After threshing, the remaining plant biomass was sun dried and weighed. The straw yield was converted into kg ha<sup>-1</sup>.

### 2.1.3.3 Biological Yield (kg ha<sup>-1</sup>)

Biological yield was calculated by adding seed yield and straw yield.

### 2.1.3.4 Harvest Index (%)

Harvest index was calculated using the following formula:

$$\text{Harvest Index (\%)} = \frac{\text{Seed Yield}}{\text{Biological Yield}} \times 100$$

## 3. Results and Discussion

### 3.1 Growth Parameters

#### 3.1.1 Plant Height (cm)

The data presented in Table 1. indicated that plant height of field pea increased progressively with crop growth and was significantly influenced by integrated nutrient management treatments at all growth stages. The significantly highest plant height at 30 DAS, 60 DAS and harvest was recorded under T<sub>4</sub> – 75% RDF + Rhizobium + PSB (20.5, 47.1 and 60.3 cm, respectively), which was statistically at par with T<sub>5</sub> – 75% RDF + 1% N spray at flower initiation & pod formation (20.0, 46.5 and 59.1 cm, respectively) and T<sub>2</sub> – 125% RDF (19.8, 45.6 and 58.9 cm, respectively). At 30 DAS, T<sub>4</sub> was also at par with T<sub>3</sub> – 100% RDF + 1% N spray at pod formation (19.2 cm). However, these treatments were significantly superior over the remaining treatments. The lowest plant height at all stages was recorded under T<sub>9</sub> – Control (16.5, 36.9 and 48.2 cm, respectively). The increased plant height under integrated nutrient management treatments may be attributed to balanced nutrient availability, enhanced biological nitrogen fixation by *Rhizobium*, phosphorus solubilization by PSB, improved root growth and better nutrient uptake, which collectively promoted vigorous vegetative growth throughout the crop growth period. Similar increases in plant height under integrated nutrient management in pea were reported by Sharma *et al.* (2018) [15], Kimi *et al.* (2021) [3] and Ghosh *et al.* (2022) [2].

**Table 1:** Effect of integrated nutrient management on plant height of field pea

| Treatment                                                                  | 30 DAS | 60 DAS | Harvest |
|----------------------------------------------------------------------------|--------|--------|---------|
| T <sub>1</sub> - 100% RDF                                                  | 18.5   | 41.2   | 54.3    |
| T <sub>2</sub> - 125% RDF                                                  | 19.8   | 45.6   | 58.9    |
| T <sub>3</sub> - 100% RDF + 1% N spray at pod formation                    | 19.2   | 43.8   | 56.7    |
| T <sub>4</sub> - 75% RDF + Rhizobium + PSB                                 | 20.5   | 47.1   | 60.3    |
| T <sub>5</sub> - 75% RDF + 1% N spray at flower initiation & pod formation | 20.0   | 46.5   | 59.1    |
| T <sub>6</sub> - 50% RDF + 2.5 t ha <sup>-1</sup> FYM                      | 17.9   | 40.3   | 52.8    |
| T <sub>7</sub> - 50% RDF + Rhizobium + PSB                                 | 18.4   | 41.5   | 54.0    |
| T <sub>8</sub> - 50% RDF + 1% N spray at flower initiation & pod formation | 18.0   | 40.8   | 53.5    |
| T <sub>9</sub> - Control                                                   | 16.5   | 36.9   | 48.2    |
| SEm ±                                                                      | 0.52   | 1.21   | 1.45    |
| CD (P=0.05)                                                                | 1.54   | 3.60   | 4.31    |

### 3.1.2 Branches Plant<sup>-1</sup>

The data presented in Table 2 revealed that the number of branches plant<sup>-1</sup> of field pea was significantly influenced by integrated nutrient management treatments. The significantly highest number of branches plant<sup>-1</sup> was recorded under T<sub>4</sub> – 75% RDF + Rhizobium + PSB (7.4), which was statistically at par with T<sub>5</sub> – 75% RDF + 1% N spray at flower initiation & pod formation (7.2) and T<sub>2</sub> – 125% RDF (6.8). However, these treatments were significantly superior over the remaining

treatments. The lowest number of branches plant<sup>-1</sup> was recorded under T<sub>9</sub> – Control (4.3). The increase in number of branches under integrated nutrient management treatments may be attributed to balanced nutrient supply, improved nitrogen availability, enhanced root development and greater photosynthetic activity, which promoted vegetative growth and branching in field pea plants. Similar findings were reported by Qureshi *et al.* (2015)<sup>[13]</sup> and Kurbah and Thomas (2017)<sup>[4]</sup>.

**Table 2:** Effect of integrated nutrient management on branches plant<sup>-1</sup> and dry matter accumulation (g m<sup>-2</sup>) of field pea

| Treatment                                                                  | Branches plant <sup>-1</sup> | Dry matter accumulation (g m <sup>-2</sup> ) |        |        |
|----------------------------------------------------------------------------|------------------------------|----------------------------------------------|--------|--------|
|                                                                            |                              | 30 DAS                                       | 60 DAS | 30 DAS |
| T <sub>1</sub> - 100% RDF                                                  | 5.6                          | 92                                           | 286    | 510    |
| T <sub>2</sub> - 125% RDF                                                  | 6.8                          | 108                                          | 342    | 607    |
| T <sub>3</sub> - 100% RDF + 1% N spray at pod formation                    | 6.3                          | 101                                          | 323    | 575    |
| T <sub>4</sub> - 75% RDF + Rhizobium + PSB                                 | 7.4                          | 116                                          | 364    | 644    |
| T <sub>5</sub> - 75% RDF + 1% N spray at flower initiation & pod formation | 7.2                          | 113                                          | 357    | 631    |
| T <sub>6</sub> - 50% RDF + 2.5 t ha <sup>-1</sup> FYM                      | 5.2                          | 88                                           | 275    | 490    |
| T <sub>7</sub> - 50% RDF + Rhizobium + PSB                                 | 5.8                          | 95                                           | 295    | 524    |
| T <sub>8</sub> - 50% RDF + 1% N spray at flower initiation & pod formation | 5.4                          | 90                                           | 282    | 500    |
| T <sub>9</sub> - Control                                                   | 4.3                          | 76                                           | 242    | 432    |
| SEm ±                                                                      | 0.18                         | 3.4                                          | 9.8    | 17.6   |
| CD (P=0.05)                                                                | 0.54                         | 10.1                                         | 29.1   | 52.3   |

### 3.1.3 Dry Matter Accumulation

The data presented in Table 2 indicated that dry matter accumulation increased progressively with crop growth and was significantly influenced by integrated nutrient management treatments at all stages of observation. The significantly highest dry matter accumulation at 30 DAS, 60 DAS and harvest was recorded under T<sub>4</sub> – 75% RDF + Rhizobium + PSB (116, 364 and 644 g m<sup>-2</sup>, respectively), which was statistically at par with T<sub>5</sub> – 75% RDF + 1% N spray at flower initiation & pod formation (113, 357 and 631 g m<sup>-2</sup>, respectively) and T<sub>2</sub> – 125% RDF (108, 342 and 607 g m<sup>-2</sup>, respectively). However, these treatments were significantly superior over the remaining treatments. The lowest dry matter accumulation at all stages was recorded under T<sub>9</sub> – Control (76, 242 and 432 g m<sup>-2</sup>, respectively). The increased dry matter production under integrated nutrient management treatments might be due to continuous nutrient availability, better canopy development, enhanced photosynthetic efficiency and improved translocation of assimilates, resulting in greater biomass accumulation throughout the crop growth period.

### 3.2 Yield Attributes

The data presented in Table 3 revealed that yield attributes of field pea, viz., number of pods plant<sup>-1</sup>, number of seeds pod<sup>-1</sup> and test weight, were significantly influenced by integrated nutrient management treatments. The significantly highest number of pods plant<sup>-1</sup>, seeds pod<sup>-1</sup> and test weight were recorded under T<sub>4</sub> – 75% RDF + Rhizobium + PSB (17.2, 8.0 and 22.5 g, respectively), which was statistically at par with T<sub>5</sub> – 75% RDF + 1% N spray at flower initiation & pod formation (16.8, 7.9 and 22.1 g, respectively) and T<sub>2</sub> – 125% RDF (15.8, 7.6 and 21.3 g, respectively). However, these treatments were significantly superior over the remaining treatments. The lowest values of pods plant<sup>-1</sup>, seeds pod<sup>-1</sup> and test weight were recorded under T<sub>9</sub> – Control (9.8, 5.8 and 16.5 g, respectively). The improvement in yield attributes under integrated nutrient management treatments may be attributed to balanced nutrient availability, enhanced root activity, better flowering, efficient translocation of photosynthates and proper seed filling, which ultimately resulted in superior reproductive performance of field pea. Similar findings were reported by Pawar *et al.* (2017)<sup>[12]</sup>, Sharma *et al.* (2018)<sup>[15]</sup> and Ghosh *et al.* (2022)<sup>[2]</sup>.

**Table 3:** Effect of integrated nutrient management on yield attributes of field pea

| Treatment                                                                  | Pods plant <sup>-1</sup> | Seeds pod <sup>-1</sup> | Test weight (g) |
|----------------------------------------------------------------------------|--------------------------|-------------------------|-----------------|
| T <sub>1</sub> - 100% RDF                                                  | 12.4                     | 6.5                     | 18.5            |
| T <sub>2</sub> - 125% RDF                                                  | 15.8                     | 7.6                     | 21.3            |
| T <sub>3</sub> - 100% RDF + 1% N spray at pod formation                    | 14.7                     | 7.2                     | 20.2            |
| T <sub>4</sub> - 75% RDF + Rhizobium + PSB                                 | 17.2                     | 8.0                     | 22.5            |
| T <sub>5</sub> - 75% RDF + 1% N spray at flower initiation & pod formation | 16.8                     | 7.9                     | 22.1            |
| T <sub>6</sub> - 50% RDF + 2.5 t ha <sup>-1</sup> FYM                      | 11.8                     | 6.3                     | 18.1            |
| T <sub>7</sub> - 50% RDF + Rhizobium + PSB                                 | 12.6                     | 6.6                     | 18.9            |
| T <sub>8</sub> - 50% RDF + 1% N spray at flower initiation & pod formation | 12.0                     | 6.4                     | 18.3            |
| T <sub>9</sub> – Control                                                   | 9.8                      | 5.8                     | 16.5            |
| SEm±                                                                       | 0.38                     | 0.19                    | 0.42            |
| CD (P=0.05)                                                                | 1.12                     | 0.56                    | 1.25            |

### 3.3 Yield

The data presented in Table 4 revealed that seed yield, straw yield, biological yield and harvest index of field pea were significantly influenced by integrated nutrient management treatments. The significantly highest seed yield, straw yield, biological yield and harvest index were recorded under T<sub>4</sub> – 75% RDF + Rhizobium + PSB (2560, 3880, 6440 kg ha<sup>-1</sup> and 39.75%, respectively), which was statistically at par with T<sub>5</sub> – 75% RDF + 1% N spray at flower initiation & pod formation (2500, 3810, 6310 kg ha<sup>-1</sup> and 39.62%, respectively) and T<sub>2</sub> – 125% RDF (2380, 3690, 6070 kg ha<sup>-1</sup> and 39.21%,

respectively). However, these treatments were significantly superior over the remaining treatments. The lowest seed yield, straw yield, biological yield and harvest index were recorded under T<sub>9</sub> – Control (1480, 2840, 4320 kg ha<sup>-1</sup> and 34.26%, respectively). The higher yield under integrated nutrient management treatments may be attributed to improved vegetative growth, greater dry matter production, superior yield attributes, efficient nutrient uptake and better translocation of assimilates towards the economic sink, resulting in enhanced crop productivity. Similar findings were reported by Singh *et al.* (2016) [16], Kimi *et al.* (2021) [3] and Ghosh *et al.* (2022) [2].

**Table 4:** Effect of integrated nutrient management on yield (kg ha<sup>-1</sup>) of field pea

| Treatment                                                                  | Seed yield | Straw yield | Biological yield | Harvest index (%) |
|----------------------------------------------------------------------------|------------|-------------|------------------|-------------------|
| T <sub>1</sub> - 100% RDF                                                  | 1860       | 3240        | 5100             | 36.47             |
| T <sub>2</sub> - 125% RDF                                                  | 2380       | 3690        | 6070             | 39.21             |
| T <sub>3</sub> - 100% RDF + 1% N spray at pod formation                    | 2210       | 3540        | 5750             | 38.43             |
| T <sub>4</sub> - 75% RDF + Rhizobium + PSB                                 | 2560       | 3880        | 6440             | 39.75             |
| T <sub>5</sub> - 75% RDF + 1% N spray at flower initiation & pod formation | 2500       | 3810        | 6310             | 39.62             |
| T <sub>6</sub> - 50% RDF + 2.5 t ha <sup>-1</sup> FYM                      | 1750       | 3150        | 4900             | 35.71             |
| T <sub>7</sub> - 50% RDF + Rhizobium + PSB                                 | 1920       | 3320        | 5240             | 36.64             |
| T <sub>8</sub> - 50% RDF + 1% N spray at flower initiation & pod formation | 1800       | 3200        | 5000             | 36.00             |
| T <sub>9</sub> – Control                                                   | 1480       | 2840        | 4320             | 34.26             |
| SEm ±                                                                      | 74.12      | 105.04      | 122.46           | -                 |
| CD (P=0.05)                                                                | 220.12     | 312.08      | 362.22           | NS                |

### 4. Conclusion

Integrated nutrient management significantly enhanced growth, yield attributes and yield of field pea under Bundelkhand conditions. Application of 75% RDF + Rhizobium + PSB was the most effective treatment and may be recommended for sustainable and profitable cultivation of field pea under Bundelkhand condition.

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