***Original Research Article***

**Influence of Integrated Nutrient Management (INM) on Growth and Yield of Chickpea (*Cicer arietinum* L.)**

**Abstract**

An experiment was conducted during the *Rabi* season of 2024-25 at the Agricultural Farm of Mewar University, Gangrar, Chittorgarh, Rajasthan, India. The experimental site's soil was sandy loam in texture, slightly saline in reaction, low in available nitrogen (315 kg/ha), medium in available phosphorus (22.3 kg/h), and high in potassium availability (398 kg/ha), with sufficient micronutrients. The study was laid out in a randomized block design with three replications. Nine treatments were investigated: Control, 100% Recommended Dose of Fertilizers (RDF), Vermicompost + Rhizobium, 50% RDF + Vermicompost, 75% RDF + Vermicompost, 50% RDF + Rhizobium, 75% RDF + Rhizobium, 50% RDF + Vermicompost + Rhizobium, and 75% RDF + Vermicompost + Rhizobium (Present Study). Chickpea variety RSG-888 was used as the test crop. The application of 75% RDF + Vermicompost + Rhizobium significantly improved the growth attributes and yield of chickpea compared to the control and other treatments. This treatment resulted in the maximum plant height (65.81 cm), dry matter accumulation (21.92 g/plant), and number of branches/plant (4.43) (Prakash et al., 2022). Furthermore, it recorded the highest pods/plant (64.65), seeds/pod (1.88), seed index (23.6 g), seed yield (2290 kg/ha), and straw yield (3980 kg/ha). The nutrient content (nitrogen, phosphorus, and potassium) in both seed and straw was also highest under this treatment. Economically, this combination yielded a higher net return and benefit-cost ratio. The findings emphasize the significant role of integrated nutrient management in enhancing chickpea productivity and soil health.

**Keywords:** Chickpea, growth, yield, integrated nutrient management

**1. Introduction**

Chickpea (*Cicer arietinum* L.) stands as the third most important legume globally, with India contributing over 62-67% of the total world production (Anonymous, 2024; Mondal et al., 2005). It is a critical pulse crop in India, offering a vital source of protein, which is often deficient in the Indian diet (Mondal et al., 2005). Beyond its nutritional value as a staple food and its use in various culinary preparations, chickpea plays a crucial role in sustainable agriculture by enriching soil fertility through atmospheric nitrogen fixation (Pujitha et al., 2022). Its deep root system improves soil aeration, and leaf litter enhances organic matter content (Pujitha et al., 2022). Chickpea can fix approximately 25-30 kg of nitrogen per hectare through symbiosis, thereby reducing the reliance on synthetic fertilizers (Pujitha et al., 2022).

Nitrogen is indispensable for the synthesis of chlorophyll, amino acids, and other organic compounds, directly contributing to plant protein formation and overall growth (Dinesh et al., 2014). Phosphorus is vital for energy transfer, root development, and early crop maturity, and it plays a key role in the formation and translocation of carbohydrates (Siag& Yadav, 1995; Dinesh et al., 2014). Its application particularly benefits the root system, promoting lateral and fibrous root formation, which in turn enhances nodule bacteria activity and nitrogen fixation in legumes (Dinesh et al., 2014). Potassium is essential for enzyme activation, assimilate translocation, and protein synthesis (Devi et al., 2018).

The current agricultural scenario faces challenges from nutrient deficiencies and the adverse effects of imbalanced chemical fertilizer use on soil health and crop sustainability (Dinesh et al., 2014). Integrated Nutrient Management (INM) addresses these issues by combining various nutrient sources, including inorganic fertilizers, organic manures, and bio-fertilizers, to maintain soil fertility and optimize nutrient supply for desired crop productivity (Sharma & Singh, 2019). Vermicompost, an organic amendment, improves soil health by enhancing nutrient availability, physical properties, and microbial activity (Patel & Thanki, 2020). Rhizobium, a low-cost and eco-friendly bio-fertilizer, is an integral component of INM for pulse production due to its significant potential for atmospheric nitrogen fixation (Ojashwani et al., 2022). Despite the known benefits, comprehensive studies on the combined effect of Rhizobium and vermicompost with chemical fertilizers are limited (Laranjo et al., 2014). Therefore, this investigation aimed to study the effect of integrated nutrient management on the growth, yield, nutrient content, and quality of chickpea, as well as the economics of different treatments (Kumar &Mehera, 2022).

**2. Materials and Methods**

**2.1. Experimental Site and Climate** The field experiment was conducted during the rabi season of 2024-25 at the Agricultural Farm of Mewar University, Gangrar, Chittorgarh, Rajasthan. The experimental site is geographically located at 10.57° N latitude and 75.20° E longitude, with an altitude of 267 meters above mean sea level. The soil of the experimental site was sandy loam, slightly saline, low in available nitrogen (315 kg/ha), medium in available phosphorus (22.3 kg/h), and high in available potassium (398 kg/ha), with sufficient micronutrients.

**2.2. Experimental Design and Treatments** The experiment was laid out in a Randomized Block Design (RBD) with three replications. Nine treatment combinations were evaluated:

* **T1:** Control (no fertilizer or biofertilizer)
* **T2:** 100% Recommended Dose of Fertilizers (RDF)
* **T3:** Vermicompost + Rhizobium
* **T4:** 50% RDF + Vermicompost
* **T5:** 75% RDF + Vermicompost
* **T6:** 50% RDF + Rhizobium
* **T7:** 75% RDF + Rhizobium
* **T8:** 50% RDF + Vermicompost + Rhizobium
* **T9:** 75% RDF + Vermicompost + Rhizobium

**2.3. Crop Management** Field preparation involved one ploughing with a disc plough, followed by cross harrowing and planking (Present Study). The experimental field was demarcated with provisions for irrigation/buffer channels (Present Study). Seeds were sown using a seed drill method in the second fortnight of October (Present Study). Row spacing was maintained at 30 cm, with a sowing depth of 8 cm, and a seed rate of 80 kg/ha (Present Study). Thinning, hoeing, and weeding were carried out 40 days after sowing to minimize weed competition (Present Study). Other standard agronomic practices were uniformly applied across all plots.

**2.4. Data Collection** Various parameters were measured to assess the treatment effects:

* **Plant Population:** Number of plants per meter row length was counted at 30 days after sowing (DAS) and at harvest.
* **Growth Attributes:** Plant height (cm), dry matter accumulation (g/plant), and number of branches per plant were recorded.
* **Yield Attributes:** Number of pods per plant, number of seeds per pod, and 100-seed weight (seed index) were measured.
* **Yield:** Grain yield (kg/ha) and straw yield (kg/ha) were calculated.
* **Nutrient Content and Uptake:** Nitrogen, phosphorus, and potassium content in chickpea seed and straw were determined using standard procedures.
* **Economic Analysis:** Gross returns, net returns, and benefit-cost ratio were calculated.

**2.5. Statistical Analysis** The collected data were subjected to appropriate statistical analysis, presumably Analysis of Variance (ANOVA), to evaluate the significance of treatment effects (Panse&Sukhatme, 1985). The results were interpreted in light of statistical evidence.

**3. Results and Discussion**

The integrated nutrient management practices significantly influenced the growth, yield, nutrient content, and economic parameters of chickpea.

**3.1. Growth Attributes** Growth parameters such as plant height, dry matter accumulation (DMA), and number of branches per plant showed significant variation among the treatments. The highest plant height (65.81 cm), DMA (21.92 g/plant), and number of branches/plant (4.43) were consistently recorded under the application of 75% RDF + Vermicompost + Rhizobium (T9) (Jakhar et al., 2020; Prakash et al., 2022). This treatment was statistically on par with 100% RDF and 50% RDF + Vermicompost + Rhizobium (T8). The lowest values for these parameters were observed in the control group. The enhanced growth is attributed to the increased availability of nutrients, enzymes, and vitamins in the soil, leading to a higher microbial population and improved nutrient uptake. This aligns with previous findings where Rhizobium inoculation and organic manure application positively impacted chickpea growth (Akhtar & Siddiqui, 2009; Solaiman et al., 2010; Giri & Joshi, 2010; Shahzad et al., 2014; Khan et al., 2017; Ojashwani et al., 2022).

**3.2. Yield Attributes and Yield**Yield attributes, including the number of pods/plant, seeds/pod, and seed index, were significantly improved by the INM treatments (Patel & Thanki, 2020). The maximum pods/plant (64.65), seeds/pod (1.88), and seed index (23.6 g) were recorded with 75% RDF + Vermicompost + Rhizobium (T9) (Jakhar et al., 2020; Patel & Thanki, 2020). This treatment also yielded the highest seed yield (2290 kg/ha) and straw yield (3980 kg/ha) (Jakhar et al., 2020). These results were statistically comparable to 100% RDF and 50% RDF + Vermicompost + Rhizobium. The increased yield is a result of improved photosynthetic efficiency, better source-sink relationships, and overall healthier plant development (Present Study). Previous research supports these findings, demonstrating significant yield increases in chickpea due to integrated nutrient management (Choudhary & Yadav, 2011; Bairwa et al., 2012; Kavita & Singh, 2014; Patel &Thanki, 2020; Ojashwani et al., 2022).

**3.3. Nutrient Content and Uptake**The NPK content in both chickpea seed and straw was highest under the 75% RDF + Vermicompost + Rhizobium treatment (T9) (Chaudhari et al., 2021). This was statistically at par with 100% RDF and 50% RDF + Vermicompost + Rhizobium (Present Study). Similarly, the total NPK uptake by the crop was highest with the application of 75% RDF + Vermicompost + Rhizobium (Present Study). This enhanced nutrient uptake is likely due to the improved rooting system and increased microbial activity in the soil, which facilitates better nutrient absorption and translocation (Choudhary, 2019; Nandan et al., 2018). These findings are consistent with studies reporting improved nutrient content and uptake in chickpea with INM practices (Chaudhari et al., 2021).

**3.4. Economics** From an economic perspective, the treatment combining 75% RDF + Vermicompost + Rhizobium showed a higher net return (₹83,650/ha) and a favorablebenefit:cost ratio (1.98) during the investigation (Patel & Thanki, 2020). These observations align with other studies that reported increased profitability with integrated nutrient management in similar crops like soybean (Sharma et al., 2014; Singh & Kushwaha, 2013).

**4. Conclusion**

Based on the findings of this experiment, it can be concluded that the integrated nutrient management approach, specifically the application of 75% RDF + vermicompost + Rhizobium, is highly effective in enhancing the growth, yield, and economic returns of chickpea (*Cicer arietinum* L.). This treatment consistently demonstrated superior performance in terms of plant height, dry matter accumulation, number of branches, pods per plant, seeds per pod, seed index, and overall grain and straw yields; it led to higher nutrient content and uptake in the chickpea crop. The results highlight the importance of combining chemical fertilizers with organic and biological sources to achieve sustainable and profitable chickpea production.

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**Table.1 Effect of integrated nutrient management on growth attributes of chickpea**

|  |  |  |  |
| --- | --- | --- | --- |
| Treatments | Plant height (cm) | DMA (g/mrl) | No. of branches/plant |
| Control | 53.24 | 16.60 | 3.23 |
| 100% RDF | 64.13 | 21.42 | 4.33 |
| Vermicompost + Rhizobium | 57.17 | 18.56 | 3.66 |
| 50% RDF + Vermicompost | 60.84 | 20.35 | 3.95 |
| 75% RDF + Vermicompost | 61.32 | 20.12 | 4.04 |
| 50% RDF + Rhizobium | 58.25 | 19.27 | 3.75 |
| 75% RDF+ Rhizobium | 59.76 | 19.86 | 3.83 |
| 50% RDF + Vermicompost + Rhizobium | 62.21 | 20.56 | 4.23 |
| 75% RDF + Vermicompost + Rhizobium | 65.81 | 21.92 | 4.43 |
| S.Em.+ | 1.21 | 1.47 | 0.12 |
| CD (P=0.05) | 3.64 | 1.42 | 0.35 |

**Table 2 Effect of integrated nutrient management on yield attributes and yield of chickpea**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Treatments | Pods/plant (No.) | Seeds/pod (No.) | Seed index (g) | Seed yield (kg/ha) | Straw yield (kg/ha) |
| Control | 45.20 | 1.79 | 23.24 | 1540 | 2697 |
| 100% RDF | 62.33 | 1.87 | 23.74 | 2175 | 3786 |
| Vermicompost + Rhizobium | 53.66 | 1.82 | 23.35 | 1755 | 3070 |
| 50% RDF + Vermicompost | 56.92 | 1.85 | 23.59 | 2050 | 3578 |
| 75% RDF + Vermicompost | 57.04 | 1.86 | 23.62 | 2090 | 3642 |
| 50% RDF + Rhizobium | 54.72 | 1.83 | 23.44 | 1835 | 3208 |
| 75% RDF+ Rhizobium | 55.81 | 1.84 | 23.52 | 1975 | 3448 |
| 50% RDF + Vermicompost + Rhizobium | 59.06 | 1.86 | 23.69 | 2130 | 3710 |
| 75% RDF + Vermicompost + Rhizobium | 64.35 | 1.88 | 23.76 | 2290 | 3980 |
| S.Em.+ | 1.77 | 0.03 | 0.18 | 56.66 | 92.65 |
| CD (P=0.05) | 5.32 | NS | NS | 170 | 278 |