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Effect of integrated nutrient management on productivity of chickpea (*Cicer arietinum* L.)

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ABSTRACT

A field experiment entitled “Effect of Integrated Nutrient Management on Productivity of Chickpea (*Cicer arietinum* L.)” was conducted during the Rabi season of 2025–26 at the Agricultural Research Farm, Department of Agronomy, School of Agriculture, Suresh Gyan Vihar University, Jaipur, Rajasthan. The experiment was undertaken to evaluate the effect of different combinations of inorganic fertilizers, organic manures and biofertilizers on growth, yield and productivity of chickpea. Eleven nutrient management treatments comprising different levels of recommended dose of fertilizer (RDF) in combination with vermicompost, farmyard manure (FYM), poultry manure and Rhizobium + phosphate-solubilizing bacteria (PSB) were evaluated. Integrated nutrient management significantly influenced most of the growth and yield attributes, whereas plant population remained statistically non-significant.

Among the treatments, application of 100% RDF + vermicompost @ 3 t ha⁻¹ recorded superior performance for major growth attributes, including plant height, dry matter accumulation, number of branches and root nodules. The treatment also produced the highest number of pods plant⁻¹ and seeds pod⁻¹. The maximum seed yield (1625 kg ha⁻¹) and stover yield (2985 kg ha⁻¹) were also recorded with 100% RDF + vermicompost @ 3 t ha⁻¹. This treatment was statistically at par with 100% RDF + poultry manure @ 2.5 t ha⁻¹ and 100% RDF + FYM @ 6 t ha⁻¹ for several growth and yield parameters. The control treatment recorded the lowest values for major growth and yield characteristics, with a seed yield of 1025 kg ha⁻¹.

The study indicates that integrated application of inorganic fertilizer with organic nutrient sources, particularly vermicompost, can improve chickpea growth, yield attributes and productivity under the agro-climatic conditions of Jaipur, Rajasthan.

Keywords: Chickpea, Integrated Nutrient Management, Vermicompost, Biofertilizers, Yield

1. Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops cultivated in semi-arid and arid regions and plays a significant role in food and nutritional security. It is an important source of plant protein, carbohydrates, minerals and other essential nutrients, while its symbiotic association with *Rhizobium* contributes to biological nitrogen fixation and improvement of soil fertility. Pulses also contribute to sustainable agricultural systems by enhancing soil biological activity and nutrient cycling (FAO, 2024).

Chickpea productivity is strongly influenced by the availability and balanced supply of essential plant nutrients. Continuous dependence on chemical fertilizers alone may not adequately maintain soil organic matter, biological activity and long-term soil fertility. Therefore, integrated nutrient management (INM), involving the combined use of inorganic fertilizers, organic manures and biofertilizers, has emerged as an important approach for improving nutrient-use efficiency and sustaining crop productivity. Organic sources such as farmyard manure, poultry manure and vermicompost supply nutrients gradually and improve soil physical, chemical and biological properties. Long-term studies in maize–chickpea systems have demonstrated that integration of mineral fertilizers with organic manures can improve crop productivity as well as soil-health indicators.

Biofertilizers such as *Rhizobium* and phosphate-solubilizing bacteria (PSB) further complement nutrient management by enhancing biological nitrogen fixation and improving phosphorus availability. Earlier research has demonstrated beneficial effects of combined microbial inoculation on chickpea growth, nutrient uptake and yield. Recent evidence also indicates that compost and vermicompost can improve nodulation, biomass production and yield of legume crops through improved soil biological processes and nutrient availability (2025).

Considering the importance of balanced nutrient supply for sustainable chickpea production, the present investigation was undertaken to evaluate different combinations of inorganic fertilizers, organic manures and

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biofertilizers for improving the growth, yield, nutrient content and uptake, and economic performance of chickpea under the agro-climatic conditions of Jaipur, Rajasthan.

2. Materials and Methods

A field experiment entitled “Effect of Integrated Nutrient Management on Productivity of Chickpea (*Cicer arietinum* L.)” was conducted during the Rabi season of 2025–26 at the Agricultural Research Farm, Department of Agronomy, School of Agriculture, Suresh Gyan Vihar University, Jaipur, Rajasthan. The experiment comprised 11 integrated nutrient management treatments, involving different combinations of recommended dose of fertilizer (RDF), vermicompost, farmyard manure (FYM), poultry manure and biofertilizers (*Rhizobium* + PSB). The treatments included 100, 75 and 50% RDF in combination with organic manures and biofertilizers, along with 100% RDF and an untreated control. The experiment was evaluated for growth, yield attributes and yield of chickpea. Observations were recorded on plant population, plant height, dry matter accumulation, branches plant⁻¹, nodules plant⁻¹, pods plant⁻¹, seeds pod⁻¹, seed yield and stover yield. The recorded data were statistically analysed to determine the significance of treatment effects.

3. Results and Discussion

3.1 Growth attributes

The results showed that integrated nutrient management significantly influenced most of the growth attributes of chickpea, whereas plant population remained non-significant. Plant population ranged from 8.75 to 9.78 plants m⁻¹ at 30 DAS and from 7.98 to 9.02 plants m⁻¹ at harvest, indicating that nutrient management treatments did not substantially affect crop establishment. The relatively uniform plant population may be attributed to similar seed quality, seed placement and environmental conditions during crop establishment. Similar observations have been reported in chickpea, where nutrient management practices had greater effects on subsequent vegetative growth and yield than on initial crop establishment (Meena *et al.*, 2014; Jat *et al.*, 2025) [2, 1]. Recent work has also demonstrated that integrated nutrient management improves chickpea productivity primarily through improved nutrient availability and crop growth rather than through major changes in plant population (Raghuwanshi *et al.*, 2025; Zuber *et al.*, 2026) [3, 4].

Plant height was significantly improved by integrated nutrient management. The maximum plant height was recorded with T₃: 100% RDF + vermicompost @ 3 t ha⁻¹, registering 22.08, 41.25 and 54.25 cm at 30 DAS, 60 DAS and harvest, respectively, whereas the control recorded the minimum values of 16.85, 30.89 and 40.15 cm. The improvement in plant height under integrated application of inorganic fertilizer and vermicompost may be attributed to the continuous release of nutrients, improved soil physical conditions, greater microbial activity and enhanced nutrient-use efficiency. Vermicompost supplies nutrients in readily available as well as slowly mineralizable forms and may improve root development and nutrient acquisition. Similar increases in plant height under integrated application of RDF, vermicompost and biofertilizers have been reported by Zala *et al.* (2024) [5], Meena *et al.* (2025) [6], and Jat *et al.* (2025) [1].

The present findings are also supported by Saurabh *et al.* (2022) [7], who reported that combinations of organic and inorganic fertilizers significantly improved plant height and dry matter accumulation compared with the unfertilized control. Likewise, Cathrine *et al.* (2024) [8] observed improved physiological growth of chickpea with 100% NPK combined with microbial-enriched vermicompost. These improvements can be explained by the complementary role of mineral fertilizers and organic amendments, whereby inorganic fertilizers provide readily available nutrients while vermicompost improves nutrient retention, soil biological activity and nutrient release.

Dry matter accumulation followed a similar trend. Treatment T₃ produced the highest dry matter accumulation of 2.25, 5.30 and 7.35 g plant⁻¹ at 30, 60 DAS and harvest, respectively, compared with 1.25,

2.95 and 4.12 g plant⁻¹ under the control. The greater biomass production may have resulted from improved availability of nitrogen, phosphorus and other essential nutrients, which promoted leaf development, photosynthetic activity and assimilate production. Comparable increases in dry matter accumulation due to integrated nutrient management have been reported in chickpea by Zala *et al.* (2024) [5], Saurabh *et al.* (2022) [7], and Meena *et al.* (2025) [6].

The beneficial effect of vermicompost on plant biomass may also be associated with improved soil structure, moisture retention and microbial activity. A recent systematic review and meta-analysis by Amaya-Gómez *et al.* (2025) [9] showed that compost application increased plant biomass and plant height in legume crops, while vermicompost generally produced still greater responses. The authors attributed these effects to improved soil fertility, biological activity and enhanced plant-microbe interactions.

The number of branches and root nodules plant⁻¹ was also significantly influenced by nutrient management. T₃ recorded the maximum branches (19.78) and nodules (55.47 plant⁻¹), while the control recorded 10.45 branches and 32.25 nodules plant⁻¹. The greater branching under integrated nutrient management may be related to improved nutritional status and greater vegetative vigour. Similarly, enhanced nodulation may have resulted from favourable root-zone conditions created by vermicompost and balanced nutrient availability. Kumar *et al.* (2024) [10] reported that dual inoculation with *Rhizobium* + PSB significantly improved nodulation, pods plant⁻¹ and yield of chickpea.

The recent systematic review of Amaya-Gómez *et al.* (2025) [9] provides further support, showing that compost and vermicompost can improve nodulation, biological nitrogen fixation, plant biomass, plant height and yield of legume crops. The meta-analysis reported substantial improvements in nodule number and biomass following compost application. Thus, the higher nodulation observed in T₃ may have contributed to improved nitrogen nutrition and subsequent crop growth.

3.2 Yield attributes and yield

Integrated nutrient management significantly increased yield attributes. The maximum number of pods plant⁻¹ (48.20) and seeds pod⁻¹ (2.28) was recorded with T₃, compared with 22.63 pods plant⁻¹ and 1.55 seeds pod⁻¹ in the control. The improvement in yield attributes appears to be associated with enhanced vegetative growth, greater dry matter accumulation, improved nodulation and better nutrient availability during reproductive development. Similar improvements in pods plant⁻¹ and seeds pod⁻¹ through integrated nutrient management have been reported by Jakhar *et al.* (2021) [11], Zala *et al.* (2024) [5], and Raghuwanshi *et al.* (2025) [3].

Jakhar *et al.* (2021) [11] reported that the combined application of 75% RDF + vermicompost + PSB substantially improved pods plant⁻¹, seeds pod⁻¹, seed yield and haulm yield compared with the control. Similarly, Zala *et al.* (2024) [5] observed maximum yield attributes under 75% RDF + vermicompost + *Rhizobium* + PSB. These findings suggest that integrated nutrient supply can improve reproductive growth through better plant nutritional status and efficient translocation of assimilates towards developing pods and seeds.

Seed yield was significantly affected by the treatments. The highest seed yield (1625 kg ha⁻¹) was obtained with T₃: 100% RDF + vermicompost @ 3 t ha⁻¹, followed by T₅, 100% RDF + poultry manure @ 2.5 t ha⁻¹ (1568 kg ha⁻¹), and T₄, 100% RDF + FYM @ 6 t ha⁻¹ (1500 kg ha⁻¹). The control produced the lowest seed yield of 1025 kg ha⁻¹. Thus, T₃ produced approximately 58.5% higher seed yield than the control. The superior performance of vermicompost combined with full RDF may be explained by the complementary supply of readily available nutrients from fertilizers and gradually mineralizable nutrients and organic matter from vermicompost.

The present findings are in agreement with Meena *et al.* (2025) [6], who reported that integrated application of RDF, vermicompost and biofertilizers significantly improved chickpea growth, yield attributes and grain yield. Similarly, Jat *et al.* (2025) [1] reported that integrated

nutrient management involving RDF, organic manure and biofertilizers significantly improved growth and yield attributes of chickpea. Saurabh *et al.* (2022) [7] also found that combined application of organic and inorganic fertilizers produced substantially higher growth and yield of chickpea than the control. Their results demonstrated that integrated nutrient sources improved plant height, branches, dry matter, pods plant⁻¹ and seed yield.

The long-term findings of Ghosh *et al.* (2019) [12] further support the importance of combining organic and inorganic nutrient sources. Their long-term maize–chickpea study demonstrated that integrated nutrient management sustained crop productivity and improved soil health, whereas exclusive reliance on either chemical fertilizers or organic sources was less effective in maintaining long-term productivity.

Stover yield showed a similar response, with the maximum value of 2985 kg ha⁻¹ under T₃, followed by T₅ (2902 kg ha⁻¹) and T₄ (2845 kg ha⁻¹), while the control recorded 2058 kg ha⁻¹. The increase in stover production corresponds with the greater plant height, branching and dry matter accumulation observed under integrated nutrient management. Similar improvements in straw or haulm yield under integrated nutrient management have been reported by Jakhar *et al.* (2021) [11], Zala *et al.* (2024) [5], and Rolaniya *et al.* (2023) [13].

The findings are also supported by Kumar *et al.* (2018) [14], who reported that application of inorganic NPK along with FYM increased chickpea yield and nutrient uptake compared with fertilizer or farmer-practice treatments. Likewise, Singh *et al.* (2018) reported that combining organic manure with inorganic fertilizers increased chickpea yield and improved post-harvest soil nutrient status.

Organic nutrient sources may also improve the efficiency of mineral fertilizers by enhancing nutrient retention and biological activity in the rhizosphere. Meena *et al.* (2014) [2] reported that integrated nutrient management improved chickpea productivity, soil fertility and economic returns in Vertisols of Rajasthan. Similarly, Tanwar *et al.* reported positive effects of combining FYM, phosphorus and PSB on chickpea productivity and nutrient balance.

The role of biofertilizers in integrated nutrient management is also important. Kumar *et al.* (2024) [10] observed that dual inoculation with *Rhizobium* and PSB enhanced nodulation, yield attributes and seed yield of chickpea. Although T₃ in the present study did not include biofertilizer inoculation, the high nodulation observed under vermicompost plus RDF indicates that organic amendments may have created favourable conditions for indigenous rhizobial populations.

Recent evidence further indicates that vermicompost can improve plant growth and nutrient acquisition through improved soil biological properties. The systematic review by Amaya-Gómez *et al.* (2025) [9] showed positive effects of compost and vermicompost on nodulation, nitrogen fixation, biomass and seed yield in legume–*Rhizobium* systems. This provides a physiological basis for the higher growth, nodulation and yield observed under T₃ in the present investigation.

Conclusion

The present investigation demonstrated that integrated nutrient management had a positive influence on the growth, nodulation, yield attributes and productivity of chickpea. Although plant population was not significantly affected by nutrient management, the integrated application of mineral fertilizer with organic manure substantially improved plant growth, dry matter accumulation, branching and nodulation. Among the treatments, 100% RDF + vermicompost @ 3 t ha⁻¹ showed superior performance by providing a balanced and sustained nutrient supply, which resulted in better vegetative growth and reproductive development. The treatment also recorded the highest pods plant⁻¹, seeds pod⁻¹, seed yield and stover yield. The overall improvement may be attributed to enhanced nutrient availability, improved soil biological activity, favourable root-zone conditions and better nutrient-use efficiency. Therefore, under the agro-climatic conditions of Jaipur, 100% RDF + vermicompost @ 3 t ha⁻¹ can be considered an effective integrated nutrient management practice for improving the overall productivity of chickpea while maintaining a more balanced approach to soil fertility management.

Table 1. Effect of integrated nutrient management on plant population of chickpea

Treatments	Plant population per m row length	
	30 DAS	At harvest
T ₁ -Control	8.75	7.98
T ₂ -100% RDF	8.98	8.26
T ₃ - 100 % RDF + Vermicompost 3t/ha	9.78	9.02
T ₄ -100 % RDF + FYM 6t/ha	9.54	8.82
T ₅ -100 % RDF + Poultry manure 2.5t/ha	9.65	8.91
T ₆ -100 % RDF + Rhizobium + PSB	9.08	8.32
T ₇ -75 % RDF + Vermicompost 3t/ha + Rhizobium + PSB	9.45	8.73
T ₈ -75 % RDF + FYM 6t/ha + Rhizobium + PSB	9.28	8.52
T ₉ -75 % RDF + Poultry manure 2.5t/ha + Rhizobium+ PSB	9.35	8.65
T ₁₀ -50 % RDF + Vermicompost 3t/ha + Rhizobium+ PSB	9.20	8.42
T ₁₁ -50 % RDF+ FYM 6t/ha + Rhizobium+ PSB	9.14	8.38
S.Em.±	0.43	0.40
CD	NS	NS
CV%	8.07	8.11

Table 4.2. Effect of integrated nutrient management on plant height of chickpea

Treatments	Plant height (cm)		
	30 DAS	60.DAS	At harvest
T ₁ -Control	16.85	30.89	40.15
T ₂ -100% RDF	18.89	34.65	45.36
T ₃ - 100 % RDF + Vermicompost 3t/ha	22.08	41.25	54.25
T ₄ -100 % RDF + FYM 6t/ha	21.25	39.20	51.84

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Treatments	Plant height (cm)		
	30 DAS	60.DAS	At harvest
T ₅ -100 % RDF + Poultry manure 2.5t/ha	21.52	39.52	52.08
T ₆ -100 % RDF + Rhizobium + PSB	19.15	35.20	46.25
T ₇ -75 % RDF + Vermicompost 3t/ha + Rhizobium + PSB	20.95	38.62	50.85
T ₈ -75 % RDF + FYM 6t/ha + Rhizobium + PSB	20.05	36.82	48.52
T ₉ -75 % RDF + Poultry manure 2.5t/ha + Rhizobium+ PSB	20.65	38.05	50.23
T ₁₀ -50 % RDF + Vermicompost 3t/ha + Rhizobium+ PSB	19.85	36.42	48.00
T ₁₁ -50 % RDF+ FYM 6t/ha + Rhizobium+ PSB	19.45	36.82	48.72
S.Em.±	0.79	1.58	1.84
CD	2.34	4.66	5.43
CV%	6.85	7.39	6.56

Table 3. Effect of integrated nutrient management on dry matter accumulation of chickpea

Treatments	Dry matter accumulation (g/plant)		
	30 DAS	60.DAS	At harvest
T ₁ -Control	1.25	2.95	4.12
T ₂ -100% RDF	1.38	3.32	4.72
T ₃ - 100 % RDF + Vermicompost 3t/ha	2.25	5.30	7.35
T ₄ -100 % RDF + FYM 6t/ha	1.98	4.65	6.48
T ₅ -100 % RDF + Poultry manure 2.5t/ha	2.08	4.92	6.72
T ₆ -100 % RDF + Rhizobium + PSB	1.45	3.42	4.75
T ₇ -75 % RDF + Vermicompost 3t/ha + Rhizobium + PSB	1.90	4.55	6.15
T ₈ -75 % RDF + FYM 6t/ha + Rhizobium + PSB	1.74	4.10	5.60
T ₉ -75 % RDF + Poultry manure 2.5t/ha + Rhizobium+ PSB	1.52	3.52	5.28
T ₁₀ -50 % RDF + Vermicompost 3t/ha + Rhizobium+ PSB	1.62	3.80	5.32
T ₁₁ -50 % RDF+ FYM 6t/ha + Rhizobium+ PSB	1.54	3.62	5.10
S.Em.±	0.06	0.16	0.21
CD	0.19	0.47	0.63
CV%	6.45	7.25	7.02

Table 4. Effect of integrated nutrient management on number of branches per plant and nodules per plant of chickpea

Treatments	Number of branches per plant	Number of root nodules per plant
T ₁ -Control	10.45	32.25
T ₂ -100% RDF	13.85	37.96
T ₃ - 100 % RDF + Vermicompost 3t/ha	19.78	55.47
T ₄ -100 % RDF + FYM 6t/ha	18.36	50.28
T ₅ -100 % RDF + Poultry manure 2.5t/ha	19.00	52.85
T ₆ -100 % RDF + Rhizobium + PSB	14.25	39.45
T ₇ -75 % RDF + Vermicompost 3t/ha + Rhizobium + PSB	17.65	49.52
T ₈ -75 % RDF + FYM 6t/ha + Rhizobium + PSB	16.25	45.30
T ₉ -75 % RDF + Poultry manure 2.5t/ha + Rhizobium+ PSB	17.00	47.18
T ₁₀ -50 % RDF + Vermicompost 3t/ha + Rhizobium+ PSB	15.68	43.25
T ₁₁ -50 % RDF+ FYM 6t/ha + Rhizobium+ PSB	14.85	41.25
S.Em.±	0.60	1.77
CD	1.78	5.21
CV%	6.49	6.79

Table 5. Effect of integrated nutrient management on number of pods per plant and seeds per pod of chickpea

Treatments	Number of pods per plant	Number of seeds per pod
T ₁ -Control	22.63	1.55
T ₂ -100% RDF	29.45	1.72
T ₃ - 100 % RDF + Vermicompost 3t/ha	48.20	2.28
T ₄ -100 % RDF + FYM 6t/ha	43.36	2.13

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Treatments	Number of pods per plant	Number of seeds per pod
T ₅ -100 % RDF + Poultry manure 2.5t/ha	45.18	2.20
T ₆ -100 % RDF + Rhizobium + PSB	31.55	1.78
T ₇ -75 % RDF + Vermicompost 3t/ha + Rhizobium + PSB	41.25	2.06
T ₈ -75 % RDF + FYM 6t/ha + Rhizobium + PSB	37.12	1.93
T ₉ -75 % RDF + Poultry manure 2.5t/ha + Rhizobium+ PSB	39.02	2.00
T ₁₀ -50 % RDF + Vermicompost 3t/ha + Rhizobium+ PSB	35.85	1.89
T ₁₁ -50 % RDF+ FYM 6t/ha + Rhizobium+ PSB	33.45	1.84
S.Em.±	1.30	0.08
CD	3.85	0.23
CV%	6.09	6.84

Table 6. Effect of integrated nutrient management on seed and stover yield of chickpea

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)
T ₁ -Control	1025	2058
T ₂ -100% RDF	1145	2365
T ₃ - 100 % RDF + Vermicompost 3t/ha	1625	2985
T ₄ -100 % RDF + FYM 6t/ha	1500	2845
T ₅ -100 % RDF + Poultry manure 2.5t/ha	1568	2902
T ₆ -100 % RDF + Rhizobium + PSB	1195	2452
T ₇ -75 % RDF + Vermicompost 3t/ha + Rhizobium + PSB	1452	2805
T ₈ -75 % RDF + FYM 6t/ha + Rhizobium + PSB	1345	2689
T ₉ -75 % RDF + Poultry manure 2.5t/ha + Rhizobium+ PSB	1378	2742
T ₁₀ -50 % RDF + Vermicompost 3t/ha + Rhizobium+ PSB	1285	2608
T ₁₁ -50 % RDF+ FYM 6t/ha + Rhizobium+ PSB	1235	2565
S.Em.±	55.40	104.45
CD	163.42	308.12
CV%	7.15	6.86

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