E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(1): 341-342
Received: 08-11-2025
Accepted: 13-12-2025

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

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DOI: https://www.doi.org/10.33545/2618060X.2026.v9.i1e.4673

Abstract
A field experiment entitled Effect of Integrated Nutrient Management on Chickpea (*Cicer arietinum* L.) conducted during *rabi* 2024 at Agriculture farm, Suresh Gyan Vihar University, Jaipur on sandy loam soil. Application of 75% RDF + 2.5 ton vermicompost significantly increased the number of pods per plant, seeds per pod, seed, stover and biological yield over control, 50% RDF + 5.0 ton vermicompost and 100% RDF and remained statistically at par with 50% RDF + Rhizobium + PSB, 50% RDF + 5.0 ton + vermicompost + PSB and 75 RDF + 2.5% ton vermicompost + Rhizobium. Highest net returns (₹ 114627 ha^{-1}) was obtained with 75% RDF + 2.5 ton vermicompost followed by 100% RDF (₹ 107984 ha^{-1}), 75 RDF + 2.5% ton vermicompost + Rhizobium (₹ 105638 ha^{-1}). The highest B: C ratio (3.49) was obtained with 100% RDF followed by 50% RDF + Rhizobium + PSB (3.23).

Keywords: Integrated nutrient management, chickpea, RDF, vermicompost

Introduction
Chickpea (*Cicer arietinum*), often referred to as the queen of pulses, is a key crop grown worldwide due to its nutritional value and environmental benefits. It is an excellent source of protein, fibre, vitamins, and minerals, making it a staple food in many countries, especially in regions where animal protein is scarce. Beyond its nutritional value, chickpea plays a vital role in crop rotation and sustainable agriculture by fixing nitrogen in the soil, thus improving soil fertility (Badr *et al*., 2015). India is the world's largest producer of chickpeas, which are cultivated across the world. It is cultivated in an area of 9.61 million ha around the world, with a total production of 11.34 million tons and annual production of 1180 kg/ha (DA&FW 2023-24). In Rajasthan total production of chickpea (2023-24) was 1.92 million tons from 1.78 million ha area with an annual production 1081 kg/ha (DES 2023, MOAF&W, GoI). The concept behind integrated nutrient management is Maintaining the fertility of the soil and providing vital plant nutrients at the ideal level for the sustained growth of the targeted crop and crop yield. Vermicompost is a valuable resource of organic matter and nutrients, which may enhance the soil physical characteristics, activity of microbes, moisture retention, availability of nutrients, and soil structures. Rhizobium is an essential part of integrated nutrient management (INM) for chickpea production, which provides an inexpensive, cost efficient, environmentally acceptable biofertilizer input. Biofertilizers must be applied conjunction with both organic and inorganic fertilizers in order to boost the productivity of crops (Kapgate *et al.* 2025) [6].

Methods and Materials
The experiment was conducted during *kharif* 2024 at Agronomy farm, School of Agriculture, Suresh Gyan Vihar University, Jaipur. Geographically, the study area is located at 75o48’84” E longitude and 26o82’47” N latitude and this region falls under agro-climatic zone III A (Semi-arid Eastern Plain Zone) of Rajasthan. The experiment consisting seven treatments Control, 100% RDF, 75% RDF + 2.5 ton vermicompost, 50% RDF + 5.0 ton vermicompost, 75 RDF + 2.5% ton vermicompost + Rhizobium, 50% RDF + 5.0 ton + vermicompost + PSB and 50% RDF + Rhizobium + PSB. The total seven treatment combinations were tested in randomized block design with three replications.

Results and Discussion

The number of pods per plant and seeds per pod were significantly increased with application of 75 RDF + 2.5% ton vermicompost + Rhizobium over to control and 50% RDF + Rhizobium + PSB and remained statistically at par with 100% RDF, 75% RDF + 2.5 ton vermicompost, 50% RDF + 5.0 ton vermicompost and 50% RDF + 5.0 ton + vermicompost + PSB at 30, 60 DAS and at harvest. RDF with seed inoculated PSB and rhizobium might have played a pivotal role in various plant processes, including starch cell division, enhanced sugar utilization, and the rate of photosynthesis through increased availability of nutrient which ultimately resulted in better yield attributing characters of the crop. The above findings are in accordance the findings of Nyekha *et al.* (2015) [9], Kalsaria *et al.* (2017) [5] and Meena *et al.* (2023).

The seed, stover and biological yield was significantly increased with application of 75% RDF + 2.5 ton vermicompost which was statistically at par with 75 RDF + 2.5% ton vermicompost + Rhizobium. An improvement in the yield of seeds is also linked to the cumulative effect of number of pods plant^{-1}, pod length and number of seeds pod^{-1}. The above observation was found to be in conformity with the findings of Mishra *et al.* (2023) [8] who observed that integrated use of organic manures along with optimum doses of chemical fertilizers increased the growth parameters and yield of gram. The highest net returns (₹ 114627 ha^{-1}) was obtained with 75% RDF + 2.5 ton vermicompost followed by 100% RDF (₹ 107984 ha^{-1}), 75 RDF + 2.5% ton vermicompost + Rhizobium (₹ 105638 ha^{-1}), 50% RDF + Rhizobium + PSB (₹ 96273 ha^{-1}).

The highest B: C ratio (3.49) was obtained with 100% RDF followed by 50% RDF + Rhizobium + PSB (3.23), 75% RDF + 2.5 ton vermicompost (2.87), 75 RDF + 2.5% ton vermicompost + Rhizobium (2.61) and control (2.23). The higher seed and stover yields obtained through the application of 50% RDF + 2% NPK mixture (12:32:16) spray at 20 and 40 DAS might be the reason for the resultant net return, and B: C ratio (Lal *et al.*, 2022) [7] and Arsalan Muhammad *et al*. (2016) [1].

Table 1: Effect of integrated nutrient management on yield attributes

Treatments	Yield attributes	
	Pods/plant	Seeds/pod
Control	39.67	1.22
100% RDF	51.67	1.55
75% RDF + 2.5 ton vermicompost	55.00	1.89
50% RDF + 5.0 ton vermicompost	52.33	1.66
75 RDF + 2.5% ton vermicompost + Rhizobium	55.66	2.00
50% RDF + 5.0 ton + vermicompost + PSB	54.67	1.77
50% RDF + Rhizobium + PSB	48.00	1.48
S.Em±	1.67	0.12
CD (p=0.05)	5.14	0.38

Table 2: Effect of integrated nutrient management on yields

Treatments	Yield (kg/ha)		
	Seed	Straw	Biological
Control	1413	1912	3325
100% RDF	2224	3034	5257
75% RDF + 2.5 ton vermicompost	2480	3317	5797
50% RDF + 5.0 ton vermicompost	2137	2918	5055
75 RDF + 2.5% ton vermicompost + Rhizobium	2338	3223	5560
50% RDF + 5.0 ton + vermicompost + PSB	2237	3089	5326
50% RDF + Rhizobium + PSB	2020	2733	4753
S.Em±	73	86	153
CD (p=0.05)	226	265	470

Table 3: Effect of integrated nutrient management on economics (Rs/ha)

Treatments	Economics (Rs/ha)	
	Net return	B: C ratio
Control	60908	2.23
100% RDF	107984	3.49
75% RDF + 2.5 ton vermicompost	114627	2.87
50% RDF + 5.0 ton vermicompost	84383	1.72
75 RDF + 2.5% ton vermicompost + Rhizobium	105638	2.61
50% RDF + 5.0 ton + vermicompost + PSB	90267	1.82
50% RDF + Rhizobium + PSB	96273	3.23
S.Em±	4464	0.12
CD (p=0.05)	13755	0.38

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