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Effect of NPK and vermicompost on growth characteristics and yield of chickpea (*Cicer arietinum* L.)

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Abstract
Chickpea (*Cicer arietinum* L.) is a nutritionally and economically important legume crop in India and many semi-arid regions. However, productivity remains below potential due to suboptimal nutrient management. This study evaluates the individual and combined effects of different levels of NPK and vermicompost on the growth, yield attributes, and productivity of chickpea under field conditions at Mewar University, Rajasthan. The experiment, arranged in a split-plot design with three replications, examined three NPK levels (50%, 75%, 100% RDF) and three vermicompost levels (0, 50%, 100% RD). The highest values for plant height, branch number, biomass accumulation, seed weight, and overall seed and straw yields were recorded under the integrated treatment of 100% RDF + 100% vermicompost. These findings affirm the synergistic role of integrated nutrient management (INM) in enhancing soil fertility, plant health, and chickpea productivity in resource-limited environments.

Keywords: Chickpea, integrated nutrient management, NPK, vermicompost, growth, yield, soil fertility

Introduction
Chickpea (*Cicer arietinum* L.), a winter season pulse crop, is widely grown across semi-arid and subtropical regions due to its adaptability and ability to fix atmospheric nitrogen, enriching soil fertility. Globally, chickpea is cultivated on about 15.2 million hectares, producing 18.9 million tonnes (FAOSTAT, 2024) [7]. India alone accounts for over 70% of global production, covering 10.12 million hectares (DAC & FW, 2024) [4]. Despite this vast area, productivity remains low (~1.23 t/ha) compared to its potential due to poor agronomic practices, particularly nutrient mismanagement (Yadav *et al*., 2020) [19].

Chemical fertilizers are often applied uniformly across regions without accounting for spatial soil variability. This leads to overuse in some areas and under-application in others, contributing to low yields, soil degradation, and environmental concerns (Rana *et al*., 2022) [16]. Furthermore, smallholder farmers often cannot afford high-cost fertilizers, increasing reliance on low-input farming systems. Hence, sustainable nutrient management practices that integrate organic and inorganic inputs are necessary.

Among these strategies, integrated nutrient management (INM), involving the combined use of chemical fertilizers and organic manures such as vermicompost, has shown promise in enhancing soil fertility, crop productivity, and resource-use efficiency (Ghosh *et al*., 2023) [8]. Vermicompost, produced through the bio-oxidation of organic matter by earthworms (e.g., *Eisenia fetida*), is rich in nutrients, humic substances, beneficial microorganisms, and plant growth hormones (Arancon *et al*., 2008) [1]. Given chickpea's relatively low external nutrient requirements and its symbiotic nitrogen fixation, it is an ideal candidate for INM approaches. This study evaluates the effects of different levels of NPK and vermicompost—individually and in combination—on the growth characteristics and yield of chickpea under field conditions in Rajasthan, India.

Materials and Methods

The experiment was conducted during rabi season 2024-25 at the Agricultural Research Farm of Mewar University, Gangarar, Chittorgarh, Rajasthan (24.84°N latitude and 74.63°E longitude), characterized by semi-arid climatic conditions. The soil at the experimental site was sandy loam, low in organic carbon and available nitrogen but medium in phosphorus and potassium. A split-plot design was employed with three replications:

- **Main plot:** NPK at 50%(F_1), 75%%(F_2), and 100%%(F_3) of Recommended Dose of Fertilizer (RDF)
- **Sub-plot:** Vermicompost at 0 (V_0), 50% (V_1), and 100% (V_2) of recommended dose

The recommended dose was 20:60:40 kg/ha N:P:K for chickpea. Vermicompost was applied at 2 t/ha for 100% RD. The test variety was RSG 888, with row spacing maintained at 30 cm. Irrigation and intercultural operations were performed as per standard protocols. Observations were recorded on growth parameters (plant height, branch number), biomass accumulation, reproductive traits (pods per plant, seeds per pod), seed yield (g/plant and kg/ha), 100-seed weight (seed index), straw yield, and harvest index.

Results and Discussion

The application of NPK and vermicompost had a significant influence on plant height at all growth stages. Among the NPK levels, 100% RDF (F_3) produced the tallest plants (53.16 cm), significantly higher than F_2 (51.41 cm) and F_1 (48.65 cm). Similarly, among vermicompost treatments, 100% RD (V_2) resulted in the highest plant height (52.68 cm), with the maximum height observed under the interaction treatment F_3V_2 (54.63 cm) (Table 1 & Fig.1). These findings are in agreement with Edwards *et al*. (2010) [6], who reported that vermicompost enhances microbial activity, root development, and nutrient availability, thereby improving vegetative vigor. Chaudhary *et al*. (2018) [2] also observed increased plant height under integrated nutrient application, attributing the improvement to the synergistic effect of immediate nutrient availability from fertilizers and sustained release from organic inputs.

The number of primary branches per plant increased progressively from 30 to 90 DAS across treatments. F_3 (13.17 branches) and V_2 (12.80 branches) produced significantly higher branching compared to lower levels of nutrient application. The treatment F_3V_2 yielded the highest number of branches (14.04), indicating a strong synergistic effect between chemical and organic inputs (Table 1). These results corroborate the observations of Zala *et al*. (2024) [20], who found that combining 75% RDF with vermicompost and Rhizobium significantly increased branching due to enhanced root growth, better nodulation, and improved nutrient uptake. Prakash *et al*. (2022) [15] also reported similar increases in branching under integrated nutrient management practices, highlighting the continuous nutrient supply provided by vermicompost.

Dry matter accumulation was significantly improved by the application of both NPK and vermicompost. The highest total dry matter at 90 DAS was recorded under F_3 (19.35 g/plant), followed closely by F_2 (18.91 g) (Table 1). Among vermicompost treatments, V_2 (18.96 g/plant) outperformed V_1 and V_0. The interaction treatment F_3V_1 resulted in the highest dry matter accumulation (20.27 g/plant). These results align with the findings of Dwivedi *et al*. (2024) [5], who noted improved dry matter production in chickpea under integrated nutrient regimes due to enhanced nutrient synchrony, better root development, and improved photosynthetic activity.

Pod number is a vital yield-determining trait and was significantly influenced by nutrient treatments. The maximum number of pods per plant (53.84) was recorded under F_3V_2, while F_3 alone produced 52.32 pods and V_2 yielded 52.41 pods (Table 2). These findings are supported by Patel *et al*. (2025) [14] and Kumar *et al*. (2024) [11], who reported enhanced pod formation under integrated nutrient management due to improved flowering, better nutrient partitioning, and stronger sink strength during the reproductive phase. The number of seeds per pod increased significantly with both NPK and vermicompost levels. F_3 and V_2 each produced 2.32 and 2.24 seeds per pod, respectively, with the highest value of 2.52 recorded under the F_3V_2 combination (Table 2). This result is consistent with the findings of Zala *et al*. (2024) [20] and Uçar *et al*. (2020) [18], who demonstrated that integrated nutrient management and microbial inoculants positively influence reproductive development by enhancing pollen viability, fertilization efficiency, and pod filling.

Seed yield per plant was significantly higher in integrated treatments, particularly F_3V_1 (19.26 g/plant) and F_3V_2 (16.93 g/plant), compared to F_1V_0 (12.80 g/plant). Similarly, 100-seed weight (seed index) peaked under F_3V_2 (21.20 g), followed by F_3 (20.66 g) and V_2 (20.61 g) (Table 2 & Fig. 2). This improvement is attributed to enhanced nutrient translocation, improved carbohydrate assimilation, and balanced phosphorus supply during the grain-filling phase (Chaudhary *et al*., 2022) [2]. Khan *et al*. (2021) [10] reported that integrated application of vermicompost and RDF improved seed quality by maintaining consistent nutrient flow during critical developmental stages. Both seed and straw yields were significantly influenced by the nutrient treatments. The highest seed yield (3297 kg/ha) and straw yield (6137 kg/ha) were recorded in F_3V_2, confirming the beneficial effect of integrated application (Table 2). F_3 alone produced 3138 kg/ha seed yield and 5932 kg/ha straw yield, while V_2 resulted in 3107 kg/ha and 5850 kg/ha, respectively. These findings align with earlier studies by Zala *et al*. (2024) [20], Patel *et al*. (2025) [14], and Chavan *et al*. (2023) [3], which showed that combining vermicompost with fertilizers enhanced both vegetative and reproductive biomass by improving soil microbial dynamics, nutrient availability, and water retention. Harvest Index (HI) represents the partitioning efficiency of total biomass into economic yield. While the differences in HI were modest, the maximum HI (34.60%) was recorded in F_3V_2, indicating a slightly improved partitioning under integrated nutrient application (Table 2). F_3 and V_2 individually recorded 34.48% and 34.41%, respectively. This aligns with the findings of Pathak *et al*. (2022) [13], who documented modest but statistically significant improvements in HI under INM, driven by more efficient translocation of photosynthates.

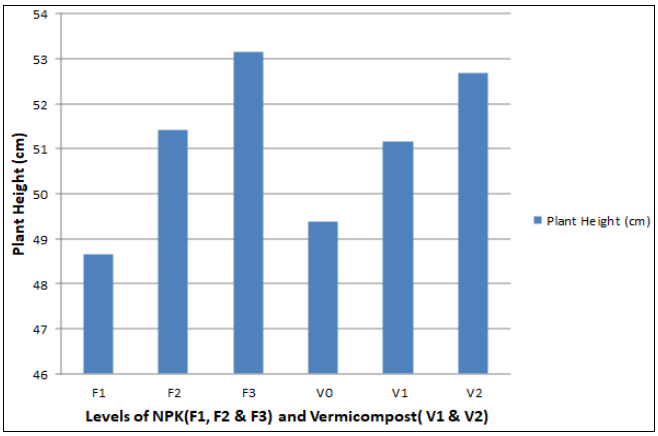

Fig 1: Effect of NPK and Vermicompost on Plant Height

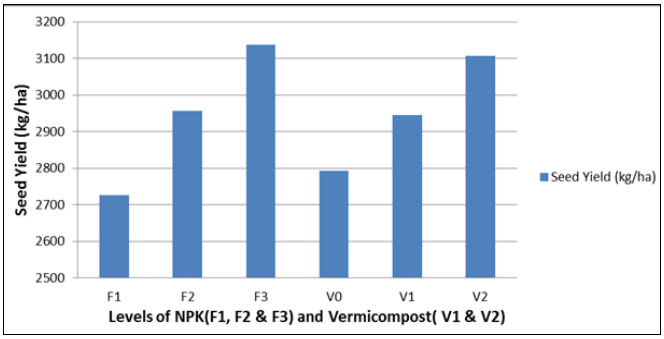

Fig 2: Effect of NPK and Vermicompost on yield

Table 1: Effect of NPK and Vermicompost on Growth Attributes of Chickpea

Treatment	Plant Height (cm)	Primary Branches (no./plant)	Dry Matter (g/plant)
F_1	48.65	11.61	17.03
F_2	51.41	12.20	18.91
F_3	53.16	13.17	19.35
S.Em±	0.42	0.31	0.43
LSD (0.05)	1.25	0.93	1.29
V_0	49.37	11.53	17.49
V_1	51.17	12.23	18.85
V_2	52.68	12.80	18.96
S.Em±	0.36	0.27	0.39
LSD (0.05)	1.10	0.84	1.18
F × V	F_3V_2 (54.63)	F_3V_2 (14.04)	F_3V_1 (20.27)
S.Em±	0.61	0.45	0.64
LSD (0.05)	1.83	1.34	1.91

Table 2: Effect of NPK and Vermicompost on Yield Attributes and Productivity of Chickpea

Treatment	Pods/ Plant	Seeds/ Pod	Seed index (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
F_1	45.48	1.90	19.61	2725	5533	34.35
F_2	50.50	2.16	20.17	2957	5689	34.35
F_3	52.32	2.32	20.66	3138	5932	34.48
S.Em±	1.28	0.06	0.17	44.3	66.2	0.06
LSD (0.05)	3.83	0.18	0.52	132.6	198.1	0.19
V_0	47.21	1.89	19.94	2792	5536	34.33
V_1	50.67	2.16	20.33	2945	5709	34.42
V_2	52.41	2.24	20.61	3107	5850	34.41
S.Em±	1.11	0.05	0.15	38.4	57.3	0.05
LSD (0.05)	3.33	0.15	0.45	115.0	171.7	0.17
F × V	F_3V_2 (53.84)	F_3V_2 (2.52)	F_3V_2 (21.20)	F_3V_2 (3297)	F_3V_2 (6137)	F_3V_2 (34.60)
S.Em±	1.87	0.08	0.28	66.7	94.1	0.08
LSD (0.05)	5.59	0.23	0.83	198.4	280.1	0.23

Conclusion

The experiment demonstrated that integrated nutrient management using 100% RDF in combination with 100% vermicompost significantly enhanced the growth, yield attributes, and productivity of chickpea. The V2F3 treatment consistently outperformed others across growth stages, pod development, seed traits, and yield parameters. These findings underscore the synergistic effect of INM in improving nutrient use efficiency and soil health. Vermicompost not only supplements plant nutrients but also improves microbial activity, soil texture, and water retention. Adopting INM practices can be a sustainable approach to address yield stagnation and environmental concerns in pulse production systems.

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