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Sarthak Dwivedi

M.Sc. Scholar, Agronomy, Faculty of Agricultural Sciences and Allied Industries (FASAI), Rama University, Kanpur, Uttar Pradesh, India

Mandeep Kumar

Assistant Professor, Faculty of Agricultural Sciences and Allied Industries (FASAI), Rama University, Kanpur, Uttar Pradesh, India

Ravikesh Kumar Pal

Assistant Professor, Faculty of Agricultural Sciences and Allied Industries (FASAI), Rama University, Kanpur, Uttar Pradesh, India

Naveen Kumar Maurya

Assistant Professor Sanskriti University, Mathura, Semri, Uttar Pradesh, India

Durgesh Kumar Maurya

SMS agronomy, KVK Santkabirnager (ANDUA&T), Uttar Pradesh, India

Rishu Kumari

M.Sc. Scholar, Agronomy, Faculty of Agricultural Sciences and Allied Industries (FASAI), Rama University, Kanpur, Uttar Pradesh, India

Corresponding Author:

Sarthak Dwivedi

M.Sc. Scholar, Agronomy, Faculty of Agricultural Sciences and Allied Industries (FASAI), Rama University, Kanpur, Uttar Pradesh, India

Effect of integrated nutrient management on growth parameters and nodulation of Lentil (*Lens culinaris* M.)

Sarthak Dwivedi, Mandeep Kumar, Ravikesh Kumar Pal, Naveen Kumar Maurya, Durgesh Kumar Maurya and Rishu Kumari

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Abstract

The experiment "Effect of Integrated Nutrient management on nodulation, growth and yield of lentil (*Lens culinaris* M.)" was conducted at the Agricultural Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur, during the rabi season of 2025-26. Eight treatments comprising various levels of Recommended Dose of Fertilizers (RDF), organic manure (Vermicompost), and biofertilizers (Rhizobium and PSB) were evaluated in a Randomized Block Design with three replications. The results indicated that the application of RDF 75% + Vermicompost + PSB + Rhizobium (T₈) significantly improved all growth parameters. Treatment T₈ recorded the maximum final plant population (38.66 m⁻²), plant height at harvest (49.43 cm), number of branches per plant (11.66), dry matter accumulation (772.50 g m⁻²), and number of nodules per plant (20.66). Additionally, it reduced the days to 50% flowering (45.83 days) and maturity (109.33 days). It is concluded that integrating chemical fertilizers with organic and biological sources promotes vigorous vegetative growth and nodulation in lentil.

Keywords: Lentil, integrated nutrient management, vermicompost, rhizobium, PSB, growth parameters

Introduction

Lentils have been a nutritional mainstay for humans from the Pottery Neolithic period due to its early domestication in the Near East, when pottery was not yet developed (Ahmad *et al.*, 2018) ^[1]. Lentil is a pulse crop that belongs to the leguminous or fabaceous family and is often grown during the winter months. They are well-known for their protein-rich grains, which have a wide range of culinary applications. Lentils are a key rabi pulse in India, predominantly grown in Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, Jharkhand, Rajasthan, and Assam (Malik *et al.*, 2022) ^[9].

This crop yields less than other legumes because to its low care requirements, cultivation in poor quality soils, and dependency on rainfall (Singh *et al.*, 2025) ^[17]. Nutrients have a direct impact on both the plant and the symbiotic nitrogen, significantly influencing lentil yield. The continued loss of soil nutrients has resulted in numerous nutritional deficits in a variety of crops, including lentils. Nonetheless, an overreliance on artificial chemical fertilizers has gradually led to significant environmental dangers, soil degradation, and lower agricultural production (Chaudhay and Pathak, 2024). Integrated nutrient management (INM) has been used in conventional agriculture for a very long time because soil plant systems have a low rate of nutrient turnover (Patel *et al.*, 2026) ^[14].

Rhizobium is a soil bacteria that works in tandem with pulse crops to promote their development and productivity. It enters legume root hairs and forms root nodules where biological nitrogen fixation (BNF) occurs (Surya Kant *et al.*, 2016) ^[19]. This natural nitrogen source significantly enhances plant growth indicators such as height, biomass, and branching. Treating pulse seeds with the right Rhizobium inoculum is a cost-effective and environmentally friendly way to improve soil fertility and reduce the need for synthetic nitrogen fertilizers (Amat *et al.*, 2020) ^[2]. Vermicompost is an organic fertilizer filled with nutrients that helps plants grow by supplying easily accessible macronutrients, micronutrients, plant hormones, and beneficial bacteria that promote root development and biomass. Additionally, phosphate-solubilizing bacteria (PSB) are beneficial soil microbes that convert insoluble phosphorus molecules to plant-accessible

orthophosphate by releasing organic acids and phosphatases. This procedure enhances phosphorus absorption, encourages root development, and improves overall plant health. Keeping these facts in view, this study is proposed to understand the impact of integrated nutrient management on the nodulation and growth parameters of lentil (Kumar, 2023) ^[7].

Materials and Methods

The experiment was carried out at the Agricultural Research Farm, Rama University, Kanpur, Uttar Pradesh, during the Rabi season of 2025-26. The soil was sandy loam in texture, low in available nitrogen, medium in available phosphorus and potassium, and slightly alkaline. The variety Shekhar Masoor-2 (KLB-303) was sown at a seed rate of 45 kg/ha with a spacing of 30 x 10 cm. The experiment was laid out in a Randomized Block Design (RBD) with 8 treatments and 3 replications. The treatments were: T₁ (Control), T₂ (RDF 100%), T₃ (RDF 50% + Vermicompost 10 t/ha), T₄ (RDF 50% + Vermicompost 5 t/ha + PSB), T₅ (RDF 50% + Vermicompost t/ha + PSB + Rhizobium), T₆ (RDF 75% + Vermicompost 10 t/ha), T₇ (RDF 75% + Vermicompost 5 t/ha + PSB), and T₈ (RDF 75% + Vermicompost + PSB + Rhizobium). Biometric observations for growth parameters and nodulation were recorded at 30, 60, 90 DAS, and at harvest.

Result and Discussion

Plant height

Plant height was significantly enhanced by nutrient treatments across all growth intervals, with treatment T₈ (RDF 75% + Vermicompost + PSB + Rhizobium) consistently recording the maximum heights: 13.70 cm at 30 DAS, 18.25 cm at 60 DAS, 38.40 cm at 90 DAS, and 49.43 cm at harvest. Treatments T₇ (RDF 75% + Vermicompost 5 t/ha + PSB) and T₆ (RDF 75% + Vermicompost 10 t/ha) closely followed, ultimately reaching 47.68 cm and 45.72 cm at harvest, respectively. Conversely, the T₁ (Control) treatment consistently exhibited the shortest plants at every stage, progressing from a minimum of 12.23 cm at 30 DAS to 12.24 cm at 60 DAS, 24.58 cm at 90 DAS, and at harvest the smallest harvest height of 30.24 cm. The addition of vermicompost, PSB, and Rhizobium greatly increases lentil plant height by providing a consistent supply of critical macro- and micronutrients, as well as growth-promoting phytohormones. This symbiotic mixture enhances root development, biological nitrogen fixation, and phosphorus solubility, resulting in enhanced vegetative growth and strong canopy architecture. The similar results observed by Pandey *et al.* (2017) ^[13] and Fatima *et al.* (2018) ^[6].

Number of branches

The number of branching was significantly enhanced by integrated nutrient applications, with treatment T₈ (RDF 75% + Vermicompost + PSB + Rhizobium) consistently producing the maximum number of branches per plant: 2.83 at 30 DAS, 3.96 at 60 DAS, 8.06 at 90 DAS, and 11.66 at harvest. Treatments T₇ and T₆ closely trailed this trend across all growth intervals, ultimately reaching 11.33 and 10.96 branches at harvest, respectively. In contrast, the T₁ (Control) treatment consistently exhibited the lowest branching rate, yielding minimums of just 1.66 at 30 DAS, 1.83 at 60 DAS, 5.50 at 90 DAS, and concluding with only 9.00

branches at harvest. These results are in close agreement with the findings of Mekuria *et al.* (2019) ^[11], Samar and Kumar (2020) ^[16] and Begom *et al.* (2021) ^[4].

Dry matter accumulation

Dry matter accumulation was maximized across all growth intervals under treatment T₈ (RDF 75% + Vermicompost t/ha + PSB + Rhizobium), which recorded 54.26, 276.56, 656.48, and 772.50 g m⁻² at 30, 60, 90 DAS, and harvest, respectively. Treatments T₇ and T₆ closely followed this superior trend at every stage, culminating in harvest accumulations of 760.80 and 748.55 g m⁻². Conversely, the T₁ (Control) treatment consistently exhibited the poorest performance throughout the crop cycle, yielding the minimum dry matter of just 37.48 at 30 DAS, 216.20 at 60 DAS, 542.88 at 90 DAS, and terminating with 628.32 g m⁻² at harvest. The combined application of vermicompost, PSB, and Rhizobium considerably stimulates vegetative growth and leaf area expansion, directly increasing the crop's net photosynthetic rate and seasonal dry matter accumulation. Furthermore, Rhizobium's symbiotic nitrogen fixation and PSB's improved phosphorus solubility work synergistically with the micronutrients in vermicompost to promote better dry matter distribution. This outcome strongly aligns with prior research by Tarek *et al.* (2021) ^[20], Rakesh and Mehra (2022) ^[15] and Kumar and Singh (2023) ^[8].

Number of days to 50% flowering and maturity

Integrated nutrient management significantly accelerated the crop's phenological development, with treatment T₈ (RDF 75% + Vermicompost + PSB + Rhizobium) achieving the earliest 50% flowering at 45.83 days and the earliest maturity at 109.33 days. This rapid progression was closely followed by T₇ (46.50 days to flowering; 110.66 days to maturity) and T₆ (48.33 days to flowering). In contrast, the purely inorganic T₂ (RDF 100%) treatment delayed flowering to 49.83 days and maturity to 115.66 days. The maximum duration for both parameters was consistently observed in the T₁ (Control), which took 57.50 days to reach 50% flowering and 123.23 days to mature, followed by T₃ which took 120.66 days to reach maturity. These findings mirror the results reported by Pandey *et al.* (2017) ^[13] and Math (2018) ^[10].

Number of Nodules per Plant

The incorporation of organic manures and bio-fertilizers with chemical fertilizers significantly enhanced the nodulation process in lentil. The maximum number of nodules per plant was recorded in treatment T₈ (RDF 75% + Vermicompost + PSB + Rhizobium), which observed a value of 20.66. This was significantly followed by treatment T₇ with 20.16 nodules and treatment T₆ with 18.53 nodules per plant. The minimum number of nodules per plant was observed in the T₁ (Control) treatment, which recorded 12.06, followed by the T₃ with 14.16 nodules. Inoculation with Rhizobium and PSB promotes early root colonization and nodule formation by turning insoluble phosphorus into accessible orthophosphates, thereby meeting the high energy requirement necessary for vigorous biological nitrogen fixation. A matching trend was documented by Sonkarlay (2020) ^[18], Aparna and Dawson (2022) ^[3] and Mounika *et al.* (2022) ^[12].

Table 1: Effect of Integrated Nutrient management on plant height and number of branch per plant

S. No.	Treatments	Plant height (cm)				Number of branches per plant			
		30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T ₁	Control	12.23	12.24	24.58	30.24	1.66	1.83	5.50	9.00
T ₂	RDF 100%	13.39	15.88	33.42	43.37	2.33	2.83	7.50	10.65
T ₃	RDF 50% + Vermicompost 10 t/ha	12.96	13.75	27.86	36.60	1.96	2.33	6.76	9.83
T ₄	RDF 50% + Vermicompost 5 t/ha + PSB	13.04	14.15	29.62	39.48	2.00	2.50	7.00	10.33
T ₅	RDF 50% + Vermicompost t/ha + PSB + Rhizobium	13.21	14.50	31.45	41.60	2.15	2.66	7.33	10.49
T ₆	RDF 75% + Vermicompost 10 t/ha	13.48	16.64	34.52	45.72	2.53	3.06	7.66	10.96
T ₇	RDF 75% + Vermicompost 5 t/ha + PSB	13.56	17.13	36.78	47.68	2.66	3.33	7.83	11.33
T ₈	RDF 75% + Vermicompost t/ha + PSB + Rhizobium	13.70	18.25	38.40	49.43	2.83	3.96	8.06	11.66
	SE(m)	0.165	0.244	0.529	0.439	0.035	0.041	0.097	0.173
	C.D.	0.505	0.746	1.619	1.343	0.108	0.126	0.296	0.529

Table 2: Effect of Integrated Nutrient management on dry matter accumulation, days to 50% flowering days to maturity and number of nodule per plant

S. No.	Treatments	Dry matter accumulation (g m ⁻²)				Days to 50% Flowering	Days to maturity	Number of nodules per plant
		30 DAS	60 DAS	90 DAS	At harvest			
T ₁	Control	37.48	216.20	542.88	628.32	57.50	123.23	12.06
T ₂	RDF 100%	49.34	251.62	626.49	730.16	49.83	115.66	16.66
T ₃	RDF 50% + Vermicompost 10 t/ha	41.40	232.30	574.38	671.15	53.66	120.66	14.16
T ₄	RDF 50% + Vermicompost 5 t/ha + PSB	44.39	238.58	589.46	684.97	52.83	118.50	15.00
T ₅	RDF 50% + Vermicompost t/ha + PSB + Rhizobium	46.27	246.47	605.12	706.46	51.53	116.53	15.50
T ₆	RDF 75% + Vermicompost 10 t/ha	51.67	262.35	645.84	748.55	48.33	112.33	18.53
T ₇	RDF 75% + Vermicompost 5 t/ha + PSB	52.24	270.40	650.21	760.80	46.50	110.66	20.16
T ₈	RDF 75% + Vermicompost t/ha + PSB + Rhizobium	54.26	276.56	656.48	772.50	45.83	109.33	20.66
	SE(m)	0.645	3.767	9.860	13.510	0.685	1.216	0.207
	C.D.	1.977	11.537	30.196	41.376	2.098	3.725	0.635

References

- Ahmad N, Sinha DK, Singh KM. Economic analysis of production and instability of lentil in major lentil growing states of India. 2018.
- Amat D, Thakur JK, Mandal A, Sahu A, Kiran Kumar Reddy K. Production and utilization of legume inoculants (Rhizobium) in India. Harit Dhara. 2020;3(2):28–31.
- Aparna B, Dawson J. Effect of bio-fertilizers and sulphur on growth and yield of lentil (*Lens culinaris* M.). International Journal of Plant & Soil Science. 2022.
- Begom F, Ahmed GMU, Sultana R, Akter F. Impact of Rhizobium biofertilizer on agronomical performance of lentil (BARI Masur-6) in Bangladesh. Archives of Agriculture and Environmental Science. 2021;6(2):114–120.
- Chaudhari SK, Pathak H. Nature-positive farming: the future of sustainable agriculture. 2024;11.
- Fatima K, Ganie SA, Kumar Y, Masoodi TH, Shah A. Effect of organic and inorganic fertilizer doses on growth and yield of lentil under cold arid conditions of Ladakh. International Journal of Current Microbiology and Applied Sciences. 2018;7(11):1449–1455.
- Kumar CS. Response of garden pea (*Pisum sativum* L.) cv. Him Palam Matar-1 to different nutrient management practices. Palampur: Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya; 2023.
- Kumar M, Singh R. Influence of biofertilizers and phosphorus on growth and yield of lentil (*Lens culinaris* Medik). International Journal of Plant & Soil Science. 2023;35(14):159–164.
- Malik DP, Devi M, Reddy AA. Global status of lentil production with special reference to India. Indian Journal of Agricultural Sciences. 2022;92(4):474–479.
- Math G, Balol G, Jaggal L. Integrated nutrient management in lentil. International Journal of Chemical Studies. 2018;6(6):201–202.
- Mekuria GF, Worku W, Woldemedhin AF. Nutrient utilization and yield response of lentil (*Lens culinaris* Medikus) to Rhizobium inoculant and sulphur fertilization. Agriculture, Forestry and Fisheries. 2019;8(3):64.
- Mounika S, Mehera B, Sathvik D, Chandan N. Influence of bio fertilizers and zinc on growth and yield of lentil (*Lens culinaris* L.). International Journal of Environment and Climate Change. 2022;12(10):788–793.
- Pandey P, Dahiya OS, Mor Yadav VS, Jitender R, Peerzada OH, Brar A. Impact of integrated nutrient management on seed yield and its attributes in field pea (*Pisum sativum* L.). Chemical Science Review and Letters. 2017;6(23):1428–1431.
- Patel VK, Singh SV, Patel C, Ingle SN, Das SP, Singh AK, et al. Importance of integrated nutrient management for pulse crops amidst climate change in India: a review. Agricultural Reviews. 2026;47(1):93–99.
- Rakesh K, Mehera B. Effect of bio fertilizers on different varieties of lentil (*Lens culinaris* L.). The Pharma Innovation Journal. 2022;11(7):688–691.
- Samar S, Kumar A. Co-inoculation potential impact of PSB and Rhizobium on physico-chemical properties of soil and legume crop growth. Research Journal of Agricultural Sciences. 2020;11(1):1–9.
- Singh SA, Mishra N, Yadav PK. Constraints experienced by the farmers in respect of gaining knowledge and adopting the organic farming practices. Journal of Experimental Agriculture International. 2025;47(1):523–529.
- Sonkarlay E, Luikham E, Athokpam HS. Effect of chemical fertilizer, organic manure and biofertilizer on nodulation, yield and economics of lentil (*Lens culinaris* Medik.). International Journal of Current Microbiology and Applied Sciences. 2020;9(8):2653–2662.
- Surya Kant SK, Achin Kumar AK, Satendra Kumar SK, Vipin Kumar VK, Yogesh Pal YP, Shukla AK. Effect of Rhizobium, PSB and P-levels on growth, yield attributes and yield of urdbean (*Vigna mungo* L.). 2016.
- Tarek M, Billah RB, Chowdhury S. Effect of Rhizobium isolates and nitrogen on nodulation, growth and yield in lentil. World Journal of Biology and Biotechnology. 2021;6(2):5.