

Integrated Nutrient Management through RDF and Organic Amendments (Vermicompost and Vermiwash) on Growth and Yield of Pea (*Pisum sativum* L.)

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Abstract

This study was conducted to assess the effect of integrated nutrient management practices on the growth and yield performance of garden pea (*Pisum sativum* L.). The experiment was arranged in a Randomized Block Design (RBD) with three replications and eight nutrient management treatments: T_0 (Control), T_1 (50% RDF + vermicompost), T_2 (75% RDF + vermicompost), T_3 (100% RDF + vermicompost), T_4 (50% RDF + vermiwash), T_5 (75% RDF + vermiwash), T_6 (100% RDF + vermiwash), and T_7 (100% RDF). Significant variations were observed among the treatments for growth and yield-related parameters. The treatment T_3 (100% RDF + vermicompost) produced the highest vegetative growth, recording maximum plant height (68.90 cm), number of branches per plant (6.03), dry matter accumulation ($37.61 \text{ g m}^{-2} \text{ day}^{-1}$), number of nodules per plant (34.19), and root dry weight (1.72 g). The earliest flowering (55.51 days to 75% flowering) and shortest duration to maturity (109.79 days) were observed in the control treatment (T_0). Among the yield attributes, the highest number of pods per plant (20.09), pod weight per plant (44.69 g), number of seeds per pod (7.61), seed weight per plant (21.21 g), 1000-seed weight (194.19 g), and shelling percentage (53.37%) were recorded under T_7 (100% RDF). The findings indicate that integrated nutrient management, particularly the combined application of recommended fertilizer doses and organic amendments, can significantly improve the growth, productivity, and yield attributes of garden pea.

Keywords: vermicompost, vermiwash, integrated nutrient management, pea.

INTRODUCTION

Garden pea (*Pisum sativum* L.) is one of the most important cool-season vegetable crops belonging to the family Fabaceae. It is extensively cultivated in temperate and subtropical regions across the world for its tender green pods and nutritious seeds. Pea is highly valued for its nutritional composition, containing approximately 20–25% protein, substantial amounts of carbohydrates, dietary fiber, vitamins, and essential minerals. The seeds are rich in vitamins A, B-complex, and C, as well as important mineral elements such as calcium, phosphorus, and iron. Besides fresh consumption, peas are widely utilized in the processing industry for canning, freezing, and dehydration, as a leguminous crop, pea contributes significantly to soil fertility through symbiotic nitrogen fixation by *Rhizobium* bacteria present in root nodules, thereby reducing dependence on external nitrogen inputs and enhancing soil health [1]. Pea cultivation is widespread throughout Europe, Asia, North America, South America, and Oceania. According to the Food and Agriculture Organization (FAO), peas are cultivated on approximately 7–8 million hectares worldwide, producing nearly 14–16 million tonnes annually [2]. Owing to its short growth duration, adaptability to diverse agro-climatic conditions, and relatively low input requirements, pea occupies an

important position in sustainable agricultural systems and crop diversification programs [3]. In India, pea is an important winter-season vegetable crop grown extensively in states such as Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Bihar, and West Bengal. Recent estimates indicate that the crop occupies nearly 0.75 million hectares with an annual production of approximately 0.91 million tonnes and an average productivity of about 1.22 t ha^{-1} . Despite its economic and nutritional significance, the productivity of pea in many regions remains below its genetic potential due to inadequate nutrient management practices and declining soil fertility. Nutrient management is a critical factor influencing crop growth, yield, and quality. Balanced and adequate nutrient availability is essential for maintaining optimal physiological processes, vegetative growth, reproductive development, and productivity. Chemical fertilizers are widely used to meet crop nutrient requirements and ensure the supply of essential macronutrients such as nitrogen, phosphorus, and potassium. The application of the recommended dose of fertilizers (RDF) has been shown to enhance crop growth and yield by improving nutrient availability and uptake. However, continuous and excessive dependence on inorganic fertilizers may adversely affect soil structure, reduce soil organic carbon content, create nutrient

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imbalances, and contribute to environmental degradation [4]. In recent years, increasing attention has been directed toward integrated nutrient management (INM), which combines inorganic fertilizers with organic nutrient sources to achieve sustainable crop production. Organic amendments such as vermicompost and vermiwash improve soil physical, chemical, and biological properties while enhancing nutrient availability and microbial activity. Vermicompost is a nutrient-rich organic manure produced through the decomposition of organic materials by earthworms and is known to improve soil fertility, water-holding capacity, and nutrient-use efficiency. Similarly, vermiwash, a liquid organic extract obtained from vermicompost systems, contains plant growth-promoting substances, micronutrients, enzymes, and beneficial microorganisms that stimulate plant growth and development [5].

The integration of RDF with organic amendments offers a promising strategy for improving crop productivity while maintaining soil health and environmental sustainability. Such an approach can enhance nutrient-use efficiency, promote root development, increase biological nitrogen fixation, and improve yield attributes in leguminous crops. Therefore, the present investigation was undertaken to evaluate the effect of integrated nutrient management involving RDF, vermicompost, and vermiwash on the growth, development, and yield performance of garden pea under field conditions.

Materials and Methods

The study "Integrated Nutrient Management through RDF and Organic Amendments (Vermicompost and Vermiwash) on Growth and Yield of Pea (*Pisum sativum* L.)" in the Semi-Arid environment of the Bundelkhand Region was conducted during the Rabi season of 2025-26. The study was conducted in the agriculture experiment field Nehru Mahavidyalaya, Lalitpur (U.P.) during 2025-26. The Lalitpur district experimental station is situated at 100-200 m in the southern center of Lalitpur city on Sagar Road. Geographically, Lalitpur district is a part of the Bundelkhand plateau. Betwa River is the boundary between Jhansi and Lalitpur in the north. Most of the area is under an average elevation of 300-450m from the sea level. Its latitude extension is from 24°10" N to 25°15" N and its longitudinal extension is from 78°10" E to 79° 00" E falls in the zone of subtropical climate and may be characterized by a very hot summer and cold winter. The soil of the experimental site was silty loam with a slightly alkaline in reaction (pH 7.8). It was medium in organic matter low in available nitrogen and phosphorus and medium in potash content.

Vermicompost was applied as a basal dose during final land preparation to improve soil fertility and provide a sustained nutrient supply. A quantity of 2 t/ha vermicompost was uniformly incorporated into the top 15 cm of soil prior to sowing, ensuring enhanced organic matter content and microbial activity in the rhizosphere. Vermiwash was prepared from the effluent of vermicompost units, diluted at a 1:10 ratio with water, and applied as foliar spray at critical growth stages. The first spray was given at 30 days after sowing (DAS) to promote vegetative growth, the second at flowering stage to enhance reproductive development, and the third at pod filling stage to improve seed quality.

This combined application aimed to synergize the slow-release nutrient effect of vermicompost with the readily available bio-stimulants present in vermiwash, thereby supporting nodulation, biomass accumulation, and yield attributes. Observations were recorded on plant height, branching, root traits, nodulation, phenological parameters, pod yield, and seed characteristics to evaluate varietal responses under organic nutrient management. The integration of vermicompost and vermiwash was expected to improve soil health, enhance nutrient uptake efficiency, and contribute to sustainable pea production.

Result and Discussion

A. Growth Parameters

The effect of integrated nutrient management on the growth parameter of pea is depicted in Table 1. The result show that the maximum plant height (68.90 cm), number of branches (6.03), dry matter accumulation (37.61 g/m²/day), Number of nodules (34.19) and root dry weight (1.72 g) were recorded in the treatment T₃ (100% RDF + vermicompost), which proved to be significantly superior over all other treatments. The next higher treatment was observed under T₆ (100% RDF + Vermiwash), followed by T₂ (75% RDF + Vermicompost) and T₅ (75% RDF + Vermiwash), and all these treatments were significantly superior to the remaining treatments. T₇ (100% RDF alone), which was significantly higher than T₁ (50% RDF + Vermicompost) and T₄ (50% RDF + Vermiwash). The minimum value recorded under T₀ (Control) treatment, which was significantly lower than all other treatments. Vermicompost improves the physical, chemical and biological properties of soil. It enhances soil structure, increases water holding capacity, improves aeration and promotes microbial activity in the rhizosphere. The presence of humic substances and growth hormones in vermicompost stimulates seed germination, root growth and overall plant development. Several research studies have reported that application of vermicompost significantly improves plant height, number of branches, dry matter accumulation, number of nodules, flowering, in vegetable crops including pea. The slow release of nutrients from vermicompost ensures continuous nutrient supply to plants and reduces nutrient losses through leaching. Vermiwash is commonly used as a foliar spray or soil drench in organic farming systems. It enhances physiological activities in plants such as photosynthesis, nutrient absorption and enzyme activity. Recent studies have also reported that vermicompost enhances soil microbial population and enzymatic activity, which play an important role in nutrient cycling and soil fertility improvement [5-6].

B. Yield Attributes

The finding to investigation revealed that a maximum increase yield parameter like number of pod per plant (20.09), pod weight (44.69g), number of seed per pod (7.61), seed weight per plant (21.21g), 1000 seed weight (194.19g), shelling percentage (27.33), grain yield (22.50 q ha⁻¹), straw yield (25.32 q ha⁻¹), biological yield (47.82 q ha⁻¹) and harvest index (47.06) were attend in T₃ (100% RDF + vermicompost) followed by T₆ (100% RDF + Vermiwash). The control (T₀) was significantly lowest. These findings are in agreement with [7-10] who reported that vermicompost enhanced grain yield in legumes.

Table 1: Effect of integrated nutrient management of growth parameter on pea

Treatment	Plant height	Number of branches (plant ⁻¹)	Dry matter accumulation (g/m ² /day)	Number of Nodules (Plant ⁻¹)	Days to 75% Flowering	Days to Maturity
T ₀	55.31	4.31	25.11	22.11	61.41	115.61
T ₁	62.09	5.19	32.41	29.59	58.21	112.31
T ₂	66.41	5.69	35.79	32.51	56.69	110.69
T ₃	68.9	6.03	37.61	34.19	55.91	109.79
T ₄	60.81	5.01	31.2	28.3	59.09	113.11
T ₅	65.22	5.51	34.69	31.19	57.3	111.51
T ₆	67.81	5.79	36.49	32.9	56.21	110.39
T ₇	63.5	5.31	33.91	30.51	58.01	112.01
SE(m) ±	0.007	0.01	0.006	0.004	0.004	0.005
CD at 5%	0.023	0.031	0.019	0.012	0.013	0.014

Table 2: Effect INM treatment on the yield attributes

Treatment	Number of pod (Plant ⁻¹)	Pod Weight (g)	Number of seed (Pod ⁻¹)	Seed weight per plant (g)	1000 Seed Weight (g)	Shelling percent age	Grain Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)	Biologic al Yield (q ha ⁻¹)	Harvest Index
T ₀	12.41	28.61	5.81	12.81	162.41	17.77	14.5	17.92	32.42	44.74
T ₁	16.79	36.39	6.71	17.61	178.59	24.69	19.11	21.51	40.61	47.05
T ₂	18.71	41.81	7.19	19.79	188.91	26.23	21.02	24.21	45.23	46.47
T ₃	20.09	44.69	7.61	21.21	194.19	27.33	22.5	25.32	47.82	47.06
T ₄	15.91	34.89	6.39	16.89	174.79	24.44	18.49	20.38	38.87	47.57
T ₅	17.91	39.61	7.01	18.91	185.61	26.07	20.5	23.44	43.94	46.66
T ₆	19.39	42.81	7.31	20.39	190.71	27.1	22	24.52	46.53	47.29
T ₇	16.51	37.49	6.69	17.81	181.19	26.56	19.5	22.97	42.47	45.92
SE(m) ±	0.005	0.005	0.005	0.005	0.005	0.609	0.017	0.008	0.019	0.023
CD at 5%	0.015	0.014	0.015	0.014	0.015	1.848	0.052	0.024	0.056	0.07

CONCLUSION

The results of the present study demonstrated that integrated nutrient management significantly influenced the growth, yield attributes, and economic performance of garden pea (*Pisum sativum* L.). Among the various nutrient management treatments evaluated, the combined application of 100% recommended dose of fertilizers (RDF) with vermicompost (T₃) produced the most favorable results. This treatment recorded superior vegetative growth, enhanced root development, greater nodulation, and improved biomass accumulation, which collectively contributed to higher productivity and profitability. The beneficial effects of vermicompost may be attributed to its ability to improve soil physical properties, enhance nutrient availability, stimulate microbial activity, and promote efficient nutrient uptake by plants. Although treatments involving vermiwash also improved crop performance compared with the control, their effectiveness was comparatively lower than that of vermicompost-based nutrient management. The sole application of inorganic fertilizers improved certain yield parameters; however, integrating organic and inorganic nutrient sources proved more advantageous for sustaining crop growth and overall productivity. Economic analysis further revealed that the integrated use of RDF and vermicompost generated the highest net returns and benefit-cost ratio, indicating its suitability for profitable pea cultivation. Therefore, the application of vermicompost in combination with the recommended fertilizer dose can be considered an effective and sustainable nutrient management strategy for enhancing garden pea production while maintaining soil fertility and long-term agricultural sustainability under similar agro-climatic conditions.

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