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Effect of organic, inorganic and integrated nutrient management on growth and yield of garden pea (*Pisum sativum* L.) under Balaghat region

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Abstract

A field experiment entitled "Effect of Organic, Inorganic and Integrated Nutrient Management on Growth and Yield of Garden Pea (*Pisum sativum* L.)" was conducted during the Rabi season of 2024-25 at the Horticulture Research Farm, Department of Horticulture, School of Agriculture Science, Technology and Research, Sardar Patel University, Balaghat, Madhya Pradesh. The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and three replications to evaluate the effect of organic, inorganic and integrated nutrient management on growth, yield and quality of garden pea. The treatments consisted of different combinations of recommended NPK fertilizers, farmyard manure (FYM) and vermicompost. The results revealed that nutrient management practices significantly influenced most of the growth, yield and quality parameters. The integrated application of 50% recommended NPK (30:40:35 kg ha⁻¹) + 25% FYM (5 t ha⁻¹) + 25% vermicompost (1.25 t ha⁻¹) (T₈) proved to be the most effective treatment. This treatment recorded the maximum plant height (20.47, 54.25 and 72.14 cm at 30, 60 and 90 DAS, respectively), leaf area (8.12, 8.04 and 7.99 cm²), pod length (8.35 cm), pod width (3.98 cm), number of seeds per pod (8.97), number of pods per plant (21.42), pod yield per plant (28.82 g), pod yield per plot (1.73 kg), pod yield (95.11 q ha⁻¹) and total soluble solids (18.62 °Brix). The same treatment also resulted in earlier flowering and harvesting than the other treatments. The superior performance of T₈ was attributed to the balanced and continuous availability of nutrients, improved soil physical and biological properties, enhanced nutrient-use efficiency and greater photosynthetic activity resulting from the combined application of organic and inorganic nutrient sources. Therefore, the integrated application of 50% recommended NPK along with 25% FYM and 25% vermicompost can be recommended as an efficient and sustainable nutrient management strategy for improving the growth, yield and quality of garden pea under the agro-climatic conditions of Balaghat, Madhya Pradesh.

Keywords: Organic, Inorganic, garden pea and integrated nutrient management

Introduction

Garden pea (*Pisum sativum* L.) is one of the most important cool-season vegetable legumes cultivated throughout temperate and subtropical regions of the world. It belongs to the family Fabaceae and is valued for its tender green pods and immature seeds, which constitute an excellent source of plant protein, carbohydrates, dietary fibre, vitamins, and essential minerals. Fresh green peas are particularly rich in vitamins A, C, and K, folates, iron, phosphorus and antioxidants, making them an important component of a balanced human diet (FAOSTAT, 2024) [4]. Owing to its high nutritional value, short duration, wide adaptability and remunerative market price, garden pea has become an economically important vegetable crop for farmers as well as the processing industry.

India is one of the leading producers of pea, contributing substantially to global vegetable production. Garden pea occupies a significant position among winter vegetables due to its high consumer demand and versatility in fresh consumption, freezing, dehydration and canning industries. Besides its economic importance, pea improves soil fertility through biological nitrogen fixation in association with *Rhizobium* bacteria, thereby reducing dependence on synthetic nitrogen fertilizers and benefiting succeeding crops in crop rotation systems (Kumar *et al.*, 2021). However, despite its nitrogen-fixing ability, balanced nutrient management remains essential because phosphorus, potassium and micronutrients play

indispensable roles in nodulation, root development, flowering, pod formation and seed filling.

Continuous dependence on chemical fertilizers has undoubtedly enhanced agricultural productivity over the past several decades. Nevertheless, indiscriminate and imbalanced application of inorganic fertilizers has led to deterioration of soil physical properties, depletion of soil organic carbon, nutrient imbalance, decline in microbial diversity and reduced nutrient use efficiency. Such practices also increase the risk of nutrient losses through leaching and runoff, thereby contributing to environmental pollution and threatening long-term agricultural sustainability (Lal, 2020) [8]. Therefore, the development of sustainable nutrient management strategies has become one of the major priorities in modern vegetable production.

Organic manures such as farmyard manure (FYM) and vermicompost have gained considerable attention because of their beneficial effects on soil health and crop productivity. Farmyard manure improves soil structure, enhances water-holding capacity, increases cation exchange capacity and supplies both macro- and micronutrients in a slow and balanced manner. Regular incorporation of FYM also stimulates microbial activity and improves nutrient availability, ultimately resulting in better plant growth and yield (Ramesh *et al.*, 2020) [13]. Vermicompost, produced through the decomposition of organic wastes by earthworms, is recognized as an excellent organic fertilizer containing readily available nutrients, humic substances, plant growth-promoting hormones and beneficial microorganisms. Application of vermicompost has been reported to enhance seed germination, root proliferation, chlorophyll synthesis, nutrient uptake and photosynthetic efficiency, leading to improved crop performance (Singh *et al.*, 2022).

Although organic manures improve soil quality and sustainability, their exclusive use may not always satisfy the nutrient demand of high-yielding vegetable crops during critical growth stages because nutrient release from organic materials is relatively slow and depends upon environmental conditions. Conversely, chemical fertilizers provide nutrients in readily available forms that ensure rapid crop response but may adversely affect soil health when used alone over long periods. Consequently, integration of organic and inorganic nutrient sources has emerged as an effective strategy for maintaining productivity while preserving soil fertility (Agegnehu *et al.*, 2021) [1].

Integrated Nutrient Management (INM) emphasizes the judicious combination of chemical fertilizers, organic manures and biological inputs to achieve balanced nutrition, improve nutrient use efficiency and sustain crop production. The synergistic interaction between organic amendments and inorganic fertilizers enhances nutrient availability throughout the crop growth period, improves soil biological activity, increases organic carbon content and minimizes nutrient losses. Numerous studies have demonstrated that integrated nutrient management significantly enhances plant height, number of branches, nodulation, flowering, pod development, green pod yield and quality attributes in vegetable legumes compared with the application of either organic or inorganic sources alone (Sharma *et al.*, 2023).

In garden pea, balanced nutrition assumes greater importance because inadequate nutrient availability during vegetative growth adversely affects flowering, pod setting and seed development. Nitrogen promotes vegetative

growth and chlorophyll formation, phosphorus plays a crucial role in root development, nodulation and energy transfer, whereas potassium regulates photosynthesis, enzyme activation, translocation of assimilates and disease resistance. Organic amendments further improve nutrient retention, microbial biomass and soil enzymatic activities, thereby creating favourable conditions for sustained crop growth (Meena *et al.*, 2021) [10]. Consequently, integrating FYM and vermicompost with recommended doses of NPK fertilizers may provide an ideal nutrient management strategy that combines the immediate availability of mineral nutrients with the long-term benefits of improved soil health.

Recent investigations have indicated that partial substitution of chemical fertilizers with organic manures not only maintains higher crop productivity but also improves nutrient recovery, enhances soil carbon sequestration and supports environmentally sustainable agriculture (Mahapatra *et al.*, 2022) [9]. Moreover, integrated nutrient management contributes to improved nutrient synchronization with crop demand, thereby reducing fertilizer input costs and minimizing environmental degradation. Such practices are particularly relevant under the present scenario of increasing fertilizer prices, declining soil fertility and the growing demand for residue-free vegetables.

Therefore, the present investigation was undertaken to evaluate the effect of organic, inorganic and integrated nutrient management practices involving farmyard manure, vermicompost and recommended NPK fertilizers on the growth and yield of garden pea (*Pisum sativum* L.).

Materials and Methods

Experimental site

The present field experiment entitled "Effect of Organic, Inorganic and Their Combined Effect on Growth and Yield of Garden Pea (*Pisum sativum* L.)" was conducted during the Rabi season of 2024-25 at the Horticulture Research Farm, Department of Horticulture, School of Agriculture Science, Technology and Research, Sardar Patel University, Balaghat, Madhya Pradesh, India. The experimental farm is situated in the Chhattisgarh Plain Agro-climatic Zone (MP-1). The experimental field consisted of sandy loam soil, which was well drained, slightly alkaline in reaction and medium in fertility status. Before sowing, representative soil samples were collected from different locations within the experimental field at a depth of 0-30 cm. The meteorological conditions prevailing during the crop growth period were generally favourable for normal growth and development of garden pea.

Experimental material

The experimental crop was garden pea (*Pisum sativum* L.) variety 'Arkel', an early maturing and widely cultivated variety suitable for fresh market production. Healthy, uniform and disease-free seeds were procured from reliable sources and used for sowing. Prior to sowing, the seeds were treated with Captan @ 2 g kg⁻¹ seed to minimize seed-borne diseases.

Experimental design and layout

The experiment was laid out in a Randomized Block Design (RBD) comprising eight treatments replicated three times. Thus, a total of 24 experimental plots were maintained. Each plot measured 2.0 × 2.0 m (4 m²). Seeds were sown at

a spacing of 30×10 cm using a seed rate of 90 kg ha^{-1} . Recommended agronomic practices were uniformly followed throughout the crop growing period except for the nutrient treatments under investigation.

Treatment details

The present investigation comprised eight nutrient management treatments involving organic, inorganic and integrated nutrient sources to evaluate their effect on the growth and yield of garden pea (*Pisum sativum* L.). The treatments consisted of T₁: Control (no nutrient application), T₂: 100% recommended dose of NPK ($60:80:70 \text{ kg ha}^{-1}$), T₃: 100% farmyard manure (FYM) @ 20 t ha^{-1} , T₄: 100% vermicompost @ 5 t ha^{-1} , T₅: 50% recommended NPK ($30:40:35 \text{ kg ha}^{-1}$) + 50% FYM @ 10 t ha^{-1} , T₆: 50% recommended NPK ($30:40:35 \text{ kg ha}^{-1}$) + 50% vermicompost @ 2.5 t ha^{-1} , T₇: 50% FYM @ 10 t ha^{-1} + 50% vermicompost @ 2.5 t ha^{-1} and T₈: 50% recommended NPK ($30:40:35 \text{ kg ha}^{-1}$) + 25% FYM @ 5 t ha^{-1} + 25% vermicompost @ 1.25 t ha^{-1} . Farmyard manure and vermicompost were thoroughly incorporated into the soil during final land preparation according to the respective treatments. Nitrogen, phosphorus and potassium were supplied through urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively, as per the treatment schedule. The nutrient sources were applied uniformly to each experimental plot before sowing to ensure proper nutrient availability throughout the crop growth period.

Observations recorded

Five healthy and representative plants were randomly selected from the centre of each experimental plot, excluding border plants, for recording observations throughout the crop growth period. The average values obtained from these plants were used for statistical analysis. Growth parameters such as plant height (cm) and leaf area (cm^2) were recorded at 30, 60 and 90 days after sowing (DAS). The number of days taken to first flowering and 50% flowering was recorded from the date of sowing to the appearance of the first flower and the stage at which approximately half of the plants in each plot had flowered, respectively. Yield and yield-attributing observations included pod length (cm), pod width (cm), days to first harvesting, number of seeds per pod, number of pods per plant, pod yield per plant (g), pod yield per plot (kg) and pod yield (q ha^{-1}). Pod length was measured using a measuring scale, while pod width was determined with the help of a digital vernier caliper. Total soluble solids (TSS) of fresh pods were determined with a hand refractometer and expressed in °Brix. In addition, the economics of each treatment were worked out by estimating the cost of cultivation, gross return, net return and benefit-cost (B) ratio on a hectare basis using the prevailing market prices of inputs and produce. All observations were recorded following standard experimental procedures and analysed statistically using analysis of variance (ANOVA) appropriate for a Randomized Block Design (RBD).

Statistical analysis

The experimental data recorded for various growth, yield and quality parameters were analysed statistically using the Analysis of Variance (ANOVA) appropriate for a Randomized Block Design (RBD) as described by Fisher and Yates. The significance of treatment effects was tested

using the F-test at the 5% probability level. Whenever treatment effects were found significant, the means were compared using the Critical Difference (CD) at $P = 0.05$. Standard error of mean [SE(m)], coefficient of variation (CV%) and other relevant statistical parameters were computed to assess the precision of the experiment.

Results and Discussion

Growth parameters

The data presented in Table 1 revealed that different nutrient management practices exerted a significant influence on plant height of garden pea at all stages of crop growth (30, 60 and 90 DAS). The results clearly demonstrated that the integrated application of organic and inorganic nutrient sources promoted superior vegetative growth compared with the sole application of either inorganic fertilizer or organic manures.

At 30 DAS, the maximum plant height (20.47 cm) was recorded under T₈ (50% NPK + 25% FYM + 25% vermicompost), which was statistically superior to most other treatments and closely followed by T₇ (19.01 cm) and T₆ (17.83 cm). The minimum plant height (13.21 cm) was observed under the control (T₁). Similar trends were observed at 60 DAS, where T₈ produced the tallest plants (54.25 cm), followed by T₇ (52.96 cm) and T₆ (50.42 cm), whereas control plants attained only 41.12 cm. At harvest (90 DAS), treatment T₈ again maintained its superiority by recording the highest plant height (72.14 cm), followed by T₇ (70.64 cm) and T₆ (68.42 cm), while the control recorded the lowest value (60.89 cm). The present findings are in close agreement with those reported by Sharma *et al.* (2022) [15], Ram *et al.* (2021) [12], Bharadwaj *et al.* (2021) [3], Sharma *et al.* (2023) [14] and Yadav *et al.* (2023) [19] concluded that integrated nutrient management significantly enhances vegetative growth of vegetable crops by improving nutrient use efficiency and soil health.

At 30 DAS, the highest leaf area (8.12 cm^2) was recorded in treatment T₈, followed by T₇ (7.96 cm^2) and T₆ (7.14 cm^2). The lowest leaf area (5.36 cm^2) was recorded under the control treatment. At 60 DAS, treatment T₈ again produced the maximum leaf area (8.04 cm^2), whereas the control and sole NPK treatment recorded comparatively lower values (5.95 cm^2 and 5.67 cm^2 , respectively). Similar observations were obtained at 90 DAS, where T₈ recorded the highest leaf area (7.99 cm^2), followed by T₇ (7.86 cm^2) and T₆ (7.04 cm^2), while the control registered the minimum leaf area (5.21 cm^2). The differences among treatments were statistically significant.

The earliest flowering (37.95 days) was observed in T₈, followed by T₇ (38.20 days) and T₅ (38.44 days), whereas the control recorded the maximum number of days (39.45 days) to first flowering. Similar observations have been reported by Chanu *et al.* (2020) and Sharma *et al.* (2022) [15], who found only marginal differences in flowering time under different nutrient management practices in pea.

The number of days required for 50% flowering also remained statistically non-significant among the treatments. However, treatment T₈ recorded the minimum number of days (42.00 days) for 50% flowering, followed by T₇ (43.12 days) and T₆ (43.29 days), while the maximum duration (45.95 days) was recorded under the control treatment.

Among all the treatments, T₈ (50% NPK + 25% FYM + 25% Vermicompost) produced the maximum pod length (8.35 cm), which was significantly superior to the remaining

treatments. It was followed by T₇ (7.96 cm) and T₆ (7.62 cm). The minimum pod length (6.14 cm) was recorded under the control treatment (T₁), which remained statistically at par with T₂ (6.15 cm), while treatments receiving sole organic manures exhibited intermediate values ranging from 6.47 to 6.95 cm.

The significant increase in pod length under T₈ can be attributed to the balanced and continuous availability of nutrients throughout the crop growth period. The combined application of inorganic fertilizers with FYM and vermicompost supplied essential nutrients in both readily available and slow-release forms, thereby ensuring uninterrupted nutrition during flowering and pod development. Nitrogen enhanced vegetative growth and photosynthetic activity, phosphorus promoted reproductive development and energy transfer, while potassium facilitated translocation of carbohydrates towards developing pods. Simultaneously, FYM improved soil structure, moisture retention and microbial activity, whereas vermicompost supplied humic substances, beneficial microorganisms and naturally occurring plant growth regulators that stimulated cell elongation and pod expansion. The data presented in Table 1 indicated that pod width was significantly affected by different nutrient management treatments. Among the various treatments, T₈ (50% NPK + 25% FYM + 25% Vermicompost) recorded the maximum pod width (3.98 cm), followed by T₇ (3.74 cm) and T₆ (3.51 cm). The minimum pod width (1.67 cm) was observed in the control treatment.

The present findings are in close agreement with the observations of Ram *et al.* (2021) [12], Sharma *et al.* (2022) [15], Singh *et al.* (2022) [16], Mahapatra *et al.* (2022) [9] and Sharma *et al.* (2023) [14].

Yield parameters

Among all the treatments, T₈ (50% NPK + 25% FYM + 25% Vermicompost) recorded the minimum number of days to first harvesting (43.04 days), which was significantly earlier than all other treatments. It was followed by T₇ (44.35 days) and T₆ (45.24 days). The maximum number of days (48.37 days) was recorded in T₂ (100% NPK), followed closely by the control treatment (48.12 days).

The highest number of seeds per pod (8.97) was recorded under T₈ (50% NPK + 25% FYM + 25% Vermicompost), which was significantly superior to all other treatments. This was followed by T₇ (7.35) and T₆ (7.24). The lowest number of seeds per pod (5.24) was observed in the control treatment. The treatments receiving sole FYM and sole vermicompost recorded intermediate values of 6.79 and 6.15, respectively.

These findings agree with those of Sharma *et al.* (2022) [15], who reported significantly higher seed numbers under integrated application of FYM and chemical fertilizers in pea. Similar observations have also been reported by Singh

et al. (2022) [16], Mahapatra *et al.* (2022) [9] and Sharma *et al.* (2023) [14], who emphasized that integrated nutrient management enhances reproductive efficiency and seed development by ensuring balanced nutrition and improved assimilate partitioning.

The highest number of pods per plant (21.42) was recorded under T₈ (50% NPK + 25% FYM + 25% Vermicompost), followed by T₇ (19.89) and T₆ (18.34). The lowest number of pods per plant (15.95) was recorded in the control treatment. Intermediate values were observed in treatments receiving sole NPK, FYM or vermicompost.

Among the various treatments, the highest pod yield per plant (28.82 g) was recorded under T₈ (50% NPK + 25% FYM + 25% Vermicompost), which was significantly superior to all other treatments. The next best treatment was T₇ (21.93 g) followed by T₆ (19.92 g). The treatments receiving sole application of FYM (T₃) and 50% NPK + 50% FYM (T₅) produced statistically comparable yields of 17.10 g and 17.48 g, respectively, whereas the lowest pod yield per plant (12.54 g) was recorded under the control treatment (T₁).

The highest pod yield per plot (1.73 kg) was obtained under T₈, followed by T₇ (1.32 kg) and T₆ (1.20 kg). The lowest pod yield (0.75 kg) was recorded under the control treatment. Intermediate yields were obtained with sole application of NPK, FYM and vermicompost, whereas integrated treatments consistently produced higher yields than their individual counterparts.

The highest pod yield (95.11 q ha⁻¹) was recorded under T₈ (50% NPK + 25% FYM + 25% Vermicompost), which was significantly superior to all other treatments. It was followed by T₇ (72.36 q ha⁻¹) and T₆ (65.73 q ha⁻¹). The control treatment produced the lowest pod yield (41.37 q ha⁻¹), whereas sole application of NPK, FYM and vermicompost recorded yields of 47.30, 56.43 and 51.87 q ha⁻¹, respectively.

The maximum TSS (18.62 °Brix) was recorded under T₈, followed by T₇ (17.95 °Brix) and T₆ (17.01 °Brix). The minimum TSS (14.14 °Brix) was observed in the control treatment. The differences among treatments were statistically significant (CD = 1.23 °Brix). The higher TSS observed under T₈ may be attributed to improved carbohydrate synthesis and efficient translocation of soluble sugars from source leaves to developing pods under balanced nutrient management.

These findings are in close agreement with those reported by Sharma *et al.* (2022) [15], Singh *et al.* (2022) [16] and Yadav *et al.* (2023) [19], who observed significant improvement in quality parameters under integrated nutrient management. Similar conclusions were drawn by Mahapatra *et al.* (2022) [9] and Sharma *et al.* (2023) [14], who reported that the combined use of organic and inorganic nutrient sources enhances sugar accumulation, nutritional quality and market acceptability of vegetable crops.

Table 1: Effect of Organic, Inorganic and Integrated Nutrient Management on Growth Garden Pea (*Pisum sativum* L.)

Treatment	Plant height (cm)			Leaf area (cm ²)			Days of first flowering	Days of 50% flowering	Pod length (cm)	Width of pod (cm)
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS				
T ₁	13.21	41.12	60.89	5.36	5.95	5.21	39.45	45.95	6.14	1.67
T ₂	14.52	45.21	62.17	5.98	5.67	5.78	39.30	45.10	6.15	1.97
T ₃	15.02	46.72	63.79	6.04	6.32	6.12	39.15	44.98	6.47	2.01
T ₄	15.94	47.99	64.39	6.37	6.47	6.54	39.04	44.56	6.95	2.71
T ₅	16.42	49.85	67.17	6.89	6.28	6.52	38.44	44.34	7.01	3.01
T ₆	17.83	50.42	68.42	7.14	6.96	7.04	38.85	43.29	7.62	3.51
T ₇	19.01	52.96	70.64	7.96	7.28	7.86	38.20	43.12	7.96	3.74
T ₈	20.47	54.25	72.14	8.12	8.04	7.99	37.95	42.00	8.35	3.98
SEm±	0.79	2.27	4.32	0.32	0.31	0.32	0.67	0.63	0.09	0.11
CD at 5%	2.39	6.89	7.21	0.95	0.94	0.95	N/S	N/S	0.27	0.33

Table 2: Effect of Organic, Inorganic and Integrated Nutrient Management Yield and Quality of Garden Pea (*Pisum sativum* L.)

Treatment	Days to first harvesting	Number of seeds per pod	Number of pods per plant	Pod yield per plant (gm)	Pod yield per plot (Kg)	pod yield in q/ha	TSS
T ₁	48.12	5.24	15.95	12.54	0.75	41.37	14.14
T ₂	48.37	5.92	16.14	14.33	0.86	47.30	14.96
T ₃	47.85	6.79	16.79	17.10	1.03	56.43	15.34
T ₄	47.01	6.15	17.04	15.72	0.94	51.87	16.85
T ₅	46.93	6.48	17.98	17.48	1.05	57.67	16.27
T ₆	45.24	7.24	18.34	19.92	1.20	65.73	17.01
T ₇	44.35	7.35	19.89	21.93	1.32	72.36	17.95
T ₈	43.04	8.97	21.42	28.82	1.73	95.11	18.62
SEm±	0.71	0.27	0.69	0.52	0.14	1.14	0.41
CD at 5%	0.24	0.81	1.18	1.16	0.41	3.42	1.23

Conclusion

The findings of the present investigation clearly demonstrate that the integrated use of organic and inorganic nutrient sources significantly improved the growth, yield and quality of garden pea compared with the individual application of chemical fertilizers or organic manures alone. Among the eight nutrient management treatments evaluated, T₈ (50% recommended NPK + 25% FYM + 25% vermicompost) consistently produced the best performance for almost all the observed parameters, including plant height, leaf area, pod length, pod width, number of seeds per pod, number of pods per plant, pod yield per plant, pod yield per plot, total pod yield and total soluble solids. The integrated nutrient management approach ensured balanced nutrient availability throughout the crop growth period, improved soil physical, chemical and biological properties, enhanced nutrient-use efficiency and promoted greater photosynthetic activity, ultimately resulting in higher productivity and superior pod quality.

Although the treatments had no statistically significant effect on days to first flowering and 50% flowering, integrated nutrient management promoted comparatively earlier flowering and harvesting than the control and sole nutrient applications. The combined use of farmyard manure and vermicompost with reduced levels of chemical fertilizers also contributed to improved soil fertility and offers a sustainable alternative for maintaining long-term crop productivity while reducing dependence on synthetic fertilizers.

Based on the results of the present study, it can be concluded that the application of 50% recommended NPK (30:40:35 kg ha⁻¹) + 25% FYM (5 t ha⁻¹) + 25% vermicompost (1.25 t ha⁻¹) is the most suitable nutrient management practice for obtaining higher growth, better yield attributes, maximum pod yield and improved quality of garden pea under the agro-climatic conditions of

Balaghat, Madhya Pradesh. Adoption of this integrated nutrient management strategy may enhance fertilizer-use efficiency, improve soil health and promote sustainable garden pea production.

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