Study of performance of integrated nutrient management on soil fertility in garden pea (*Pisum sativus* L.)

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DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12n.4519

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

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 962-964
Received: 08-09-2025
Accepted: 13-10-2025

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Abstract
A field experiment on integrated nutrient management on soil fertility of Garden pea (*Pisum sativus* L.) was carried out during *rabi season* 2022-2023 at MAPRS, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad. The experiment was laid out in a randomized block design with seven treatments in three replications. There are significant differences, which were observed among with treatments. The experiment revealed that the soil analysis (before & after harvest) Available Nitrogen (178.40 Kg/ha) after (178.32 Kg/ha), Available Phosphorus (12.93 Kg/ha) after (12.84 Kg/ha), Available Potassium (199.25 Kg/ha) after (197.90 Kg/h).

Keywords: Garden pea, Integrated Nutrient Management (INM), treatments, growth and soil analysis

Introduction
The garden pea, *Pisum sativum* L., belongs to the family Fabaceae with chromosome number 2n=2x=14. The garden pea is one of the most significant and versatile legume crops. The most significant off-season vegetable in the North Indian hills, it is grown as both a summer and an autumn crop, making green pods available from March onwards to the end of October, when they are not available in the lowlands. After Russia, India is the world's second-largest producer of peas.

It is an important pulse crop farmed in India. The USA, China, France, UK and other countries are important pea growers in addition to India. Uttar Pradesh, Bihar, Haryana, Punjab, Himachal Pradesh, Odisha, and Karnataka are the principal pea-growing states in India. Garden peas are grown over about 551 hectares and produce 5363 Mt in India (NHB, 2017-2018).

Pea is a nutritional vegetable crop; it has a significant amount of digestible carbohydrates, protein, lipids, minerals and vitamins. It also has a high level of antioxidant activity, it contains 2% fat, 60-65% carbohydrates, 25-28% protein, and other minerals. Lysine and tryptophan are two amino acids found in peas in large quantities, like cereal grains. The seeds are free of cholesterol, abundant in fibre and low in fat. It can be cultivated for hay, pasturage, green manure, and as a forage crop. Compared to soybeans, it has 5 to 20% fewer trypsin inhibitors. As a result, it can be fed to animals without undergoing the extrusion heating process. Pea plays a key role in promoting sustainable agriculture by maintaining soil fertility through biological nitrogen fixation in conjunction with symbiotic rhizobium present in its root nodules (Negi *et al*., 2004) [4].

The availability of nutrients is directly related to food production. The need for chemical fertilizers has increased as a result of the need to produce more and more food for the growing population. Despite the best use of high yielding varieties and higher volumes of chemical fertilizers, the rise of food production has slowed over the past three decades (Sharma *et al*., 2009) [7].

According to Pawar *et al*. (2017) [5], it is the second most valuable legume crop in the world. The dry, green foliage is fed to cattle, and the exceptionally nutrient dense green pods are preferred for food. According to Gopinath *et al*. (2017) [2], this legume has a high concentration of nutrients per 100 g of edible part, including digestible protein (7.2 g), carbohydrate (15.8 g), vitamin A (139 I.U.), vitamin C (9 mg), magnesium (34 mg) and phosphorus (139 mg).

Pea is the most significant source of vegetable protein, pea enriches the soil and as it is a leguminous crop, it may not require much nitrogen. However, during the early growth and nodulation stages of the young plants, when nitrogen deficiency may manifest and the plant may suffer from nitrogen starvation, a small amount of inorganic nitrogen may be used to stimulate these processes and increase the amount of nitrogen fixed in a plant Uikey *et al*., 2015) [8].

Garden pea has long been recognised as a restorer of soil fertility due to its unique ability of symbiotic nitrogen fixation (Rana *et al*., 1998) [6]. This ability has made the crop one of the most important and useful components of existing cropping systems in the present context of soil fertility degradation. Improving the yield of garden peas depends on proper nutrient management and the genetic makeup of the variety.

Materials and Methods

The experiment was carried out at Medicinal and Aromatic Plant Research Station (MAPRS), Rajendranagar, Hyderabad. Telangana during *rabi* season 2022-2023. The experimental site falls under a semiarid tropical climate with an average rainfall of 800 mm per annum, located at an altitude of 542.3 m above mean sea level at a latitude of 17019' and a longitude of 79°23′. The mean monthly meteorological data, *i.e*., rainfall, mean minimum and maximum temperature. The soil was red sand loam with a pH of 7.2 and an electrical conductivity of 0.363 dsm-1. the soil had good drainage facilities with low water holding capacity. The nutrient availability of nitrogen, phosphorus and potash per hectare is, respectively. Arkel variety was taken for this experiment. The soil of the experiment site was black sandy loam. The soil is prepared by ploughing and, at last, ploughing soil enriched with well-decomposed farm yard manure @ 25 tonnes per hectare. The seeds were mixed with sand and sown in a ridge and furrow system at a depth of 1.5 cm in rows as per the treatment. The field was irrigated immediately after sowing, taking utmost care so that the seeds were not disturbed by the flow of water. Farmyard manure was applied at 10 tons per hectare at the time of plot preparation and the recommended dose of NPK (25:40:50 kg ha -1) was applied in the form of Urea, Single super phosphate (SSP) and Muriate of potash (MOP). Nitrogen 50 kg ha^{-1} was applied in two splits, half of the nitrogen was applied at the time of sowing and the rest at one month after sowing. The full dose of Phosphorus (40 kg ha^{-1}) and Potassium (50 kg ha 1) were applied as basal. The crop was irrigated immediately after sowing to obtain better and uniform germination. Subsequently, the irrigations were given at seven-day intervals depending upon the moisture condition of the experimental plot to maintain uniform soil moisture throughout the crop growth period.

Soil analysis (before & after harvest)

1 Available nitrogen (kg/ha)

The results in Table 1 revealed that the values of Available nitrogen before and after harvest.

There is no significant difference observed between the treatments in available nitrogen uptake before and after harvest.

1.1 Available phosphorus (kg/ha) before harvest

The results in Table 4.4.2 revealed that the highest values of available phosphorus before harvest (12.93 kg/ha) was recorded in the treatment T_3 -75% RDF+ FYM (5t/ha) + Vermicompost (1.5 t/ha) + Azotobacter (5kg /ha) which was at par with T_1-75% RDF + FYM (10 t/ha)+ Azotobacter (5kg/ha) followed by T_2 - 75% RDF + Vermicompost (3t /ha) + Azotobacter (5kg/ ha)) which was at par with T_4 - 50% RDF +FYM (10t/ha) + Azotobacter (5kg/ha), T_5-50% RDF + Vermicompost(3t/ha) + Azotobacter (5kg/ha), T_6 - 50% RDF + FYM (5t/ha) Vermicompost (1.5t/ha) + Azotobacter (5kg/ha) Whereas, minimum Average Available phosphorus (kg/ha) before harvesting was observed in the treatment T_7 -100% RDF.

1.2 Available phosphorus (kg/ha) after harvest

The results in Table 4.4.2 revealed that the highest values of Available phosphorus after harvest (12.84kg/ha) was recorded in the treatment T_3 -75% RDF + FYM (5t/ha) + Vermicompost (1.5 t/ha) + Azotobacter (5kg/ha) which was at par with T_1 -75%RDF + FYM (10 t/ha) + Azotobacter (5kg/ha) followed by T_5 -50% RDF + Vermicompost (3t/ha) + Azotobacter (5kg/ha) T_2 -75% RDF + Vermicompost (3t/ha) + Azotobacter (5kg/ha), T_4 -50% RDF + FYM (10t/ha)+ Azotobacter (5kg/ha), T_6 -50% RDF + FYM (5t/ha) Vermicompost (1.5t/ha) + Azotobacter (5kg/ha) Whereas, minimum Average available phosphorus (kg/ha) after harvesting was observed in the treatment T_7 -100% RDF.

1.3 Available potassium (kg/ha) before harvest

The results in Table 4.4.3 revealed that the highest values of Available potassium before harvest (199.25 kg/ha) was recorded in the treatment T_3 -75% RDF + FYM (5t /ha)+ Vermicompost (1.5 t/ha) + Azotobacter (5kg /ha) which was at par with T_6-50%RDF+FYM (5t/ha) Vermicompost (1.5t/ha) + Azotobacter (5kg/ha) followed by T_2 - 75% RDF + Vermicompost (3t /ha) + Azotobacter (5kg/ ha). Whereas, minimum Average Available phosphorus (kg/ha) before harvesting was observed in the treatment T_7 100% RDF.

Available potassium (kg/ha) after harvest

The results in Table 4.4.3 revealed that the highest values of Available potassium after harvest (197.90 kg/ha) was recorded in the treatment T_3 -75% RDF + FYM (5t/ha) + Vermicompost (1.5 t/ha) + Azotobacter (5kg/ha) after harvesting was observed in the treatment T_7 100% RDF.

Following harvest, different integrated nutrient management treatments had an impact on the available nutrients, N, P2O5, and K2O (Table 1), in the soil. According to Bhardwaj *et al.* (2012) [1], higher values of NPK at harvest may be due to residual effects of applied nutrients, the benefits of Integrated Nutrient Management in helping crops extract different nutrients from the soil, and increased mineralization of FYM as a result of the synergistic effects of inoculating crop with bacteria that fix nitrogen and bacteria that fix phosphorus.

2. Economics

2.1 Benefit: Cost ratio

The economic benefits ultimately matter for growing the crops. The economics of garden pea (*Pisum sativum* L.) in terms of gross and net profit or return for different integrated nutrient management treatments involved in the present experiment were worked out and computed (Table 2). Among the various treatments tested, the treatments combination of 75% RDF+ FYM (5t /ha)+ Vermicompost (1.5 t/ha) + Azotobacter (5kg /ha) (T_3) was found superior in terms of net returns (₹ 356,020ha^{-1}) and benefit cost ratio (2.50) followed by T_2 -75% RDF + Vermicompost (3t /ha) + Azotobacter (5kg/ ha) found was of net returns (₹ 303,420 ha^{-1}) and benefit cost ratio (2.35) Whereas, minimum T_4- 50% RDF+FYM (10t/ha) + Azotobacter (5kg/ha) net returns (₹ 243,292 ha^{-1}) and benefit cost ratio (1.58).

Table 1: Effect of integrated nutrient management on available NPK Before and after (kg/ha) of garden pea under Southern Telangana conditions

Treatments	Available nitrogen (kg/ha) Before	Available nitrogen (kg/ha) After	Available phosphorus (kg/ha) Before	Available phosphorus (kg/ha) After	Available potassium (kg/ha) Before	Available potassium (kg/ha) After
T_1	176.18	173.99	11.73	11.32	175.35	11.32
T_2	174.40	172.54	11.13	10.88	190.20	187.33
T_3	178.40	178.32	12.93	12.84	199.25	197.90
T_4	172.62	171.54	10.49	10.16	176.58	175.05
T_5	173.35	172.24	10.99	11.02	182.74	180.77
T_6	174.67	173.29	10.79	10.34	194.98	193.26
T_7	169.40	168.09	8.73	8.68	172.37	170.21
S. Em ±	4.14	3.14	0.58	0.56	2.26	3.16
C.D (5%)	NS	NS	1.78	1.74	7.04	9.84

Table 2: B: C Ratio

Treatments	Net return (Rs.)	Total cost (Rs.)	B: C Ratio
T_1	303,020	458,000	1.95
T_2	303,420	432,400	2.35
T_3	356,020	498,000	2.50
T_4	243,292	397,200	1.58
T_5	317,132	445,040	2.47
T_6	267,652	408,560	1.89
T_7	235,524	341,200	2.22

Conclusion

It could be concluded from the present investigation that integrated nutrient management significantly influenced the soil fertility in garden pea (Arkel). Among the different levels of integrated nutrient management maximum soil fertility parameters of baby corn was obtained from soil analysis (before & after harvest) Available Nitrogen (178.40 Kg/ha) after (178.32 Kg/ha), Available Phosphorus (12.93 Kg/ha) after (12.84 Kg/ha), Available Potassium (199.25 Kg/ha) after (197.90 Kg/h).

Acknowledgement

The authors sincerely thanks to J. Srinivas, J. Cheena, B. Naveen Kumar and G. Sathis for their kind help in the research work. I am highly thankful to SKLTSHU, Mulugu, Siddipet, Telangana, for providing all the facilities to complete this endeavour.

Conflict of Interest: None.

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