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Effect of integrated nutrient management on growth, yield and uptake of N, P, K and Zn in pea (*Pisum sativum* L.)

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Abstract
A field experiment was carried out during the winter (Rabi) season of 2022-23, at the student's Research farm, AKS University, Sherganj, Satna (M.P.) to ascertain the effect of integrated nutrient management on growth, yield and uptake of N, P, K and Zn in pea (*Pisum sativum* L.).The experiment consisted of ten treatments i.e. T_1-Control, T_2-100% RDF (N20: P60: K40), T_3-75% RDF + FYM, T_4- 75% RDF + Vermicompost, T_5-75% RDF + Azotobacter, T_6-75% RDF + Azotobacter + PSB, T_7- 75% RDF + Vermicompost + Azotobacter, T_8- 50% RDF + FYM + Vermicompost, T_9- 50% RDF + Vermicompost + Azotobacter + PSB and T_{10}- 50% RDF + Vermicompost + PSB. The experiment was laid out in randomized block design with three replications. Growth parameters like plant height were noted highest with treatment, T_2- 100% RDF (N20: P60: K40) followed by T_7- 75% RDF + Vermicompost + Azotobacter. Yield attributing characters such as pod length, no. of pods/plant, no. of seeds/pod, fresh pod weight, green pod yield and test weight were found maximum in T_2-100% RDF (N20: P60: K40) followed by T_7- 75% RDF + Vermicompost + Azotobacter. Nutrient uptake in seed and straw was noted highest in T_2-100% RDF (N20: P60: K40) followed by T_7- 75% RDF + Vermicompost + Azotobacter. Highest seed yield (5733 kg/ha) was obtained from application of 100% RDF (N20: P60: K40) which was followed by T_7- 75% RDF + Vermicompost + Azotobacter which was 5233 kg/ha. Growth, yield and uptake of N, P, K and Zn were increased with increasing levels of NPK. Finally concluded that higher nutrient uptake (N, P, K and Zn) was observed when 75% RDF + Vermicompost + Azotobacter was integrated with the inorganic fertilizer compared to the inorganic fertilizer applied alone. The combination of FYM and biofertilizer with inorganic fertilizers improved soil fertility compared to applying inorganic fertilizers alone.

Keywords: Pea, INM, growth, yield and nutrients uptake

Introduction
Around the world, peas (*Pisum sativum* L.) are a significant vegetable crop. In India, it is mostly produced as a summer vegetable in the highlands and as a winter crop in the plains of North India. It is often used as a raw vegetable that is processed, dried, or canned. In India, 3.74 million tonnes of pea are produced over an area of 0.408 million hectares (Anonymous, 2012). In Madhya Pradesh, 52,500 tonnes of peas were produced overall in 2018–2019. According to Faregia *et al*. (2003) [4], the average yield of pea is 70–80 q (green pods) per hectare, with a shelling percentage of 30–35.

Peas are extremely nutrient-dense, with a high digestible protein, carbohydrate, and vitamin content as well as a high mineral content.

While its dried pea grain contains 19.7% protein, 56.6 percent carbohydrate, 2.1 percent mineral matter, and 4.4 percent iron in addition to being a rich source of vitamins A, B, and C, its fresh pod contains 7.2% protein, 19.8% carbohydrate, and 0.8 percent mineral matter (Choudhary, 1967) [3]. Group III is assigned to peas based on their efficiency in producing food.

One important strategy for sustaining high crop yields over time while also enhancing soil health and safeguarding the environment is integrated nutrient management. Biofertilizers might be a low-cost, cost-effective technique for farmers. Therefore, in order to achieve integrated nutrient management—which involves using fertilisers in addition to organic manures and fertilizers—it is necessary to enhance nutrient supply systems. Recent years have seen the depletion of soil resources of many elements essential to plant growth due to the prolonged use of high-grade chemical fertilisers devoid of micronutrients and neglect of organic recycling in the rain-fed agro-ecosystem.

A reduction in organic matter increases the number of nutritional shortages; a two-thirds drop in organic matter indicates a significant decrease in availability of nutrients.

Crop production and system sustainability may be increased by using organic manures, such as FYM, compost, and biofertilizers, which are less costly and more ecologically friendly than chemical fertilisers. Incorporating vermicompost with fertilisers not only supplies macronutrients but also satisfies micronutrient needs while preserving the physical and chemical properties of the soil.

Materials and Methods

The current study's field experiment was carried out in the Research Farm at AKS University Sherganj, Satna, Madhya Pradesh, during Rabi, season of 2022–2023. Geographically, Sherganj is located 322 metres above mean sea level, in latitude 24°58' N and longitude 80°83' E, approximately 2 kilometres from Satna district headquarters.

The climate of district Satna is semi-arid and sub tropical type with hot dry summer and cold dry winter. Nearly 80 percent of total rain fall is received during the monsoon (only up to September) with a few showers in the winter. The annual rainfall is around 950 mm. May and June are the hottest month where maximum temperature reaches 45 °C. January is the coldest month of year when average minimum falls to 6 °C.

The experimental plot's soil had a clay loamy texture, a pH of 7.96, an EC of 0.17 dS/m, and an organic carbon content of 0.69 percent. The soil has low levels of accessible phosphorus (10.92 kg/ha), low levels of available nitrogen (166.30 kg/ha), and medium levels of potassium (266.50 kg/ha).T_1-Control, T_2-100% RDF (N20: P60: K40), T_3-75% RDF + FYM, T_4-7_5% RDF + Vermicompost, T_5-75% RDF + Azotobacter, T_6-7_5% RDF + Azotobacter + PSB, T_7-75% RDF + Vermicompost + Azotobacter, T_8- 50% RDF + FYM + Vermicompost, T_9- 50% RDF + Vermicompost + Azotobacter + PSB, and T_{10}- 50% RDF + Vermicompost + PSB were the ten treatments carried out in the experiment. To create a beautiful tilth, the experimental field was first prepared by ploughing with a tractor-drawn plough, then harrowing and planking. At a depth of 3 cm, the pea (Azad P3) was seeded at a rate of 80 kg/ha. Full dosages of P and K were administered, and throughout the experiments, the remaining N was divided into two doses. Half of the N was delivered as a basal dose at the time of planting. A statistical analysis was performed on the growth, yield qualities, and yields data that were gathered.

Results and Discussion

The various INM levels have a considerable impact on the plant's height. Raising the fertiliser dosage to 100% RDF boosted the plant height significantly, as seen in table 1. The plants with treatment T_7 applied had the tallest stems. The improved nutrient availability through both chemical and organic sources during crop growth stages may be the cause of this increase in pea plant height. Chemical fertiliser supplied nutrients during the crop's early growth stages, while organic manures provided nutrients at later stages through a slow and steady release of nutrients sThese findings agree with those of Singh *et al*. (2004) [15], Kumari *et al*. (2018) [9], and Sephaya *et al*. (2012) [12]. He emphasised that crop absorption of NPK was much higher when NPK + FYM and VC + PGPR were applied than when fertiliser or vermicompost/FYM were applied alone. Further, they also emphasized that maximum growth and yield was recorded when NPK + FYM and VC + PGPR was applied. The number of pods/plant increased significantly with application of 100% RDF (N20: P60: K40) which was 8.67 followed by application of 75% RDF + Vermicompost @ 4t/ha + Azotobacter (10ml/kg seed).was applied which was (8.33).1000 seed weight (80.55 g) and green pod yield (50.23 qha-1) were recorded maximum in T_2 (100% RDF) followed by T_7 (75% RDF + Vermicompost @ 4 t/ha + Azotobacter (10 ml/kg seed) and minimum was observed in T_1 (Control) plot where none of the fertilizer was applied. The increased number of pea seeds per pod under this treatment may be the result of improved nutrient availability from both chemical and organic sources during all phases of crop growth. Due to the treatment's much greater plant height, dry matter accumulation, number of pods, test weight, and other growth and yield-attributing characteristics, the pea crop's ultimate yield was increased. Kumawat *et al*. (2015) [10], Kumar *et al*. (2014) [7], and Avhad *et al*. (2014)b [2] found that applying 100% of the recommended fertiliser dose plus 50% of the recommended nitrogen dose (via vermicompost) plus 5 kg of zinc per hectare resulted in significantly higher grain yield, stover yield, biological yield, and harvest index. These results are consistent with their findings.

Nutrient uptake differed significantly due to application of different treatment presented in (Table 2). The utilization of nitrogen, Phosphorus, potash and zinc by pea seed and Stover was significantly higher over the control. Maximum uptake of Nitrogen (kg/ha) by seed and straw was recorded when T_2 (100% RDF) followed by T_7 (75% RDF + Vermicompost @ 4t/ha + Azotobacter (10ml/kg seed). The increased availability of nitrogen in sufficient amounts, which was provided by chemical fertiliser during the crop's active growth stages and steadily supplied through organic manures during the development and reproductive stages of the crop, is what caused the higher nitrogen content and uptake in pea under these treatments. Maximum uptake of Phosphorus (kg/ha), Potassium (kg/ha) and Zinc (kg/ha) by straw and seed was recorded when when T_2 (100% RDF) followed by T_7 (75% RDF + Vermicompost @ 4 t/ha + Azotobacter (10 ml/kg seed) was applied. Application of higher recommended dose of chemical fertilizer in combination with organic manures and biofertilizers increased the uptake by seed and straw. Among all treatments the significantly higher uptake by seed and straw of pea were recorded with application of 75% RDF + Vermicompost @ 4 t/ha + Azotobacter (10 ml/kg seed which was statistically at par with application of 100% RDF. These outcomes agree with the research conducted by Singh *et al*. (2004) [15], Kumari *et al*. (2018) [9], and Sephaya *et al*. (2012) [12]. He emphasised that crop absorption of NPK was much higher when NPK + FYM and VC + PGPR were applied than when fertiliser or vermicompost/FYM were applied alone.

Table 1: Effect of Integrated nutrients management on growth parameters such as plant height (cm) and yield attributes such as no. of seeds per pod, no. of pods per plants etc.

Treatment	Plant Height (cm)		Number of Pods per Plant	Number of Seeds per Pod	Pod Length (cm)	Green Pod Yield (kg/ha)	Test Weight (g)
	30 DAS	60 DAS					
Control	16.99	40.91	16.33	4.33	6.00	1620	62.56
100% RDF (N_{20}: P_{60}: K_{40})	27.71	51.90	30.67	8.67	9.77	5733	81.63
75% RDF + FYM	24.69	48.94	27.33	8.00	8.71	5120	79.67
75% RDF + Vermicompost	23.62	48.99	28.33	8.33	8.80	5200	79.14
75% RDF + Azotobacter	24.14	45.56	25.33	7.00	7.98	4353	74.38
75% RDF + Azotobacter + PSB	24.70	44.81	26.67	7.67	8.03	4573	75.82
75% RDF + Vermicompost + Azotobacter	24.89	49.41	29.33	8.33	8.85	5233	80.55
50% RDF + FYM + Vermicompost	24.50	45.51	24.67	6.33	7.51	4660	69.07
50% RDF + Vermicompost + Azotobacter + PSB	23.29	44.85	23.67	6.67	7.44	3900	69.21
50% RDF + Vermicompost + PSB	22.67	43.63	22.67	6.00	7.34	3833	65.93
SE (m) ±	2.75	4.83	2.93	0.67	0.8	0.87	1.02
CD (P=0.05)	8.26	14.51	8.81	2.01	2.4	2.61	3.05

Table 2: Effect of Integrated nutrients management on nutrients uptake such as N, P, K and Zn.

Treatment	Nitrogen (Kg/ha)		Phosphorus (Kg/ha)		Potassium (Kg/ha)		Zinc (Kg/ha)	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Control	51.67	17.93	6.89	6.78	17.68	14.88	3.80	13.20
100% RDF (N20: P60: K40)	109.03	32.01	16.44	14.26	33.81	31.29	8.44	25.85
75% RDF + FYM	104.22	29.18	13.78	11.53	29.59	28.47	7.85	23.06
75% RDF + Vermicompost	106.29	28.99	14.23	12.12	30.33	28.95	7.55	23.35
75% RDF + Azotobacter	95.52	26.13	11.90	11.01	28.04	25.85	6.52	21.00
75% RDF + Azotobacter + PSB	97.37	26.78	13.01	11.10	26.20	24.60	7.29	20.83
75% RDF + Vermicompost + Azotobacter	107.11	29.46	15.82	13.48	31.41	29.92	7.97	24.29
50% RDF + FYM + Vermicompost	86.65	22.61	11.63	10.06	24.28	23.25	5.61	18.64
50% RDF + Vermicompost + Azotobacter + PSB	91.24	23.16	13.57	10.16	24.04	22.53	6.16	18.62
50% RDF + Vermicompost + PSB	81.81	22.03	11.46	9.13	21.87	20.28	5.67	17.15
SE (m) ±	2.82	2.70	0.45	1.38	0.99	0.50	0.36	0.75
CD (P=0.05)	8.44	8.12	1.36	4.14	2.96	1.49	1.08	2.25

Conclusion

Application of optimum levels of NPK (N20: P60: K40) recorded significantly higher growth and yield attributes over 75% NPK and 50% NPK respectively. Application of 100% NPK levels significantly increased pea seed yields over those obtained at 50 and 75% NPK levels. The maximum seed yields (57.33 q/ha) observed with 100%NPK. Adding Vermicompost containing 75% and 100% NPK increased the pea seed yield. Higher nutrient uptake (NPK and Zn) was observed when 75% RDF + Vermicompost @ 4t/ha + Azotobacter (10ml/kg seed was incorporated into the soil compared to the inorganic fertilizer applied alone. The combination of FYM and bio-fertilizer with inorganic fertilizers improved soil fertility compared to applying inorganic fertilizers alone.

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