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PERFORMANCE OF GARDEN PEA (*PISUM SATIVUM* VAR. HORTENSE L.) UNDER VARIED NUTRIENT MANAGEMENT OPTIONS INCLUDING NATURAL INPUTS IN COASTAL SALINE ZONE OF WEST BENGAL INDIA

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ABSTRACT

Field experiment was conducted during the winter seasons of 2022–23 and 2023–24 at long term organic farming filed at Ramakrishna Mission Vivekananda Educational and Research Institute, Narendrapur, comes under coastal saline zone of West Bengal to evaluate the effects of varied nutrient management strategies on the growth, yield, quality, and economic viability of garden pea. The study was undertaken in randomized complete block design (RCBD) with six treatments and four replications. The treatments consisted of inorganic, organic, natural nutrient inputs, their integration and full exclusion of nutrient sources.

Results revealed that better growth attributes such as plant height, biomass and root depth were observed better under integrated application of 50% organic and 50% inorganic inputs. Maximum seed yield was obtained from 100% inorganic fertilization (8.93 and 10.32 q/ha in year 1 and year 2, respectively), being statistically similar with fully organic and combination of organic, inorganic and natural inputs while maximum economic net return was accounted from the treatment received full organic nutrient source.

***Keywords* :** Vegetable pea, Organic farming, Natural inputs, Sustainable agriculture, Coastal agriculture.

Introduction

Garden pea (*Pisum sativum* var. *hortense* L.) is a nutritionally rich winter vegetable crop, globally regarded as the second most important food legume (Pawar *et al.*, 2017). It is widely consumed as fresh vegetables and also processed for freezing, canning, and dehydration (Mukhi *et al.*, 2019). Nutritionally, peas are a valuable source of proteins, carbohydrates, fiber, vitamins, and essential minerals such as calcium, phosphorus, and iron (Vishvkarma *et al.*, 2022). Moreover, peas contribute to sustainable agriculture through biological nitrogen fixation, enriching soil fertility.

India is the world's largest producer of garden peas, with an output of 5.68 million tonnes from 549,000 hectares in 2021–22 (Yumkhaibam *et al.*, 2023), while West Bengal lags behind of its productivity (~6 t/ha) significantly below the national average (~9.8 t/ha), largely due to subsistence cultivation and poor nutrient management (Yathish *et al.*, 2021).

Modern agriculture, while enhancing yields through high-input systems, has led to serious soil degradation, nutrient imbalances, and environmental pollution (Walia *et al.*, 2024). In this context, Integrated Nutrient Management (INM) has emerged as a sustainable alternative, combining organic and natural inputs along with judicious chemical fertilizer use. INM improves soil health, nutrient availability, and crop productivity while reducing reliance on synthetic inputs and mitigating environmental risks (Shah *et al.*, 2022). Organic and Natural plays a pivotal role in INM by enhancing soil physical, chemical, and biological properties (Ibrahim *et al.*, 2020), including nutrient mobilization and microbial activity. The inclusion of legumes such as garden pea further strengthens the system, improving soil fertility, suppressing pests, and supporting carbon sequestration (Shah *et al.*, 2022).

In West Bengal's coastal saline zone (CSZ) characterized by rainfed rice monoculture and prolonged fallow periods pulse-based cropping systems under organic and INM regimes offer a promising strategy for agricultural intensification, soil desalination, and income diversification (Brahmachari *et al.*, 2019). However, knowledge gaps persist regarding nutrient management and the potential of legumes in this niche agro-ecology. Addressing these gaps through location-specific, sustainable nutrient strategies is crucial for improving productivity and resilience in coastal farming systems.

Materials and Methods

The present study was conducted during winter seasons of 2022-23 and 2023-24 at the experimental field of Ramakrishna Mission Vivekananda Educational and Research Institute, Narendrapur, West Bengal, under humid subtropical condition of coastal saline zone. The experiment was laid out in randomized complete block design (RCBD) having six treatments with four replications. The treatment consisted of 100% Recommended dose of Fertilizer (RDF) by Organic input, 50% RDF by Organic + Natural inputs, 50% RDF by Organic + 50% RDF by Inorganic input, 25% RDF by Organic +25% RDF by Inorganic + Natural Input, 100% RDF by Inorganic input and no nutrient application (Control). Recommended Dose Fertilizer ($N:P_2O_5:K_2O$= 20:60:40 kg ha^{-1}) was supplied through vermicompost as a source of organic input and through Urea, SSP and MOP as inorganic sources. Seed treatment with Beejamrit @ 25 lit 100 kg^{-1} of seed along with soil application of Ghanjeevamrit @ 250 kg ha^{-1} and foliar application of Jeevamrit @ 500 lit ha^{-1} at 15 days interval upto 50 DAS were taken as natural inputs. The seeds were sown in line @100 kg ha^{-1} at 30 cm ×10 cm spacing.

Second rows in each plot, on either side were marked for recording biometrical observations and destructive sampling, and the middle four rows were assigned for determination of yield attributes and yield. For recording biometrical observations, five plants were selected randomly and tagged in each plot. Plant height was measured with a meter scale from ground level to top of the plant. For dry matter accumulation plants were uprooted, thoroughly washed, and finally oven dried (70 ℃) for 24 hrs. to obtain a constant dry weight. Leaf area was calculated by area-weight method and leaf area index was calculated by following formula (Watson, 1947):

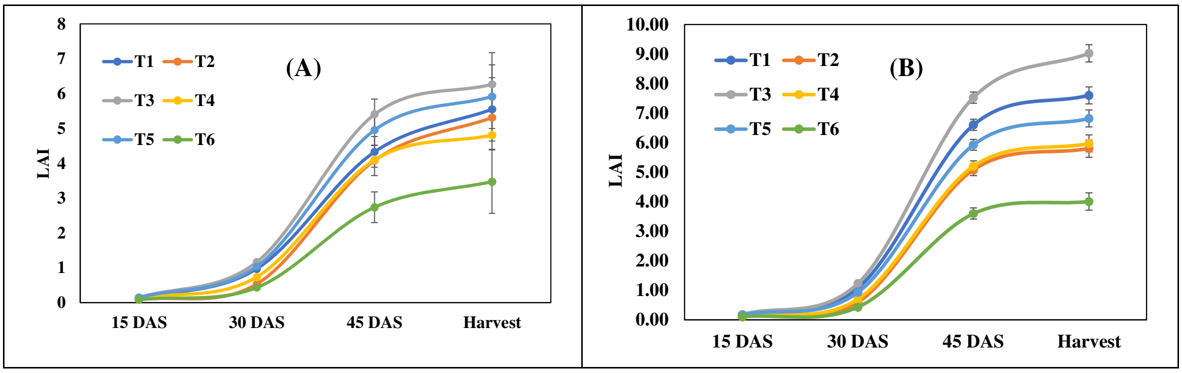
$$\text{LAI} = \frac{\text{Area of total number of leaves}}{\text{Ground area from where the samples were collected}}$$

After carefully uprooting, the roots were washed thoroughly and nodules were counted. Thereafter, the root depth (in cm) was measured from the base of the plant to tip of the longest root. The pod length was measured using a graph paper and length from base to tip of pod was considered. After measuring the length, the weight of those samples was measured through a weighing machine and mean value (g) was taken. Seed yield from the demarked net plot was recorded after de-shelled the green pod then converted into q ha^{-1}. After the harvesting of pods, remaining plants were collected and sun-dried. Finally, the dried plants were weighed to record the stover yield in kg plot-1 and then converted into t ha^{-1}. Plant samples were collected and then cleaned, oven-dried, chopped and ground separately, before measuring the N concentration following standard protocols (Garai *et al.*, 2021). Net return was calculated by subtracting the cost of cultivation from the gross returns. The gross return of the economic produce obtain from the crops was calculated based on market price of garden pea. The premium price was received from garden pea grown under fully organic condition. The collected data was analysed using R-software (R Core Team, 2023) for randomized complete block design (RCBD).

Results and Discussions

1. Growth Attributes

Plant growth indicators of garden pea *viz.* plant height, leaf area index (LAI), dry matter accumulation, root depth, nodule count was measured and the experimental data revealed that the highest plant height at harvest (64.9 cm and 63.0 cm during year 1 and year 2, respectively) was measured from fully inorganic fertilization, being statistically similar with integration of organic, inorganic and natural inputs (Table 1). LAI gradually increased and achieved its maximum value during the time of harvest with significant variation from the plant received nutrients by organic and inorganic inputs in equal dose and lowest value was obtained from full omission of nutrients (Figure 1). Similar treatment accounted maximum dry matter accumulation in plant. Li *et al.* (2012) also reported that organic fertilizers incorporation delays the senescence leaves, resulting better leaf area index, prolong the photosynthetic time of crops and accumulate the more biomass in different plants parts. Highest root depth was measured from 100% inorganic fertilization while maximum nodule number was counted from exclusive application of organic inputs for both studied years (Table 1). Chemical sources supply the plant nutrients in available form very rapidly, may be the reason of higher plant height and root depth (Al-Suhaibani *et al.,* 2020) while similar reason slowed the root nodulation in leguminous crops (Mondal *et al*., 2020). Keino *et al.* (2015) observed that slower nitrogen availability throughout the growth period resulted in higher active nodule count in pulses.



T_1: 100% RDF by Organic; T_2: 50% RDF by Organic +Natural inputs; T_3: 50% RDF by Organic +50% RDF by Inorganic; T_4: 25% RDF by Organic +25% RDF by Inorganic+Natural Input; T_5: 100% RDF by Inorganic; T_6: Control (-RDFNPK); Error bar represents the Least Significant Difference Value ($p \leq 0.05$).

Fig. 1: Effect of integrated nutrient management practices on leaf area index (LAI) of garden pea during winter season of 2022-23 (A) and 2023-24 (B).

Table 1: Effect of integrated nutrient management practices on plant growth attributes of garden pea at harvest during winter season of 2022-23 and 2023-24

Treatments	**Plant height (cm)**		**Dry matter accumulation (g plant^{-1})**		**Root depth (cm)**		**Nodule count (nos. plant^{-1})**	
	Year 1	**Year 2**	**Year 1**	**Year 2**	**Year 1**	**Year 2**	**Year 1**	**Year 2**
100% RDF by Organic	53.2b	51.4b	5.35c	5.98b	28.2b	32.8b	93.7a	110.7a
50% RDF by Organic +NI	51.1b	43.8c	4.71d	4.79d	22.4c	27.3c	83.7b	95.7ab
50% RDF by Organic +50% RDF by Inorganic	60.6a	58.6a	7.38a	6.47a	33.3a	37.1ab	85.2b	85.2bc
25% RDF by Organic+ 25% RDF by Inorganic +NI	61.2a	59.7a	5.82b	5.02d	27.9b	25.3c	91.5a	84.2bc
100% RDF by Inorganic	64.9a	63.0a	5.24c	5.46c	35.7a	39.4a	76.0c	75.2c
Control (No RDF and NI)	44.2c	36.6d	3.96e	4.36e	17.7c	22.1c	55.5d	49.5d
SEm±	**1.5**	**1.4**	**0.12**	**0.09**	**1.6**	**1.8**	**1.79**	**5.99**
CD (*$p \leq 0.05$*)	**4.4**	**4.4**	**0.35**	**0.26**	**4.9**	**5.4**	**5.40**	**18.06**

CD: Critical difference; RDF: Recommended Dose Fertilizer ($N:P_2O_5:K_2O$ = 20:60:40 kg ha^{-1}); NI: Natural inputs (Seed treatment with *Beejamrit* @ 25 lit 100 kg^{-1} of seed + Soil application of *Ghana Jeevamrit* @ 250 kg ha^{-1} + Foliar application of *Jeevamrit* @ 500 lit ha^{-1}); Numbers followed by different letters indicate significant difference at $p \leq 0.05$ (Otherwise statistically at per)

Table 2: Effect of integrated nutrient management practices on yield attributes, yield and economics of garden pea during winter season of 2022-23 and 2023-24

Treatments	Pod length (cm)		Pod weight (g)		Grain yield (q ha^{-1})		Stover yield (q ha^{-1})		Net Return (INR ha^{-1})	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
100% RDF by Organic	9.1ab	8.3b	6.84a	7.77a	7.72ab	8.62ab	0.92bc	1.00bc	91297	103172
50% RDF by Organic +NI	9.7a	8.8ab	6.47ab	7.35ab	6.51b	7.80b	0.68d	0.77d	61964	74964
50% RDF by Organic +50% RDF by Inorganic	10.2a	8.9ab	5.32bc	6.05bc	6.40b	7.75b	1.00b	1.06b	57672	63839
25% RDF by Organic+ 25% RDF by Inorganic+NI	9.7a	9.4ab	7.11a	8.08a	8.52a	10.31a	0.86c	0.98c	48151	60068
100% RDF by Inorganic	10.4a	9.9a	6.30ab	7.16ab	8.93a	10.32a	1.21a	1.27a	83547	89381
Control (No RDF and NI)	8.0b	6.8c	8.0b	6.8c	4.10c	5.17c	0.67d	0.71d	35390	39390
SEm±	**0.47**	**0.44**	**0.47**	**0.44**	**0.34**	**0.82**	**0.04**	**0.02**	**-**	**-**
CD (*p≤0.05*)	**1.42**	**1.31**	**1.42**	**1.31**	**1.06**	**2.42**	**0.12**	**0.08**	**-**	**-**

CD: Critical difference; RDF: Recommended Dose Fertilizer ($N:P_2O_5:K_2O$ = 20:60:40 kg ha^{-1}); NI: Natural inputs (Seed treatment with *Beejamrit* @ 25 lit 100 kg^{-1} of seed + Soil application of *Ghana Jeevamrit* @ 250 kg ha^{-1} + Foliar application of *Jeevamrit* @ 500 lit ha^{-1}); Numbers followed by different letters indicate significant difference at p≤0.05 (Otherwise statistically at per)

2. Productivity and profitability

Maximum pod length (10.4 cm and 9.9 cm during year 1 and year 2, respectively) was accounted from the plants treated with full inorganic fertilization in both the years of experimentation while pod weight was recorded higher from the application of 25% RDF by Organic+ 25% RDF by Inorganic inputs along with natural inputs, being statistically similar with application of 100% RDF by organic inputs (Table 2). Maximum grain yield (8.93 q ha^{-1} and 10.32 q ha^{-1} during year 1 and year 2, respectively) was recorded from the application of 100% RDF by Inorganic sources, being statistically similar with integration application of organic, inorganic and natural inputs and full supply of nutrients through organic source. Better growth attributes from fully inorganic and integrated application including natural inputs might be the reason for superior yield attributing traits and yield (Table 2). In terms of economic feasibility, the crop grown under fully organic condition accounted maximum net return, 100% inorganic fertilization. Organic fertilization and foliar application of natural inputs supply the several micronutrients, growth promoting hormones along with major nutrients that foster the photosynthesis rate, nutrient uptake and ultimately crop yield attributes and yield (Meena *et al.*, 2013; Pawar *et al.*, 2017). Several studied reported that organic and natural nutrient sources maintain a good balance of nutrient supply in soil-plant nexus (Chakraborty *et al.*, 2025), particularly during the critical yield-forming period due its slow nutrient release character and more nutrient retention potential (Li *et al.*, 2017; Chew *et al.*, 2019). Higher economic return was accounted from organically grown garden pea because the product received premium selling price over inorganic product.

3. Nutrient Uptake

Maximum grain N content was observed from plant received fully organic treatment (2.9% and 3.1% in year 1 and year 2, respectively), being statistically similar with application of RDF through inorganic inputs while maximum stover N content was obtained from the integration of organic and inorganic inputs having no statistical difference with full inorganic fertilization (Table 3). Organic inputs revitalize the soil microbiomes and mobilize the availability of soil nutrients towards the plants slowly but steady in nature (Mondal *et al.*, 2021).

Table 3: Effect of integrated nutrient management practices on plant nitrogen content and economics of garden pea during winter season of 2022-23 and 2023-24

Treatment	Grain N (%)		Stover N (%)	
	Year 1	Year 2	Year 1	Year 2
100% RDF by Organic	2.9a	3.1a	2.2b	2.5b
50% RDF by Organic + NI	2.4c	2.6c	1.9d	2.2d
50% RDF by Organic + 50% RDF by Inorganic	2.4c	2.7c	2.4a	2.8a
25% RDF by Organic + 25% RDF by Inorganic + NI	2.6bc	2.8bc	2.1c	2.4c
100% RDF by Inorganic	2.7ab	2.9ab	2.2a	2.6a
Control (No RDF and NI)	1.7d	1.8d	1.2e	1.4e
SEm±	0.06	0.07	0.02	0.02
CD (*p≤0.05*)	0.2	0.2	0.07	0.08

CD: Critical difference; RDF: Recommended Dose Fertilizer ($N:P_2O_5:K_2O$ = 20:60:40 kg ha^{-1}); NI: Natural inputs (Seed treatment with *Beejamrit* @ 25 lit 100 kg^{-1} of seed + Soil application of *Ghana Jeevamrit* @ 250 kg ha^{-1} + Foliar application of *Jeevamrit* @ 500 lit ha^{-1}); Numbers followed by different letters indicate significant difference at p≤0.05 (Otherwise statistically at per).

Conclusion

Summarizing all, it can be concluded that nutrient application through inorganic fertilizer exclusively may accounted better growth, yield attributing traits and yield but integrated nutrient management options and organic nutrient supply also performed better. In terms of economics, maximum profit was accounted from fully organic garden pea due to premium pricing. Therefore, continuous practice of organic cultivation or integrated nutrient strategy could be best option for productivity, profitability and sustainable farming in coastal agriculture.

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