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Effect of Liquid Biofertilizer with or Without Vermicompost on Growth and Yield of Field Pea (*Pisum sativum*) Grown under Laterite Soil of West Bengal

Suman Kumari [a], Mahua Banerjee [a], Ganesh Chandra Malik [a] and Sarath Kumar Duvvada [a*]

[a] Department of Agronomy, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal, 731236, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at agricultural farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal in *rabi* season of 2022-23 using the field pea cultivar IPFD 10-12. The experiment was laid out in a factorial randomized block design with two factors and ten treatment combinations. The first factor consists of vermicompost i.e., V_1: With

**Corresponding author: E-mail: sarathkumarduvvada010@gmail.com;*

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vermicompost, V_2: Without vermicompost and the second factor consists of INM i.e., N_1: Absolute Control, N_2: 100 % RDF, N_3: Liquid biofertilizer consortium, N_4: 75 % RDF+ Liquid biofertilizer consortium and N5:100 % RDF + Liquid biofertilizer consortium. The results showed that application of vermicompost 6 t/ha (V_1) recorded higher growth attributes like plant height, leaf area index and dry matter accumulation at 30, 60, 90 and at harvest, yield components like number of pods per plant (10.77), number of seeds per pod (4.22) and 1000 grain weight (125.41 g), seed (1535.91 kg/ha) and stover yield (1535.91 3487.63 kg/ha) while compared to no vermicompost application (V_2). Crop fertilized with 75% RDF + liquid biofertilizers (N_4) showed more growth attributes like plant height, leaf area index and dry matter accumulation at 30, 60, 90 and at harvest, yield components like number of pods per plant (12.19), number of seeds per pod (4.61) and 1000 grain weight (127.34 g), seed (1624.05 kg/ha) and stover yield (3550.82 kg/ha) which was at par with 100% RDF + liquid biofertilizers (N_5).

Keywords: Biofertilizer; field pea; INM and vermicompost.

1. INTRODUCTION

For farmers in both developed and developing nations, pulses constitute a significant crop in terms of revenue. Pulse crops are primarily produced and consumed in India. Pulses can be grown as mixed-grain legumes and are more cost-effective. They also include a higher protein content. In general, grain legume is also referred to as "poor man's food." Worldwide, field peas (*Pisum sativum*) are consumed by many people and are rich in protein, carbs, vitamins A and C, and the amino acids lysine and tryptophan. India is the second-biggest pea producer in the world [1]. Peas are grown on over 22.42 thousand hectares of land in India, yielding 15066 thousand tonnes at a productivity of 10.40MT per hectare. With a productivity of 6.72 MT per hectare, West Bengal produces 6130 thousand tonnes on 589.63 thousand hectares of land (Agricultural research data book, ICAR 2022).

There are two kinds of fertilizers: chemical fertilizers and biological fertilizers. By preserving soil fertility through biological nitrogen fixation in combination with the symbiotic Rhizobium found in its root nodules, its cultivation promotes sustainable agriculture [2]. The use of chemical fertilizers is required to produce large crop yields. Increased chemical use associated with intensive farming has tampered with the equilibrium between plant, soil, and microbial populations and contaminated groundwater [3,4]. Using earthworms, vermin castings, and vermin wash are produced via the bioconversion of organic waste into vermin [5]. Bio-fertilizers are carrier-based inoculants that contain cells of specific strains of effective microorganisms (bacteria) that are used by farmers to fix nitrogen from the atmosphere, solubilize phosphate from the soil, or stimulate plant growth to produce compounds that promote plant growth [6]. Utilizing biofertilizers from renewable energy sources as an affordable addition to chemical fertilizers can help minimize the substantial investment needed for fertilizer use [7]. Associative N_2-fixing bacteria were introduced into legume seed crops, changing and enhancing plant growth and productivity. The significant effects of biofertilizers may be attributed to different strain groups and nutrient-mobilizing microorganisms that facilitate metal availability and form in the decomposed material and increased quantities of minerals that may be extracted [8].

In order to support microbial development, liquid biofertilizer carriers have a suitable pH, a high water-holding capacity, and physical and chemical homogeneity [9]. Liquid biofertilizers typically consist of 35–65% carrier liquid (oil or water), 1-3 percent suspender component, 1-4 percent dispersion, and 10–40 percent microorganisms. Liquid biofertilizers should contain unique cell protectants that promote the development of cysts and dormant spores [10]. Along with their own nitrogen needs, peas release 50–60 kg/ha of residual nitrogen into the soil. According to [11], the balance between the plant and microbial populations of the soil has been upset by the heavy use of pesticides in intensive farming. Considering the importance of integrated nutrient management on field peas, the present study was conducted to find the performance of field pea (*Pisum sativum*) under the application of liquid biofertilizer with or without vermicompost to devise a suitable production technology for Laterite soil of West Bengal.

2. MATERIALS AND METHODS

During the *rabi* season, a field experiment was carried out in 2022-2023 at the agricultural farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal. The soil

was sandy loam in texture, acidic in soil pH (5.79), low in organic carbon 0.43% (Walkley and Black, 1934 and Muhr *et al.,* 1965), low in available nitrogen 145.50 kg/ha (Subbiah and Asijia, 1956), medium in available phosphorus 23.50 kg/ha (Bray and Kurtz, 1945) and medium in available potassium 220.1 kg/ha (Flame photometer Method, Muhr *et al.* 1965). There are two factors: 1st factor (Vermicompost) has two level; V_1: With Vermicompost and V_2: Without Vermicompost. 2nd Factor (INM) have five level; N_1: Absolute Control, N_2: 100 % RDF, N_3: Liquid biofertilizer consortium, N_4: 75 % RDF+ Liquid biofertilizer consortium, N_5: 100 % RDF + Liquid biofertilizer consortium and their 10 treatment combinations were laid out in Factorial RBD with three replications. Well, decomposed vermicompost @ 6t ha^{-1} followed by chemical fertilizers were applied in experimental plot as per treatment and incorporated into the soil thoroughly before sowing of the crop. Chemical fertilizers such as nitrogen, phosphorus (P_2O_5) and potassium (K_2O) were applied @ 20 Kg N/ha, 60 Kg P_2O_5 ha^{-1}, 40 Kg K_2O/hausing urea, single super phosphate (SSP) and muriate of potash (MOP), respectively as per treatment. Full quantity of nitrogen, phosphorus and potassium were applied as basal during sowing time. Seeds were treated with liquid consortia (liquid biofertilizers) @ 250ml per 60kg of seeds. The seeds were treated in the evening before the day of sowing. The field pea variety, IPFD 10-12, was sown with a seed rate of 70 kg/ha, on November 17, 2022 with uniform row to row spacing of 30 cm and plant to plant spacing of 10 cm at a soil depth of 2-3 cm. The experimental data recorded on various parameters were subjected to statistical analysis by the analysis of variance method (Gomez and Gomez, 1984). Fisher's 'F' test at probability level 0.05 tested the significance of different sources of variations. For the determination of critical difference at 5 % level of significance, Fisher and Yate's tables were consulted. The value of standard error of mean (Sem (±)) and the least significant difference (CD) to compare the differences between the treatment means have been provided in tables, the coefficient of variation (CV %) was also given in each table.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Observations on various growth attributes as plant height, leaf area index and dry matter accumulation recorded at 30DAS, 60 DAS, 90 DAS and at harvest were presented in Table 1.

With respect to vermicompost application, the significant difference was noticed in plant height and leaf area index by the application of vermicompost during different growth stages except 30 DAS. Higher plant height was recorded by application of 6t ha^{-1} vermicompost compared to no vermicompost application. Dry matter accumulation showed a significant difference was noticed in dry matter by the application of vermicompost during different growth stages except at 30 DAS and 60 DAS. By application of 6t ha^{-1} vermicompost recorded the highest dry matter compared to no vermicompost application. This might be due to better soil physical conditions, prolonged availability of major (NPK), and micronutrients to crop during the entire growing season. By providing assimilates to the root, organic manures play a significant role in root growth and development, which improves nodule formation and nitrogen fixation. Similar results were also obtained by [12] in cowpea and [13] in Chickpea.

With respect to nutrient application, the highest plant height was recorded when the crop was fertilized with 75% RDF + Liquid biofertilizer except at 30 DAS. During 30 DAS, plant fertilized with N_5 (100% RDF + Liquid biofertilizer) recorded maximum plant height which was at par with N_2 treatment (100% RDF). At 60DAS & harvest, N_4 (75% RDF + Liquid biofertilizer) is at par with N_5 (100% RDF+ Liquid biofertilizer) and N_2 treatment (100% RDF). At 90 DAS, N_4 treatment is at par with N_5 treatment (100% RDF+ Liquid biofertilizer). Significant difference was noticed during all different growth stages with respect to LAI. The highest LAI was recorded when the crop was fertilized with 75% RDF + Liquid biofertilizer. The lowest LAI was recorded during application of N_1 (control). The highest dry matter was recorded when the crop was fertilized with 75% RDF + Liquid biofertilizer which was at par with N_5 treatment (100% RDF + Liquid biofertilizer) and N_2 treatment (100% RDF) at 30, 60, 90 DAS and harvest. Leguminous plants have the unique ability to fix atmospheric nitrogen in the soil. The process of N-fixation cannot operate normally in absence of specific bacteria in soil. *Rhizobium leguminosarum* bacteria belonging to cross inoculation group are specific to this process in field pea. In order to ensure effective and efficient nodulation, it is

Table 1. Effect of liquid biofertilizer with or without vermicompost on growth parameters of field pea

Treatments	Plant height (cm)				Leaf area index			Dry matter accumulation (g/m^2)			
	30	60	90	Harvest	30	60	90	30	60	90	Harvest
Factor (A): Vermicompost Application											
V_1	13.95	28.40	48.31	51.01	0.25	1.14	1.04	50.97	162.63	425.47	467.82
V_2	13.71	26.24	42.96	45.77	0.21	1.02	0.92	49.75	158.87	400.78	436.56
SEm (±)	0.29	0.58	1.09	1.00	0.00	0.02	0.01	1.06	2.95	8.10	8.14
CD (*P* = .05)	NS	1.71	3.25	2.98	0.01	0.05	0.04	NS	NS	24.07	24.19
Factor (B): Nutrient Application											
N1	11.39	24.68	40.69	39.91	0.11	0.75	0.65	41.88	146.65	370.74	394.79
N2	15.12	27.85	46.54	49.66	0.22	1.00	0.90	55.38	166.37	426.90	464.90
N3	12.65	25.54	43.12	44.89	0.15	0.85	0.75	41.83	147.93	396.24	429.62
N4	14.23	29.92	50.46	55.16	0.38	1.55	1.45	56.72	173.70	444.68	502.95
N5	15.78	28.63	47.35	52.35	0.29	1.25	1.15	55.99	169.09	427.07	468.68
SEm (±)	0.46	0.91	1.73	1.58	0.01	0.02	0.02	1.67	4.66	12.81	12.87
CD (*P* = .05)	1.37	2.70	5.14	4.70	0.02	0.07	0.07	4.97	13.85	38.07	38.24
Interaction effects											
SEm (±)	0.65	1.28	2.44	2.24	0.008	0.04	0.03	2.36	6.59	18.12	18.20
CD (*P* = .05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	8.14	8.15	9.28	8.02	5.80	5.54	5.58	8.14	7.10	7.60	6.97

Where, V_1: With Vermicompost, V_2: Without Vermicompost, N_1: Absolute Control, N_2: 100 % RDF, N_3: Liquid biofertilizer consortium, N_4: 75 % RDF+ Liquid biofertilizer consortium and N_5: 100 % RDF + Liquid biofertilizer consortium

Table 2. Effect of Liquid Biofertilizer with or Without Vermicompost on yield and yield attributes of Field Pea

Treatments	No.of pods/ plant	No.of seeds/ pod	1000 grains weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index
Factor (A): Vermicompost Application						
V_1	10.77	4.22	125.41	1535.91	3487.63	0.30
V_2	10.10	4.15	120.18	1240.39	3156.97	0.28
SEm (±)	0.22	0.09	3.09	34.98	92.82	0.01
CD (*P* = .05)	0.65	NS	NS	103.92	275.73	0.02
Factor (B): Nutrient Application						
N1	9.07	3.50	113.96	1040.05	3041.88	0.25
N2	10.34	4.58	123.95	1444.55	3391.28	0.30
N3	9.56	3.63	119.57	1293.05	3106.84	0.29
N4	12.19	4.61	127.34	1624.05	3550.82	0.31
N5	11.02	4.60	129.17	1539.05	3520.68	0.30
SEm (±)	0.35	0.14	4.89	55.31	146.75	0.01
CD (*P* = .05)	1.03	0.41	NS	164.31	435.96	0.03
Interaction effects						
SEm (±)	0.49	0.19	6.92	78.22	207.54	0.01
CD (*P* = .05)	NS	NS	NS	NS	NS	NS
CV (%)	8.01	8.13	9.16	9.76	10.82	8.02

Where, V_1: With Vermicompost, V_2: Without Vermicompost, N_1: Absolute Control, N_2: 100 % RDF, N_3: Liquid biofertilizer consortium, N_4: 75 % RDF+ Liquid biofertilizer consortium and N_5: 100 % RDF + Liquid biofertilizer consortium

necessary that a large number of these bacteria be maintained in the soil. Nitrogen fixers help the plant by giving it atmospheric nitrogen, which helps it grow more successfully. *Rhizobium* inoculation increased plant height, dry matter accumulation, and LAI. These results are in close agreements with [14,15,16,17].

3.2 Yield Attributes

Observations on various yield attributes and yield were recorded, analyzed and presented in Table 2. No significant difference was noticed in number of pods per plant, number of seeds per pod and 1000 grain weight by the application of vermicompost. By application of 6t ha^{-1} vermicompost higher number of pods per plant was recorded compared to no vermicompost application. The positive impact of vermicompost on yield attributes may be attributable to the increased availability of macro- and micronutrients during the entire growing season, which increased food absorption and led to its subsequent partitioning in the sink. The availability and optimum supply of nutrients of plants favorably influenced the flowering and seed formation, which ultimately increased the pods per plant, seeds per pod and test weight. Similar results were also reported by [12] in cowpea and [13] in Chickpea.

With different nutrient application practices, significant difference was noticed in number of pods per plant and number of seeds per pod. The highest and lowest number of pods per plant was recorded when the crop fertilized with 75% RDF + Liquid biofertilizer and control, respectively. The highest number of seeds per pod was recorded when the crop was fertilized with 75% RDF + Liquid biofertilizer. For number of seeds per pod, N_4 (75% RDF + Liquid biofertilizer) is at par with N_5 (100% RDF + Liquid biofertilizer) and N_2 (100% RDF). Seed inoculation with Rhizobium + PSB along with RDF enhanced the yield attributes due to balanced availability of N and P. These results are in line with the findings of [18].

3.3 Yield

Significant difference was noticed in seed and stover yield and harvest index by the application of vermicompost. By application of 6t/ha vermicompost recorded the highest seed and stover yield and harvest index compare to no vermicompost application. A greater number of sites for the transfer of photosynthates were made available by enhanced vegetative development, which in turn led to an increase in the number of yields [19].

The highest seed yield was recorded when the crop fertilized with 75% RDF + Liquid biofertilizer. For seed yield N_4 (75% RDF+ Liquid biofertilizer) is at par with N_5 (100% RDF+ Liquid biofertilizer). Whereas the highest stover yield was recorded when the crop was fertilized with 75% RDF + Liquid biofertilizer which was statistically at par with N_5 (100% RDF+ Liquid biofertilizer) and N_2 (100% RDF). The highest harvest index was recorded when the crop fertilized with 75% RDF + Liquid biofertilizer which was at par with N_5 (100% RDF+ Liquid biofertilizer), N_3 (Liquid biofertilizer) and N_2 (100% RDF). It is clear that *Rhizobium* inoculation encouraged N-fixation and increased dry matter and plant production. The increased dry matter accumulation and N content together resulted in greater uptake of N which resulted in higher yield.

4. CONCLUSION

On the basis of results summarized above, it can be concluded that application of vermicompost (6 t/ha) + 75% RDF + liquid biofertilizers resulted in higher growth and productivity for field pea grown under laterite soil of West Bengal.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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