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Influence of different levels of compost sources on growth, productivity and profitability of French bean

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Abstract
Nutrient management in French bean has been a major concern under organic farming systems. Therefore, to determine the most effective compost sources for organic French bean cultivation, promoting sustainable agriculture, enhancing crop yield, and ensuring economic viability for farmers while reducing the environmental impact of farming, the present investigation was carried out in *rabi* season of 2020-2021 at certified organic field of College of Agriculture, Pune with ten treatment combinations including various levels of FYM, mushroom compost and vermicompost and replicated thrice. Assessment of various growth parameters, yield attributes and economics was carried out. The results showed that the treatment of 125% RDN through vermicompost resulted in longer vegetative stages, higher nodulation and dry matter of plant. It also resulted in higher yield attributes and seed yield (14.93 q ha^{-1}) as compared to all other treatments. The application of 125% RDN through vermicompost gave the maximum gross monetary returns (Rs 149591 ha^{-1}) and net returns (Rs 75431 ha^{-1}) than all other compost sources but maximum B:C ratio (2.30) was obtained in 100% RDN through mushroom compost. Thus, the farmers can adopt the application of 125% RDN through vermicompost to get the maximum net returns under organic French bean cultivation.

Keywords: FYM, net returns, nodulation, organic French bean, RDN

Introduction

Agriculture stands at a crossroads in the 21st century, facing the challenge of meeting the world's growing demand for food while addressing pressing environmental and economic concerns (Verma *et al*., 2023) [26-27-28]. The conventional methods of farming, characterized by the heavy use of synthetic inputs, have long been the cornerstone of global agricultural production (Jha *et al*., 2023; Tomar *et al*., 2023) [8, 24-25]. However, these practices have come under scrutiny due to their adverse effects on soil health, water quality, and overall ecosystem sustainability (Ferreira *et al.,* 2021) [4]. In response to these concerns, organic farming has emerged as a promising alternative, characterized by a commitment to environmental stewardship, biodiversity, and a reduced reliance on chemical inputs (Tal, 2018) [22]. Within the realm of organic agriculture, the cultivation of French beans (*Phaseolus vulgaris*) has gained attention for its potential to offer a sustainable and profitable crop choice (Karavidas *et al.*, 2022) [10]. It is newly introduced as non-traditional winter pulse crop in India with high yield potential of 2.5–3.5 t/ha (Kumar *et al.,* 2020) [12]. This crop is gaining importance in country for its dual uses both for green pods and dried grain (Yadav *et al.*, 2023; Jha *et al.,* 2023) [32, 8]. French beans are a versatile and nutritious food source, making them an attractive option for consumers and an economically valuable crop for farmers. In India Beans are cultivated on about 227.78 ha area with a production of 2276.95 MT ha^{-1} (Sulochna *et al.,* 2022) [20]. Inadequate nutrition management has been identified as the primary cause of the reduced yield of french beans. Poor nodulation makes biological nitrogen fixation extremely inefficient, necessitating greater nitrogen fertiliser doses for increased output (Koskay *et al.,* 2018) [11]. Chemical fertilisers are used extensively in modern agriculture; however, the cost of inorganic fertilisers has climbed significantly, driving increasing production costs and significantly lowering soil fertility (Porwal and Verma, 2023; Verma *et al.*, 2023) [16, 26-27-28]. It is now essential to reduce the usage of artificial fertilisers by adding organic sources like FYM, compost, vermicompost, mushroom compost, etc. in order to preserve the healthy and sustainable agro-ecosystem (Swati *et al.,* 2023) [21]. FYM is rich in organic matter and provides a balanced mix of essential nutrients, including nitrogen (N), phosphorus (P), and potassium (K) (Bhatt *et al.*, 2020) [3].

It also contains micronutrients and beneficial microorganisms that promote soil health (Shukla *et al.,* 2023) [31]. The unique humic substances and growth hormones in vermicompost stimulate French bean growth, leading to increased yields. It also enhances disease resistance and nutrient absorption, reducing the need for chemical inputs (Ahmad *et al.,* 2021; Jha *et al*., 2014) [1, 7]. Mushroom compost is a valuable source of organic matter and contains a range of nutrients, including nitrogen, phosphorus, and potassium, though nutrient levels can vary based on the mushroom cultivation process. Mushroom compost is a fantastic soil conditioner, improving texture and moisture retention. It's known for its ability to balance soil pH, making it suitable for a wide range of crops, including French beans (Gumus and Seker, 2017; Tomar *et al.,* 2023) [5, 24-25]. In addition to providing organic matter, organic sources improve the soil's fertility. (Verma *et al*., 2023) [26-27-28]. Composts are a rich source of organic matter which offers several benefits to soil health, including improved nutrient availability, increased water retention, and enhanced microbial activity (Pahade *et al*., 2023; Verma *et al.,* 2023) [13, 26-27-28]. These improvements can potentially boost the growth, nodulation, and yield of French beans.

While the potential benefits of compost in organic farming are well-documented, there remains a notable gap in the literature concerning the specific effects of different levels of compost sources on French bean cultivation. Furthermore, the economic implications of compost application in French bean farming have not been extensively explored. Keeping the views of above aspects, the present research work was performed to find out the response of french bean (*Phaseolus vulgaris* L.) to different sources of organic nutrients like FYM, vermicompost, mushroom compost with the objective to study the effect of organic on growth, productivity and profitability of French bean.

Materials and Methods

A field experiment was carried out during *rabi* season of 2020-21 at Agronomy Farm (certified organic field) in College of Agriculture, Pune (18°22' North latitude and 73°51' East longitudes, 557.7 m above MSL). The soil was clay loam with pH 7.78, with electrical conductivity of 0.45 dS/m, medium organic carbon (0.56%), low available nitrogen (176 kg/ha), available phosphorus (18 kg/ha) and high levels of potassium (382 kg/ha). The investigation was laid out in Randomized Block Design with three replications. There were ten treatment combinations which included different sources of organic nutrients, T_1 (75% RDN through FYM), T_2 (100% RDN through FYM), T_3 (125% RDN through FYM), T_4 (75% RDN through Mushroom compost), T_5 (100% RDN through Mushroom compost), T_6 (125% RDN through Mushroom compost), T_7 (75% RDN through Vermicompost), T_8 (100% RDN through Vermicompost), T_9 (125% RDN through Vermicompost), T_{10} (Control). French bean variety *Phule rajma* (GRB-902) was sown on 20 November 2020 at the seed rate of 90 Kg/ha after treatment with *Rhizobium* and *PSB* culture @ 250g 10 $kg^{-1}$of seed at the spacing of 45 cm x 10 cm. Crop management practices were carried out according to the recommended procedures. The nutrients were applied as per the treatments. Observations related to phenology, number of nodules, fresh weight of nodules, dry matter per plant and different yield attributes, yield and economics and plant nutrient content were recorded at specific stages of crop growth. The statistical analysis of data on various growth and yield characters studied in the investigation was carried out through the analysis of variance technique as described by Panse and Sukhatme (1954) [14]. The critical difference (C.D.) at 5 percent level of significance was given for those treatments which were found significant.

Results and Discussion

Phenology

Days to 50% flowering of french bean was found non-significant by application of various levels of compost sources (Table 1). However, the more number of days (35.65 days) required to 50% flowering were observed in 125% RDN through vermicompost and minimum (34.22 days) in control. Similarly, days to maturity of french bean were also found non-significant due to application of various levels of compost sources. More number of days 78.33 days required for maturity by the treatment of application of 125% RDN through vermicompost, while lowest number of days 75.67 days to maturity were required in control. The results indicated that the higher nutrient availability in case of vermicompost enhanced the vegetative growth and elongated vegetative stage which delayed flowering and maturity. Similar result were also found by Ishtiyaq and Khan (2013) [6].

Number of nodules plant^{-1}

The root nodule plant^{-1} at 50% flowering of french bean were not affected significantly due to different treatments under study (Table 1). The mean maximum number of root nodules (31.84) plant^{-1} were obtained at flowering of the french bean. The treatment of application of 125% RDN through vermicompost recorded maximum number of root nodules (36.33) plant^{-1} at flowering of french bean than other treatments. However, the minimum number of root nodules plant^{-1} were obtained in control treatment (26.78) at all growth stages of crop. The maximum number of root nodule plant^{-1} were obtained with application of 125% RDN through vermicompost treatment might be due to easy and early mineralization of vermicompost and steady availability of nutrients for nodule formation. Similar results were also obtained by Parween *et al*., (2019) [15].

Fresh weight of root nodules plant^{-1} (g)

The fresh weight of root nodules plant^{-1} at 50% flowering of french bean were not affected significantly due to different treatments under study (Table 1). The significantly higher fresh weight of nodule was recorded (0.36 g) in 125% RDN through vermicompost, However, control treatment recorded lower fresh weight of root nodule plant^{-1} at 50% flowering. These results are in accordance with the findings of Sharma *et al.,* (2018) [18].

Dry matter plant^{-1}

The mean dry matter plant^{-1} of french bean was significantly influenced due to application of different treatments at all the growth stages of crop (Table 1). The total dry matter accumulation plant^{-1} was increased continuously at all the stages of crop growth up to maturity (Figure 1.). The dry matter plant^{-1} of french bean was found non-significant at 28 days after sowing. The application 125% RDN through vermicompost (T_9) produced highest dry matter plant^{-1} (24.01 g) at harvest which was significantly superior over the rest of the treatments, whereas it was found at par with treatments T_3,

T_6 at 42 DAS and with T_3, T_6 and T_8 at 56 DAS and at harvest. The more nutrient absorption due to higher availability and progressive increase in growth parameters under the treatment 125% RDN through vermicompost might have increased the dry matter plant^{-1}. These results are in accordance with the findings of Saini *et al*., (2023) [17].

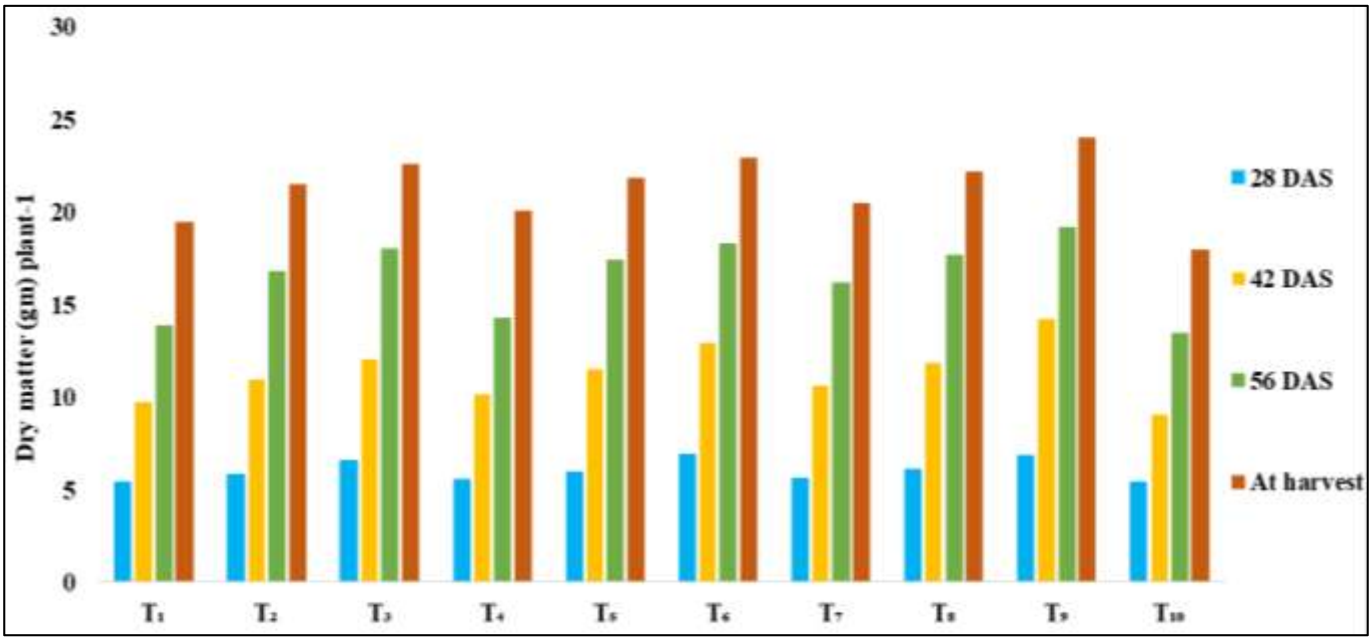

Fig 1: Effect of different compost sources on dry matter/plant of French bean

Table 1: Effect of different levels of compost sources on growth parameters of organic French bean

Tr. No.	Treatments	Days to 50% flowering	Days to maturity	At 50% flowering		Dry matter plant^{-1} (g)			
				No. of root nodules plant-1	Fresh weight of root nodules plant-1 (g)	Days after sowing 28 DAS	42 DAS	56 DAS	At harvest
T_1	75% RDN through FYM	34.32	76.00	29.00	0.30	5.41	9.77	13.87	19.44
T_2	100% RDN through FYM	34.55	76.67	31.65	0.34	5.84	10.94	16.78	21.51
T_3	125% RDN through FYM	35.00	77.67	32.65	0.35	6.54	12.05	18.04	22.55
T_4	75% RDN through Mushroom compost	34.33	76.00	30.00	0.31	5.53	10.16	14.26	20.06
T_5	100% RDN through Mushroom compost	34.66	77.00	34.00	0.34	5.96	11.51	17.42	21.83
T_6	125% RDN through Mushroom compost	35.32	78.00	34.66	0.36	6.92	12.96	18.31	22.90
T_7	75% RDN through Vermicompost	34.50	76.34	31.00	0.33	5.60	10.62	16.15	20.48
T_8	100% RDN through Vermicompost	34.78	77.33	32.33	0.35	6.11	11.86	17.70	22.19
T_9	125% RDN through Vermicompost	35.65	78.33	36.33	0.36	6.83	14.21	19.15	24.01
T_{10}	Control	34.22	75.67	26.78	0.28	5.39	9.03	13.43	17.95
S.Em. ±		0.94	0.87	2.06	0.02	0.39	0.73	0.56	0.67
C.D. at 5%		NS	NS	NS	NS	NS	2.18	1.68	1.99
General Mean		34.73	76.90	31.84	0.33	6.01	11.31	16.51	21.29

Yield attributes

Dry weight of pods plant^{-1}

The dry weight of pods plant^{-1} was significantly influenced by different treatments and more dry weight of pods plant^{-1} 8.06 g was obtained with 125% RDN through Vermicompost than all other treatments but it was found at par with 125% RDN through FYM (7.48), 125% RDN through mushroom compost (7.59 g), and 100% RDN through vermicompost (7.16).

Seed yield plant^{-1} (g)

The highest seed yield per plant (7.28 g) was obtained with application of 125% RDN through vermicompost than all other treatments (Table 2) but it was found at par with 125% RDN through FYM (6.69 g), 125% RDN through mushroom compost (6.86 g), and 100% RDN through vermicompost (6.35 g) and lowest Seed yield plant^{-1} was obtained in control plot (3.65 g). These results are on same line with work done by Barchhiya and Kushwaha (2017) [2].

Straw yield plant^{-1}

The significantly maximum straw yield 14.54 g was obtained with the application of 125% RDN through Vermicompost than all other treatments but it was found at par with 125% RDN through FYM (13.51 g), 125% RDN through mushroom compost (13.82 g) and 100% RDN through vermicompost (12.82 g) and the lowest straw yield was obtained from control plot (9.11 g.) (Table 2).

Test weight (g)

Application of 125% RDN through Vermicompost gave significantly maximum test weight (30.59 g) than all other treatments but it was found at par with 125% RDN through FYM (27.88g), 125% RDN through mushroom compost (29.50g) and 100% RDN through vermicompost (27.26g) (Table 2). The higher test weight was obtained in 125% RDN through Vermicompost (T_9) treatment might be due to enhancement of the growth and yield contributing parameters resulted to more weight of seeds. These results corroborate the findings of Kadam and Pathade (2016) [9].

Seed yield

The seed (14.93 q ha^{-1}) yield was found significantly more under the treatment of application of 125% RDN through Vermicompost than all other treatments while the lowest seed yield was obtained in control (Table 2). The application of vermicompost promotes plant growth and soil health which could have led to an increase in yield attributes and ultimately resulted in higher yields. These findings are in confirmation with Singh *et al.,* (2023) [19].

Table 2: Effect of different levels of compost sources on yield attributes of organic French bean

Tr. No.	Treatments	Dry weight of pods $plant^{-1}$ (g)	Seed yield $plant^{-1}$	Straw yield $plant^{-1}$	Test weight (g)	Seed yield (q ha^{-1})
T_1	75% RDN through FYM	5.67	4.85	9.89	23.49	9.94
T_2	100% RDN through FYM	6.60	5.69	11.55	25.24	11.95
T_3	125% RDN through FYM	7.48	6.69	13.51	27.88	12.97
T_4	75% RDN through Mushroom compost	5.89	5.04	10.29	24.93	10.60
T_5	100% RDN through Mushroom compost	6.70	5.81	11.77	26.94	12.63
T_6	125% RDN through Mushroom compost	7.59	6.86	13.82	29.50	13.21
T_7	75% RDN through Vermicompost	6.25	5.48	11.14	25.16	11.60
T_8	100% RDN through Vermicompost	7.16	6.35	12.82	27.26	12.79
T_9	125% RDN through Vermicompost	8.06	7.28	14.54	30.59	14.93
T_{10}	Control	5.44	3.65	9.11	20.83	5.89
S.Em. ±		0.43	0.37	0.77	1.14	0.74
C.D. at 5%		1.29	1.12	2.30	3.40	2.21
General Mean		6.68	5.77	11.84	26.18	11.65

Economics

The cost of cultivation (₹. 74160 ha^{-1}) required was maximum with the treatment of 125% RDN through vermicompost followed by the of application of 100% RDN through vermicompost. The lowest cost of cultivation (₹ 35960 ha^{-1}) was incurred with control. The compost sources as vermicompost and FYM recorded higher cost of cultivation due to their higher cost and higher dose of application, respectively compared to Mushroom compost. Similarly, the maximum gross monetary returns (₹.149591 ha^{-1}) and net monetary (₹.75431) were obtained with the application of 125% RDN through vermicompost than all other treatments whereas, minimum were obtained in control treatment. However, due to lower cost of mushroom compost 100% RDN through mushroom compost recorded significantly higher B: C ratio (2.30) than the other compost source treatments. Similar findings have been reported by Tasung *et al*., (2023) [23].

Table 3: Effect of different levels of compost sources on economics (Rs ha^{-1}) of organic French bean.

Tr. No.	Treatments	Gross monetary returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C ratio
T_1	75% RDN through FYM	99595	53535	46060	1.86
T_2	100% RDN through FYM	119733	59160	60573	2.02
T_3	125% RDN through FYM	129956	64785	65171	2.01
T_4	75% RDN through Mushroom compost	106200	50506	55694	2.10
T_5	100% RDN through Mushroom compost	126546	55122	71425	2.30
T_6	125% RDN through Mushroom compost	132360	59737	72623	2.22
T_7	75% RDN through Vermicompost	116226	59160	57066	1.96
T_8	100% RDN through Vermicompost	138172	66660	71512	2.07
T_9	125% RDN through Vermicompost	149591	74160	75431	2.02
T_{10}	Control	59019	35960	23059	1.64

Conclusion

From the present investigation, it can be concluded that the application of 125% recommended dose of nitrogen is an effective approach for nutrient management in organic French beans as it increases the yield. However, maximum Benefit: Cost ratio was obtained by applying 100% RDN through mushroom compost.

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