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Long-Term Effect of Different Organic Nutrient Management Practices on Growth, Yield of Field Bean (*Dolichos lablab* L.) and Soil Properties

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A B S T R A C T

A field experiment was conducted during *Kharif* season of five consecutive years from 2013 to 2017, to study the effect of organic nutrient management practices on growth and yield of Field bean (*Dolichos lablab* L.) in sandy loam soils of Zonal Agricultural and Horticultural Research Station, Navile, Shivamogga, Karnataka. Among the different nutrient management treatments, application of recommended dose of FYM (7.5 t ha^{-1}) along with 100 percent N equivalent vermi-compost (2 t ha^{-1}) has recorded significantly higher Dry pod yield (13.2 q ha^{-1}) and seed yield (9.32 q/ha) as compared to rest of the treatments. Similarly higher pods per plant (23.1 pods/ plant) yield per plant (15.9 g/plant) also recorded with the same treatment and it was closely followed by the treatment which received recommended dose of FYM (7.5 t ha^{-1}) along with application of 100 percent N equivalent FYM (5 t ha^{-1}). Maximum soil microbial population at different growth stages were also observed in the treatment which received recommended dose of FYM along with 100 percent N equivalent vermi-compost. The same treatment recorded built up in available nutrient status as compared to initial levels. Hence, application of 2 ton vermi-compost along with 7.5 ton FYM is optimum for obtaining highest yield of field bean under organic farming condition.

Keywords

Vermi-compost, FYM, N equivalent, Microbial population

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Introduction

Field bean usually known as *Dolichos* bean, Hyacinth bean or Field bean is one of the most ancient crops among cultivated plants. It is a bushy, semi-erect, perennial herb, showing no tendency to climb. It is mainly cultivated either as a pure crop or mixed with finger millet, groundnut, castor, corn, bajra or sorghum in Asia and Africa. It is a multipurpose crop grown for pulse, vegetable and forage. The crop is grown for its green pods, while dry seeds are used in various vegetable food preparations. It is also grown in home gardens as annual crop or on fences as perennial crop. It is one of the major sources of protein in the diets in southern states of India. Within India, *Lablab* is a field crop mostly confined to the peninsular region and cultivated to a large extent in Karnataka and adjoining districts of Tamil Nadu, Andhra Pradesh and Maharashtra. Karnataka contributes a major share, accounting for nearly 90 per cent in terms of both area and production in the country. Karnataka state records production of about 18,000 tonnes from an area of 85,000 hectares. Outside India, the crop is cultivated in East Africa, with similar uses, and in Australia as a fodder crop.

Lablab is remarkably adaptable to wide areas under diverse climatic conditions such as arid, semi-arid, sub-tropical and humid regions where temperatures vary between 22°C–35°C, low lands and uplands and many types of soils and the pH varying from 4.4 to 7.8. Being a legume, it can fix atmospheric nitrogen to the extent of 170 kg/ha besides leaving enough crop residues to enrich the soils with organic matter. It is a drought tolerant crop and grows well in dry lands with limited rainfall. The crop prefers relatively cool seasons (temperature ranging from 14-28^{0}C) with the sowing done in July-August. It starts flowering in short days (11-11.5 hour's day length) and continues indeterminately in spring. Hyacinth bean flowers throughout the growing season. Hence, there is a scope to develop the organic nutrient management practices for field bean under rain fed condition. Continuous use of only chemical fertilizers in intensive cropping system is leads to imbalance of nutrients in soil, which has an adverse effect on soil health and also on sustainable crop yields. Hence, In order to achieve the sustainability in crop production development of Organic package of practices for major crops in general and field bean in particular is the need of the hour. Organic farming is a holistic system designed to optimize the productivity and fitness of diverse communities in the agro-ecosystem including living organisms *viz*., soil organisms, plants, livestock and human being etc., organic farming plays a vital role in maintaining biological diversity, decrease soil and ground water contamination, optimize biological productivity (Watson *et al.,* 2002), maintain long-term soil fertility by optimizing conditions for biological activity in the soil (Ramesh *et al.,* 2005).

Production technology for organic field bean primarily involves three management practices *viz.,* efficient crop management, appropriate nutrient management and effective plant protection measures. Among them nutrient management plays important role. In addition to organic manures such as FYM, recycling of organic wastes through composting, green manures and biological inputs like vermi-compost and bio-fertilizers etc., constitute important components for plant nutrient management in organic farming and it is indispensable to identify the better source of nutrient and quantity to meet the nutrient requirement of field bean. The main objective of the present investigation was to develop organic nutrient management practice for field bean and to study the long term effect of input on soil physical chemical and biological properties of soil.

Materials and Methods

A field experiment was conducted at Organic Farming Research Centre, Navile, Shivamogga, Karnataka (13^{0} 58' 30" N and 75^{0} 34' 37" E) during *Kharif* season five consecutive years from 2013 to 2017, to study the Effect of different organic nutrient management practices on growth, yield of Field bean and soil properties. The soil of experimental site was slightly acidic in reaction (p^{H} 5.89) with normal electrical conductivity (0.01 dS/m), medium organic carbon (4.02 g/kg), low available nitrogen (211 kg/ha), high available phosphorous (112 kg/ha) and medium available potassium (144 kg/ha). The experiment was laid out in randomized block design with nine treatments and replicated thrice with gross plot size of 5.4 x 4.5 m and in-vitro culture of microbial load in the rhizosphere soil was analyzed in completely randomized design. Recommended dose of FYM and nitrogen for Field bean under rain fed situation is 7.5 tonesha^{-1} and 25 kg/ha, respectively. Experiment consisted of nine different manurial treatments. Particulars of nutrients applied in each treatment are specified in Table 1.

Entire quantity of manures was applied to each plots 15 days before sowing of the crop and incorporated into the soil. Field bean seeds were sown in the main field at a spacing 90 x 30 cm. Crop received optimum rainfall during entire growing period and lifesaving irrigations was provided at critical stages of the crop. Two inter-cultivation operations and one hand weeding were carried out to suppress the weeds. Neem oil was sprayed to control the pest hazards.

Soil samples were collected from each plot before and after the experiment at 0-30 cm depth. The soil samples were dried in shade, sieved (2 mm sieve) and analyzed for pH, organic carbon, available nitrogen, available phosphorus and available potassium content. The pH (soil: water 1:2.5) was measured with the help of pH meter (Jackson, 1973); organic carbon by Walkley and Black chromic acid digestion method as described by Jackson (1973). Available nitrogen in soil was determined by using Kel-plus nitrogen distillation unit (Subbaiah and Asija, 1956).

The available phosphorus was determined following the procedure described by Jackson (1973) and potassium was determined flame photometrically by neutral normal ammonium acetate extraction method (Hanway and Heidel, 1952). The pertinent growth, yield, soil nutrient status and soil microbial load parameters were recorded using standard procedures. All the parameters were then analyzed for drawing conclusion using analysis of variance (ANOVA) procedure (Gomez and Gomez 1984).

Results and Discussion

Effect of organic nutrient management practices on soil biological properties

The data of soil microbial analysis carried out during each year revealed that the population of micro-organisms was increased significantly from 2013 to 2017, during 2013 the population of bacteria -20.33 x 10^5, Fungi- 5.67 x 10^4, Actinomycetes- 3.33 x 10^3, PSMs- 4.33 x 10^3, N-fixers 8.00 x 10^3CFU / g soil of the experimental site, Application of organic manures significantly influences the soil biological property.

The maximum soil microbial population such as Bacteria- 60.33 x 10^5, 84.00 x 10^5, 63.00 x 10^5, Fungi- 16.67 x 10^4, 26.00 x 10^4, 15.00 x 10^4, Actinomycetes- 10.00 x 10^3, 16.33 x 10^3, 11.67 x 10^3, PSMs-16.00 x 10^3, 28.33 x 10^3, 18.33 x 10^3, N-fixers 19.33. x 10^3, 32.67 x 10^3, 21.33 x 10^3 CFU / g soil at 30 DAS, 60 DAS and at harvest respectively, was recorded in the treatment applied with Rec. FYM + 100 % N equivalent to vermi-compost followed by the treatment T1.

There is a significant increase in soil microbial population from initial to 60 days there after the microbial population was decreased.

The addition of organic inputs enhanced the microbial counts in soil significantly over the years, which might be due to carbon addition and changes in physico-chemical and biological properties of soil (Table 2).

The vermi-compost contain higher amount of growth promoting substances, vitamins, and enzymes, and increases the root biomass production, which resulted in higher production of root exudates and increasing the beneficial bacteria, fungi and actinomycetes population in rhizosphere region (Upadhyay *et al.*, 2011; Jayanthi *et al.*, 2014).

Effect of organic nutrient management practices on growth of field bean

Among the different nutrient management practices the application of 100 percent N equivalent vermin-compost (2 tonnes/ ha) along with recommended FYM (7.5 tonnes/ ha) (T_5) recorded significantly higher plant height at harvest (64 cm) as compared to rest of the treatments (Table 3). Higher dry matter production in plants results in effective utilization of applied resources and it is also the real indicator of plant growth. In the present investigation significantly higher dry matter production (31.60 g/plant) at harvest stage was also recorded in the treatment T_5as compared to rest of the treatments except the treatment T_1 (Table 3).

Higher dry matter production is the prerequisite for higher yield per plant. The higher growth parameters associated with treatment T_5 which received 100 per cent N equivalent vermi-compost along with recommended dose of FYM is attributed to higher quantity of Nitrogen (55 kg ha^{-1}) and other nutrients made available to crop through supply of 2 ton vermi-compost along with 7.5 t FYM to the crop. Further cementing action of polysaccharides and other organic compounds released during the decomposition of organic matter supplied through FYM and/or vermi-compost that provided better soil environment thus leading to taller plants, increased number of leaves and branches and in turn the final yield.

The organic manures have slow release of nitrogen due to its slow mineralization which induces the availability of nutrients commensurate with the growth and development of the plants and thus results in higher growth parameters (Channabasanagowda *et al.,* 2008). Better availability of plant growth regulators and humicacid in vermicompost results in the increased activity of microbes (Arancon *et al.,* 2004). Microbes like fungi bacteria, yeasts, actinomycetes, algae, *etc.* are capable of producing auxins, gibberellins *etc.* in appreciable quantity during vermi-composting (Arancon *et al.,* 2004) which affect plant growth appreciably (Arancon *et al.,* 2006). These results are in conformity with the findings of Mittollia *et al.,* (2015).

Effect of organic nutrient management practices on yield parameter and yield of field bean

The yield of the crop is an expression of growth and development of the crop. Among the different treatments the application of 100 percent N equivalent vermin-compost (2 tonnes/ ha) along with recommended FYM (7.5 tonnes/ ha) recorded significantly higher pods per plant (23.1) as compared to rest of the treatments. However, it was closely followed by treatment which received 100 per cent N equivalent FYM along with recommended FYM (22.1 pods per plant) and the treatment T_8 which received 125 per cent vermi- compost alone. Less number of pods per plant (18.9) was recorded in T_2 which received 75 percent N equivalent FYM.

The per plant grain yield of the Field bean found higher in T_5 (15.9 g/plant) followed by T_1 (15.1 g/plant) and both were significantly superior over the rest of the treatments. The lowest grain yield per plant was recorded in T_2 (12.5 g/plant) which received 75 percent N equivalent FYM (Table 3). Improvement in yield attributes could be due to higher quantity of macro and micronutrients added to soil in the form of FYM and vermi- compost (Table 1) resulting in increased availability of nutrients in root zone thus more uptake by crop resulting in higher values of yield attributing characters. These results are inconformity with the result obtained by Mittollia *et al.,* 2015.

Table.1 Treatment details and quantity of nutrients applied in each treatment

Tr. No.	Treatments	Total quantity of FYM applied (tonnes/ha)	Total quantity of vermi-compost applied (tones/ha)	Total N supplied (kg/ha)
T_1	Recommended FYM (7.5 t ha^{-1}) + 100 % N equivalent FYM	12.5	0	62.5
T_2	75 % N equivalent FYM	3.75	0	18.25
T_3	100 % N equivalent FYM	5	0	25.00
T_4	125 % N equivalent FYM	6.25	0	31.25
T_5	Recommended FYM (7.5 t ha^{-1}) + 100 % N equivalent vermicompost	7.5	2.0	62.5
T_6	75 % N equivalent vermicompost	0	1.5	18.75
T_7	100 % N equivalent vermicompost	0	2.0	25.00
T_8	125 % N equivalent vermicompost	0	2.5	31.25
T_9	50 % N equivalent FYM + 50 % N equivalent vermicompost	2.5	1.0	25.00

RDF- (7.5 t FYM + 25:50:25 Kg NPK ha^{-1})
***N content of FYM -0.5 % *N content of vermi-compost- 1.25 %**

Table.3 Growth and yield parameters of field bean as influenced by different nutrient management practices (pooled data of five years)

Tr. No.	Treatments	Plant height (cm)	Dry matter (g)	No. of pods $plant^{-1}$	yield $plant^{-1}$ (g)
T_1	Recommended FYM (7.5 t ha^{-1}) + 100 % N equivalent FYM	58.8	29.10	22.1	15.1
T_2	75 % N equivalent FYM	49.8	22.10	18.9	12.5
T_3	100 % N equivalent FYM	50.6	23.60	19.9	12.8
T_4	125 % N equivalent FYM	53.6	25.90	20.4	13.3
T_5	Recommended FYM (7.5 t ha^{-1}) + 100 % N equivalent vermicompost	64.0	31.60	23.1	15.9
T_6	75 % N equivalent vermicompost	51.5	23.60	19.6	12.4
T_7	100 % N equivalent vermicompost	53.2	25.30	20.3	13.0
T_8	125 % N equivalent vermicompost	57.5	28.20	21.5	13.9
T_9	50 % N equivalent FYM + 50 % N equivalent vermicompost	53.2	26.80	20.1	12.9
	S.Em.±	4.06	4.1	0.93	0.69
	C.D. at 5%	12.19	12.2	2.78	2.08

Table.2 General soil micro flora (CFU $g^{-1}$of soil) as influenced by nutrient management practices for organic cultivation of field bean

Micro flora	Bacteria (CFUs.X 10^5)				Fungi (CFUs.X 10^4)				Actinomycetes (CFUs.X 10^3)				PSM (CFUs.X 10^3)				N-fixers (CFUs.X 10^3)			
Initial	20.33				5.67				3.33				4.33				8.00			
Treatments / DAS	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS
T_1	59.00	80.67	62.00	15.00	25.33	14.67	09.67	14.33	10.00	15.33	26.67	16.67	17.00	30.33	20.67	59.00	80.67	62.00	15.00	25.33
T_2	53.33	73.00	54.33	10.33	19.33	09.33	06.67	09.67	06.00	10.00	19.33	10.67	12.00	24.00	13.33	53.33	73.00	54.33	10.33	19.33
T_3	56.00	76.33	58.00	13.00	22.00	12.33	07.33	12.00	08.33	12.00	22.00	14.33	14.00	26.33	17.00	56.00	76.33	58.00	13.00	22.00
T_4	58.67	80.00	61.67	14.33	24.33	14.00	08.67	13.67	09.67	14.67	24.00	16.00	16.67	29.00	20.00	58.67	80.00	61.67	14.33	24.33
T_5	60.33	84.00	63.00	16.67	26.00	15.00	10.00	16.33	11.67	16.00	28.33	18.33	19.33	32.67	21.33	60.33	84.00	63.00	16.67	26.00
T_6	54.00	74.67	56.00	11.33	20.33	11.33	07.00	10.67	07.33	10.00	20.00	12.33	13.00	24.67	15.33	54.00	74.67	56.00	11.33	20.33
T_7	54.67	75.00	56.67	12.00	21.67	12.00	07.67	11.33	08.00	11.33	21.67	13.00	13.33	26.00	17.00	54.67	75.00	56.67	12.00	21.67
T_8	58.00	79.33	60.00	14.00	23.00	13.33	08.33	13.67	09.00	13.00	23.33	15.33	15.33	28.67	19.00	58.00	79.33	60.00	14.00	23.00
T_9	56.67	79.00	58.33	13.33	22.33	13.00	08.00	12.00	08.33	12.33	22.00	15.00	14.67	27.33	18.33	56.67	79.00	58.33	13.33	22.33
S.Em.±	0.13	0.30	0.28	0.15	0.26	0.22	0.18	0.34	0.24	0.18	0.36	0.29	0.18	0.28	0.14	0.13	0.30	0.28	0.15	0.26
C.D @ 5%	0.39	0.92	0.85	0.46	0.81	0.68	0.56	1.02	0.73	0.56	1.08	0.87	0.56	0.85	0.43	0.39	0.92	0.85	0.46	0.81

Table.4 Pod yield and seed yield of field bean as influenced by different nutrient management practices

Tr. No.	Treatments	2013-14		2014-15		2015-16		2016-17		2017-18		Pooled data	
		Dry pod yield ha^{-1} (q)	Seed yield ha^{-1} (q)	Dry pod yield ha^{-1} (q)	Seed yield ha^{-1} (q)	Dry pod yield ha^{-1} (q)	Seed yield ha^{-1} (q)	Dry pod yield ha^{-1} (q)	Seed yield ha^{-1} (q)	Dry pod yield ha^{-1} (q)	Seed yield ha^{-1} (q)	Dry pod yield ha^{-1} (q)	Seed yield ha^{-1} (q)
T1	FYM + 100 % N equivalent FYM	14.78	10.74	15.64	11.10	11.12	7.23	11.48	7.69	10.48	7.02	12.70	8.75
T2	75 % N equivalent FYM	13.55	9.47	13.83	9.98	9.79	5.85	6.33	4.54	5.91	5.07	9.88	6.98
T3	100 % N equivalent FYM	13.88	9.96	14.24	10.40	10.18	6.34	7.95	5.32	7.29	5.25	10.71	7.45
T4	125 % N equivalent FYM	14.36	10.45	15.50	10.93	10.91	6.87	8.96	6.09	8.07	5.89	11.56	8.04
T5	FYM + 100 % N equivalent vermicompost	14.92	10.97	15.88	11.56	11.82	7.70	12.36	8.62	11.29	7.75	13.25	9.32
T6	75 % N equivalent vermicompost	13.64	9.58	14.32	9.78	10.09	5.90	8.57	5.65	7.96	5.35	10.91	7.25
T7	100 % N equivalent vermicompost	14.23	10.28	15.12	10.82	10.66	6.67	9.02	5.68	8.21	5.48	11.45	7.78
T8	125 % N equivalent vermicompost	14.53	10.56	15.50	11.02	10.91	7.03	9.75	6.33	9.50	6.60	12.03	8.30
T9	50 % N equivalent FYM + 50 % N equivalent vermicompost	14.12	10.20	14.86	10.81	10.62	6.70	9.40	5.83	8.90	6.05	11.58	7.91
	S.Em.±	0.193	0.187	10.20	0.189	0.15	0.11	0.50	0.46	1.06	1.07	0.32	0.20
	C.D. at 5%	0.58	0.54	0.61	0.56	0.44	0.32	1.49	1.37	7.09	10.18	0.94	0.60

Table.5 Nutrient status of soil as influenced by different nutrient management practices

Tr No.	Treatments details	pH (1:2.5)	EC (dSm^{-1})	OC (g/kg)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
T1	FYM + 100 % N equivalent FYM	5.90	0.04	4.31	262	159	175
T2	75 % N equivalent FYM	5.88	0.03	4.18	210	133	158
T3	100 % N equivalent FYM	5.97	0.04	4.37	232	148	167
T4	125 % N equivalent FYM	6.21	0.03	4.33	247	176	174
T5	FYM + 100 % N equivalent vermicompost	5.80	0.03	4.33	244	159	185
T6	75 % N equivalent vermicompost	5.85	0.03	3.57	201	126	159
T7	100 % N equivalent vermicompost	6.17	0.03	4.24	217	143	162
T8	125 % N equivalent vermicompost	5.75	0.03	4.24	240	147	158
T9	50 % N equivalent FYM + 50 % N equivalent vermicompost	6.22	0.03	4.06	222	151	170
	Initial	5.89	0.01	4.02	211	112	144
	SEm±	0.21	0.00	0.19	11.02	7.82	11.66
	CD@5(%)	NS	NS	NS	32.72	23.22	NS

Due to higher yield attributes associated with treatment T_5, the same treatment has recorded significantly higher dry pod yield (13.2 q/ha) and seed yield (9.32 q/ha) as compared to rest of the treatments and closely followed by the treatment which received 100 per cent N equivalent FYM along with recommended FYM T_1 Table 4. Significantly, higher grain yield associated with treatment T_5 is attributed to more effective translocation of photosynthates from source to sink (Raja rajan and Sabrinathan, 2006). Application of FYM improves soil physical condition sand NPK content of soil there by increases yield and yield attributes. Rana *et al.,* (2006) and Vyas *et al.,* (2006) also reported favorable effect of FYM on seed yield of rajmash and pigeon pea respectively.

Although the quantity of nutrients supplied both in T_1 and T_5 are same the yield was highest in T_5. This is attributed in treatment T_5 100 per cent N equivalent N was supplied through vermi- compost. The vermi-compost contains plant growth regulating materials such as humic acids (Atiyeh *et al.,* 2002) and plant growth regulators like auxins, gibberellins and cytokinins (Tomati *et al.,* 1988) which are responsible for increased plant growth and yield of many crops (Atiyeh *et al.,* 2002). These plant growth regulating materials are produced by action of microbes like fungi, bacteria, actinomycetes and earthworms (Edwards 1998). The highest population of soil micro flora at all growth stages was recorded in T_5. Vermi-compost provides large particulate surface areas that provide many micro-sites for microbial activities and for strong retention of nutrients (Shi-wei and Fu-zhen 1991). As a result most nutrients are in available form such as nitrates, phosphates, exchangeable calcium and soluble potassium (Edwards 1998). Vermi-compost application also suppresses the growth of many fungi like *Pythium*, *Rhizoctonia* and *Verticillium*; as a result many plant diseases are suppressed when vermi-compost is applied in ample quantity in the field (Hoitink and Fahy 1986).Due to all these reasons Treatment T_5 has recorded highest yield.

Soil nutrient status

Nutrient status of the soil is influenced by soil physico-chemical and biological properties. Organic manure application will improve the soil fertility and availability of nutrients through slow mineralization and slow release of nutrients which in turn results in availability of nutrients throughout the growing period of the crop (Dudhat *et al.,* 1997). Different nutrient management practices failed to influence the soil p^H, EC, OC and K_2O status significantly. Soil organic carbon is one of the major components of soil organic matter. It is extremely important in all soil processes *viz.,* nutrient availability, soil structure and soil biological activities. The OC content was improved over the years as compared to initial levels (4.02 g/kg). Significantly higher organic carbon content in the soil was recorded in T_5 (4.33 g/kg) as compared to T_2, T_4 and T_9 and lower organic carbon (4.06 g/kg) was recorded in T_2 (Table 5).

Soil nitrogen availability depends on N mineralization and which in turn results in increased root biomass this leads to increased uptake of the nutrients by the plants. In the present investigation, after harvest of the crop the soil nitrogen status found significantly higher in the T_1 (262 kg ha^{-1}) which received recommended dose of FYM (7.5 tonnes/ha) and 100 percent N equivalent FYM over the rest of the treatment. As compared to initial status (211 kg ha^{-1}) gradual buildup of Nitrogen content noticed in the treatment T_1 (262 kg ha^{-1}). However, the available nitrogen content was low and it was increased slightly with implementation of organic manure treatments as compared to initial level. It might be due to organic matter decomposition and slow release of nutrients to the soil (Srinivasulu *et al.,* 2000). The available phosphorus was found significantly higher in T_1 (159 kg/ha) gradual increase in available P content was observed as compared to initial values (112 kg ha^{-1}). This is attributed to release of organic acid during microbial decomposition of organic matter which might encompass in the solubility of native phosphates thus increasing available phosphorus pool in the soil.

In addition the organic anions compete with phosphate ions for the binding sites on the soil particles (Patra *et al.,* 2011). Different nutrient management treatments failed to influence the potassium status of soil significantly. However, the available potassium was found highest in T_5 over rest of the treatments (Table 5). Potassium content of soil was also improved over the years as compared to initial level (144 kg ha^{-1}). These results are in close conformity with the findings of Nagar *et al.,* 2015.

Amongst the different organic nutrient management practices tested for five consecutive years the application of recommended dose of FYM (7.5 tonnes) along with 100 percent N equivalent vermi-compost (2 tonnes/ha) was found superior with respect to growth, development and yield of the field bean.

The gradual improvement in soil physical, chemical and biological properties was noticed over the years. The higher soil micro flora was also recorded with the application of recommended dose of FYM (7.5 tonnes) along with 100 percent N equivalent vermi-compost (2 t ha^{-1}). Hence, application of 2 ton vermi-compost along with 7.5 ton FYM is optimum for obtaining highest yield of field bean under organic farming condition.

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