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Influence of organics, nutrients and plant growth regulators on growth, yield and yield components in french bean

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SUMMARY

Organics, nutrients, and plant growth regulators were used to assess the effect on growth, physiological traits and yield in French bean. Two organics-farm yard manure (FYM) and vermi-compost, two nutrients- potassium nitrate (KNO_3) and Iron Sulphate ($FeSO_4$), two plant growth regulators –Miraculan and Gibberellic Acid (GA) along with salicylic acid, β- nephthol and P- solubilizer were used. Significant variation in physiological traits and growth was evident due to the application of GA_3 (20ppm), P- solubiliser (2.5Kg/h) and vermicompost (2 t/ha). Similar trend was also observed with fresh pod yield (tender green pods). Use of GA_3 (20ppm) and P- solubiliser (2.5t/ha) were found to be cost effective compared to other treatments.

Key words : Farm yard manure, Vermicompost, French bean, Growth regulator

French bean a short duration leguminous vegetable crop is better known for its mature dry seeds as well as immature tender green pods. Being a most popular vegetable for its protein, carbohydrates, mineral content, crude fibre, vitamins A and C, it's becoming more popular and gaining lot of importance both in producers and consumers. Added to its short duration and high production potential it is also possesses some useful medicinal properties in diabetes and certain cardiac problems.

French bean is grown in different parts of world, occupying an area of 25.91 m.ha with total production of 18.84 m.tons. In India it is cultivated in an area of 9.72 m.ha with a production of 4.34 m.tons. The productivity in India is about 447 kg seeds per hectare as against world average productivity of 669 kg seeds per hectare. Hence, any attempt to increase the yield in French bean is a welcome note.

Organic manures apart from supplying macro and micro nutrients are also known to improve the physical, chemical and biological properties of soils. Frenchbean responds well to organic manures and results in improving quality and to sustain production. There is a need to integrate both the use of organics and chemicals for getting higher quality product which inturn is expected to substantially reduce the cost of cultivation through minimizing the use of inorganic fertilizers. In recent days more importance has been given to suitable agriculture, since the modern agriculture over the last several years depended heavily on chemical fertilizers which are cost intensive and have adverse effect on soil fertility and the environment. Therefore, there is a need to popularize these environmental safe, ecofriendly and cost effective organic manures. Application of vermicompost to different field crops has been known to reduce the requirement of chemical fertilizers without affecting crop yields (Giraddi, 1998).

Nutrients also have important role in plant metabolism, growth and developmental processes and help in increasing the biomass production and yield. Biofertilizers have been designated as alternate sources of soil fertility as they are known to improve the supply of nutrients through renewable sources of energy. Among the biofertilizers, *Rhizobium* and phosphorus-solubilizing bacteria (PSB) play a significant role in pulses in providing plant nutrients (Sexena and Tilak, 2000). The use of biofertilizers has currently attained a special significance in crop production and tremendous success has been achieved in several crops. The idea of artificial regulation of physiological processes by means of chemicals is a corollary to the concept of phytohormones which involves in regulation of plant physiological processes. The plant growth regulators have been shown to be one of the quick means of increasing crop production.

Cultivation of frenchbean is limited and less work has been done on these aspects. Therefore, it is right time to give more emphases on the evaluation of organics and other chemicals for growth performance, yield potential and quality improvement. But, there is hardly any precise and conclusive information available on the effect of

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organics micronutrients and growth regulators on various physiological processes and productivity potential in frenchbean. Hence, the present investigation was carried out to know the influence of organics, nutrients and plant growth regulators on growth, yield and yield components in frenchbean.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* 2004 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad with a view to find out the influence of organics, nutrients, biofertilizers and plant growth regulators on growth, yield and yield components in French bean var. Arka Komal. The experiment consisted of soil application of two organics *viz.*, FYM (5 and 10 tons/ha), vermicompost (1 and 2 tons/ha), P-solubilizer (2.5 kg/ha). The foliar application of two nutrients *viz.*, KNO_3 (0.5%), $FeSO_4$ (0.5%), two chemicals *viz.*, salicylic acid (50 ppm), β-nephthol (10 ppm), two plant growth regulators *viz.*, miraculan (2000 ppm) and GA_3 (200 ppm) and control.

Observations on plant height, number of branches per plant, days to 50 per cent flowering, total dry matter production, yield and yield components were recorded by following standard procedures. Leaf area index (LAI) and biomass duration (BMD) were calculated by following the formula of Sestak *et al.* (1971). Absolute growth rate (AGR) and crop growth rate (CGR) were calculated by following the formula of West *et al.* (1920) and Watson (1952), respectively. While, specific leaf weight (SLW) and leaf area duration (LAD) were calculated by following the formula of Radford (1967) and Power *et al.* (1967), respectively. The benefit: cost ratio was worked out based on tender pod yield, total cost of cultivation, cost of organics, nutrients, chemicals including plant growth regulators and market price of French bean.

RESULTS AND DISCUSSION

Morphological characters like plant height, number of branches per plant, days to 50 per cent flowering and total dry matter production presented in Table 1 indicated significant differences due to the treatments. Among the treatments GA_3 (20 ppm) recorded maximum plant height followed by vermicompost and least was recorded in control. Increase in plant height might be GA_3 effect on elongation of internodes as GA_3 is known to enhance cell elongation (Krishnamoorthy, 1981). Similar results were also reported by Deotale *et al.* (1995) in soybean and Sumabai *et al.* (1987) in greengram. The application of growth promotive substance increased the plant height and such affect was due to increased photosynthetic activity, enhancement in the mobilization of photosynthates and change in the membrane permeability (Shukla *et al.*, 1997). With respect to number of branches per plant was also differed significantly among the treatments and GA_3 followed by P-solubilizer and vermicompost showed more number of branches as compared to control. This is due to impact of these chemicals, which enhanced growth, cell division and other metabolic processes. The similar results were reported by Deotale *et al.* (1998) in soybean and Borker *et al.* (1991) in cowpea.

There was a considerable and significant reduction in number of days to 50 per cent flowering with GA_3 and P-solubilizer as compared to control and other treatments

Table 1 : Influence of organics, nutrients and plant growth regulators on plant height (cm), number of branches/plant, total dry weight (g plant^{-1}) and days to 50 per cent flowering

Treatments	Plant height	Number of branches	Total dry weight	Days to 50% flowering
FYM (5 t/ha)	29.9	8.7	22.88	32.6
FYM (10 t/ha)	32.1	8.9	25.56	30.6
Vermicompost (1 t/ha)	31.8	8.9	24.19	31.3
Vermicompost (2 t/ha)	32.5	9.0	25.70	28.6
P-soluiblizers (2.5 kg/ha)	32.7	9.2	25.85	27.0
KNO_3 (0.5%)	28.5	8.5	22.35	33.0
$FeSO_4$ (0.5%)	28.9	8.6	22.68	33.0
Salicylic acid (50 ppm)	28.4	8.5	22.21	33.3
β-naphthol (10 ppm)	31.5	8.8	23.68	32.0
Miraculan (2000 ppm)	30.7	8.7	23.13	32.3
GA_3 (20 ppm)	34.6	9.6	26.30	26.3
Control	27.1	8.3	19.59	34.0
Mean	30.7	8.8	23.67	31.1
S.E.±	0.88	0.25	0.53	1.3
C.D. (P=0.05)	2.66	0.76	1.56	3.8

which could be due to attainment of phonological stages early in the ontogeny of the crop and acceleration in growth (Bharatsingh *et al.*, 1998 and Paliwal *et al.*, 1999). From the data (Table 1) it was noticed that significant increase in the total dry matter production due to application of GA_3, P-solubilizer and among the organics vermicompost (2 t/ha) and FYM (10 t/ha) were also found to be effective. Plant growth regulator particularly GA_3 exhibited profound influence on dry matter accumulation in different plant parts which could be due to its effect in stimulating cell division, cell elongation, auxin metabolism, cell wall plasticity and permeability of cell membrane leading to enhanced growth. Increase in dry weight due to organics could be due to improved soil fertility thereby rendering more availability of nutrients required for plant growth and development (Kumar *et al.*, 2004).

It has been observed that from data (Table 2) the leaf area index was significantly high at 40 DAS and thereafter declines because of leaf senescence at later stage of the crop. Significantly high leaf area index was observed with application GA_3 followed by P-solubilizer, vermicompost and FYM. This increase in LAI could be attributed to the stimulatory effect of plant growth regulator on cell division and cell enlargement which lead to enhanced leaf area. Phosphorus is an essential component of energy transport system in all the cells (Tandon, 1987 and Armstrong, 1988). It is known that the application of P-solubilizer besides solubilization of insoluble inorganic phosphorus will have other beneficial properties like production of plant promoting substances like IAA and GA (Gaur and Gaind, 1992). The enhanced growth, leaf area and other growth parameters due to P-soluiblizer could be attributed to their effect via growth regulators. Similarly Sarawgi *et al.* (1999) reported that biofertilizer application with phosphorus increased leaf area index in chickpea. It was clear from the Table 2 that absolute growth rates (AGR) and crop growth rate (CGR) were found to increase upto 40 DAS and thereafter they started declining. Among the treatments GA_3, P-solubilizer and vermicompost showed significant influence on AGR and CGR. Similarly Sneha *et al.* (2003) reported enhancement in AGR and CGR due to application of biofertilizer in soybean. The increase in AGR and CGR was due to increase in photosynthetic efficiency, leaf thickness and retaining more chlorophyll content and effluent translocation of photosynthates. It also could be due to effectiveness of these treatments in increasing not only dry matter production but also the rate of increment in total dry matter.

The specific leaf weight (SLW) is the indicator of leaf thickness. The increase in SLW is because of increased leaf thickness which could be due to stacking of palisade cells since, French bean is C_3 plant, the photosynthetic efficiency per unit leaf area is low and such increased leaf thickness could probably the enhancement of photosynthetic efficiency. The specific leaf weight increased from 40 DAS to 60 DAS (Table 3) and it was more in GA_3 (20 ppm) followed by P-solubilizer

Table 2 : Influence of organics, nutrients and plant growth regulators on leaf area index (LAI), absolute growth rate (AGR g day^{-1}) and crop growth rate (CGR g dm^{-2} day^{-1}) at different stages in french bean

Treatments	Leaf area index			Absolute growth rate			Crop growth rate		
	20 DAS	40 DAS	60 DAS	20-40 DAS	40-60 DAS	60-harvest	20-40 DAS	40-60 DAS	60-harvest
FYM (5 t/ha)	3.58	6.85	6.32	0.315	0.540	0.126	0.210	0.360	0.084
FYM (10 t/ha)	3.52	7.46	6.65	0.346	0.584	0.184	0.20	0.389	0.122
Vermicompost (1 t/ha)	3.58	7.32	6.57	0.340	0.568	0.138	0.226	0.378	0.092
Vermicompost (2 t/ha)	3.56	7.66	6.74	0.348	0.596	0.176	0.232	0.397	0.117
P-soluiblizers (2.5 kg/ha)	3.60	7.88	6.71	0.352	0.615	0.159	0.234	0.410	0.106
KNO_3 (0.5%)	3.60	6.62	6.11	0.284	0.517	0.153	0.189	0.344	0.102
$FeSO_4$ (0.5%)	3.54	6.72	6.23	0.294	0.535	0.141	0.196	0.356	0.097
Salicylic acid (50 ppm)	3.66	6.45	6.02	0.280	0.513	0.152	0.186	0.342	0.101
β-naphthol (10 ppm)	3.61	7.14	6.47	0.310	0.556	0.154	0.206	0.370	0.102
Miraculan (2000 ppm)	3.52	6.99	6.37	0.304	0.552	0.137	0.202	0.368	0.091
GA_3 (20 ppm)	3.57	7.97	6.86	0.375	0.623	0.156	0.250	0.415	0.104
Control	3.55	6.12	5.54	0.255	0.463	0.096	0.170	0.308	0.064
Mean	3.57	7.09	6.38	0.316	0.555	0.147	0.210	0.369	0.098
S.E.±	0.12	0.18	0.23	0.034	0.007	0.002	0.020	0.002	0.006
C.D. (P=0.05)	NS	0.54	0.68	0.098	0.020	0.007	0.057	0.007	0.019

DAS-Days after sowing

Table 3 : Influence of organics, nutrients and plant growth regulators on specific leaf weight (SLW, mg cm^{-2}), biomass duration (BMD, g days) and leaf area duration (LAD) at different stages in french bean

Treatments	Specific leaf weight			Biomass duration			Leaf area duration	
	20 DAS	40 DAS	60 DAS	20-40 DAS	40-60 DAS	60-harvest	20-40 DAS	40-60 DAS
FYM (5 t/ha)	2.53	4.56	4.72	128	299	432	104	131
FYM (10 t/ha)	2.51	4.48	4.96	134	320	474	109	141
Vermicompost (1 t/ha)	2.55	4.51	4.894	133	314	456	109	139
Vermicompost (2 t/ha)	2.50	4.48	.95	135	324	478	112	144
P-soluiblizers (2.5 kg/ha)	2.51	4.51	5.09	136	330	485	114	146
KNO_3 (0.5%)	2.50	4.47	4.67	121	282	416	102	127
$FeSO_4$ (0.5%)	2.50	4.51	4.71	124	290	425	102	129
Salicylic acid (50 ppm)	2.61	4.50	4.66	121	280	413	101	124
β-naphthol (10 ppm)	2.49	4.51	4.82	127	300	442	107	136
Miraculan (2000 ppm)	2.54	4.53	4.78	126	297	435	105	134
GA_3 (20 ppm)	2.52	4.51	5.10	139	339	494	115	148
Control	2.55	4.40	4.63	115	260	372	96	117
Mean	2.52	4.49	4.83	128	303	443	97.8	134.7
S.E.±	0.01	0.03	0.15	6.2	10.2	18.1	3.2	4.0
C.D. (P=0.05)	NS	0.09	0.45	18.2	33.3	53.1	9.5	12.1

DAS-Days after sowing

and vermicompost. Similarly the foliar application of NAA in soybean (Rajamohan, 1989) and $FeSO_4$ in greengram (Prakash Rao, 1998) increased SLW.

Leaf area duration (LAD) is a useful concept not only in depicting the efficiency of photosynthetic system but also in showing a linear relationship with dry matter accumulation (Chetti and Sirohi, 1995). The LAD as indicated in Table 3 has shown significantly higher with GA_3, P-soluiblizer and vermicompost which could be attributed to more retention of green leaves for a longer duration and higher LAI. Similarly the biomass duration (BMD) which indicates the maintenance of dry weight over a period of time and is essential for prolonged supply of photosynthates to the developing sinks. Table 3 indicated the BMD significantly increased due to the application of GA_3, P-solubilizer and vermicompost and this increase in BMD was due to increase in dry matter production and its maintenance. These results are in agreement with Koti (1997) who showed a positive association between BMD and seed yield in soybean.

In the present investigation (Table 4) it has been observed that the application of GA_3, P-solubilizer and

Table 4 : Influence of organics, nutrients and plant growth regulators on yield and yield components in french bean

Treatments	Pod length (cm)	Green pod yield (g $plant^{-1}$)	Green pod yield (kg/ha)	% increase over control
FYM (5 t/ha)	12.1	102.3	13479	12.1
FYM (10 t/ha)	13.1	109.4	14609	21.5
Vermicompost (1 t/ha)	12.5	107.1	14236	18.4
Vermicompost (2 t/ha)	13.2	109.7	14657	21.9
P-soluiblizers (2.5 kg/ha)	14.3	111.4	14717	22.4
KNO_3 (0.5%)	11.0	97.6	12926	7.5
$FeSO_4$ (0.5%)	12.1	98.2	12998	8.1
Salicylic acid (50 ppm)	0.8	95.7	12709	5.7
β-naphthol (10 ppm)	12.5	104.8	13864	15.3
Miraculan (2000 ppm)	12.3	102.7	13659	13.6
GA_3 (20 ppm)	1.6	113.1	15126	25.8
Control	10.5	89.5	12024	-
Mean	12.4	103.4	13750	-
S.E.±	0.5	2.9	528	-
C.D. (5%)	1.7	8.7	1549	-

Table 5 : Influence of organics, nutrients and plant growth regulators on economics of french bean

Treatments	Green pod yield (kg/ha)	Gross return (Rs.)	Additional cost (Rs./ha)	Total cost of cultivation (Rs.)	Benefit : cost ratio
FYM (5 t/ha)	13479	53916	2700	14700	3.60
FYM (10 t/ha)	14609	58436	5200	17200	4.00
Vermicompost (1 t/ha)	14236	56944	2200	17200	0.48
Vermicompost (2 t/ha)	14657	58628	4200	16200	3.60
P-soluiblizers (2.5 kg/ha)	14717	58868	275	12275	4.80
KNO_3 (0.5%)	12926	51704	160	12160	4.30
$FeSO_4$ (0.5%)	12998	51992	130	12130	4.29
Salicylic acid (50 ppm)	12709	50836	112	12112	4.20
β-naphthol (10 ppm)	13864	55456	130	12130	4.60
Miraculan (2000 ppm)	13659	54636	340	12340	4.30
GA_3 (20 ppm)	15126	60504	220	12220	5.00
Control	12024	48096	-	12000	-

1. Basic cost of cultivation: Rs. 12,000 Cost of treatments
2. Price of fresh pod yield: Rs. 4/kg

a. FYM: Rs. 500/t b. Vermicompost: Rs.2000/t c. P-solubilizer: Rs.30/kg d. KNO_3: Rs. 180/kg
e. $FeSO_4$: Rs.100/kg f. Salicylic acid: Rs.400/kg g. β-naphtol: Rs.450/kg h. Miraculan: Rs.200/l i. GA_3 : Rs100/g

higher levels of organics resulted a significant improvement in yield of green pods. These treatments also significantly improved the number of pods per plant and the pod length and pod weight. Such an improvement in the yield and yield components in French bean could be attributed to their influence on various morph physiological characters, growth parameters and physiological attributes. In conformity with above findings, Namdeo and Gupta (1989) reported an increase in yield of pigeon pea due to application of phosphate solubilizing bacteria (PSB). Vermicompost has been found to contain growth hormones, vitamins, antibiotics, humus and beneficial microbes and thus resulted in better growth and yield (Bhawalkar, 1992). Similarly, Saig and Yadav (2004) reported that organic farming is becoming an important component of environmentally sound and sustainable agriculture and the application of vermicompost significantly increased the yield in chickpea and it was mainly due to increase secondary branches, number of pods per plant and improvement in organic carbon, available P, K and extractable Zn, Fe and Mn.

The present study (Table 5) revealed that among various treatments the benefit: cost ratio was maximum with GA_3 (20 ppm) followed by P-solubilizer (2.5 kg/ha). From the point of economics it is thus inferred that the use of GA_3 (20 ppm) could be recommended for increasing both productivity and also net returns.

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