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Integrated use of organic and inorganic sources of nutrients in french bean (*Phaseolus vulgaris*)

RAJIV[1] and SAURABH TOMAR[1]*

Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh 208 002, India

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ABSTRACT

The present experiment was conducted during winter (*rabi*) season of 2017–18 and 2018–19 to study the effect of integrated use of organic and inorganic sources of nutrients on french bean (*Phaseolus vulgaris* L.). The experiment was laid out in randomized block design with seven treatments of inorganic fertilizers (NPK 80:80:40 kg/ha) along with organic source combinations (25, 50 and 75% N through FYM and vermicompost) tested against the control (no fertilizer). Based on 2 years' pooled data, application of 75% NPK through inorganic source + 25% N through vermicompost produced highest number of pods/plant (25.98), pod length (14.38 cm), pod width (1.29 cm), average single pod weight (4.33 g), green pod weight/plant (41.67 g) and green pod yield (7.71 t/ha) and earned maximum net return of ₹1,12,212.0/ha. The treatment with 100% NPK through inorganic source @80:80:40 kg/ha produced green pod yield of 6.17 t/ha with net return ₹83,225.0/ha. The B:C ratio (3.67) was also higher under the treatment with 75% NPK through inorganic source + 25% N through vermicompost. Inorganic fertilizers (75% NPK) and vermicompost (25% N) proved to be the best treatment for enhancing yield and economics of french bean under central plain zone of Uttar Pradesh. Therefore, the practice of 75% NPK through inorganic integration with 25% N through vermicompost may serve as alternative of NPK inorganic fertilizers and may also be recommended to exploit the better eco-friendly economic green pod yield of french bean.

Keywords: Economics, French bean, INM, Inorganic fertilizers, Organic manures

French bean (*Phaseolus vulgaris* L.) is one of the most important legume vegetables grown for its tender pods at a commercial scale during winter (*rabi*) season in India. The major french bean producing states are Uttar Pradesh, Punjab, Haryana, Bihar, Himachal Pradesh, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Maharashtra, Odisha and Tamil Nadu. Its tender pods contain high amount of protein, vitamin A, vitamin C, phosphorus, potassium, calcium and magnesium.

External supply of nutrients has become important because of poor fertility status of the soil which is not able to meet the entire nutrient requirement of the crop. Application of nitrogen is imperative for exploiting yield potential of french bean. However, continuous use of chemical fertilizers has resulted in nutritional imbalance, depletion of soil organic matter, contamination of food and water, adverse effect on biodiversity as well as on human health. Thus, the importance of organic manure in present day agriculture is increasing, because it does not only improve the physical, chemical and biological properties of soil but also maintains the soil health (Naidu *et al.* 2009).

Integrated use of organic and inorganic sources of nutrients is essential because chemical input based agriculture alone is not suitable for sustainable crop productivity and maintaining soil health. Organic amendments like FYM, vermicompost and bio-fertilizers may play a major role in supplementing the crop nutrients through their direct addition, improvement of soil condition, nitrogen fixation and solubilisation of fixed forms of phosphorus in soil (Bhardwaj and Gaur 1970, Rajiv2019a).

Use of organic manure with optimum rate of fertilizer under intensive farming system increased the turnover of nutrients in soil plant system (Metkari and Dhok, 2011). Therefore, the current experiment was conducted to study the effect of integrated use of organic and inorganic sources of nutrients and its influence on yield attributes, yield and economics of french bean under central plain zone of Uttar Pradesh.

MATERIALS AND METHODS

The field experiment was conducted for two consecutive winter (*rabi*) seasons in 2017–18 and 2018–19 at Vegetable Research Station, Kalyanpur, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh under All India Coordinated Research Project on Vegetable Crops. The soil was sandy loam in texture with *p*H 7.8, which showed slightly alkaline reaction. The soil was low in organic carbon (0.40%), low in available nitrogen

[1]Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh.*Corresponding author email: chaudhary.csa@gmail.com

(162.0 kg/ha), medium in available phosphorus (15.2 kg/ha) and low in available potassium (192 kg/ha) at the begining of experiment. The experiment was conducted in fixed layout during both years with the plot size of 3.60 m × 3.00 m.

The experiment was laid out in randomized block design with three replications. There were seven different treatments, viz. 100% NPK through inorganic source @80:80:40 kg/ha, 75% NPK through inorganic source + 25% N through FYM, 75% NPK through inorganic source + 25% N through vermicompost, 50% NPK through inorganic source + 50% N through FYM, 50% NPK through inorganic source + 50% N through vermicompost, 25% NPK through inorganic source + 75% N through FYM and 25% NPK through inorganic source + 75% N through vermicompost. These were evaluated against the control treatment (no fertilizer). The available N, P and K content in vermicompost were 1.52%, 0.48% and 1.45% and in FYM, these were 0.45%, 0.25% and 0.52%, respectively. French bean variety Azad Rajmah-1 was used as test variety in the experiment. The crop was sown on ridges at 45 cm ×10 cm spacing on 30th October and 28th October during 2017–18 and 2018–19, respectively. Recommended dose of fertilizers (NPK) was applied @80:80:40 kg/ha. Package of practices recommended for the region was followed. The crop was grown for green pods. The observations were recorded for yield attributes and analyzed by using statistical techniques. On the basis of total variable cost and gross return, net returns and B:C ratio were calculated as per methods suggested by Devasenapathy *et al.* (2008).

RESULTS AND DISCUSSION

Effect of integrated use of organic and inorganic sources of nutrients on yield attributes: Yield attributes of french bean were influenced significantly by different treatments (Table 1). Application of 75% NPK through inorganic source + 25% N through vermicompost or FYM and 50% NPK through inorganic source + 50% N through vermicompost or FYM, proved better for yield attributes compared to 100% NPK through inorganic source. Based on two consecutive years' pooled data, application of 75% NPK through inorganic source + 25% N through vermicompost resulted in highest pod numbers (25.98 pods/plant) followed by 75% NPK through inorganic source + 25% N through FYM (24.68 pods/plant) and 50% NPK through inorganic source + 50% N through vermicompost (23.95 pods/plant) however, the effect of these three treatments was statistically at par with each other in terms of pod numbers. The treatment 100% NPK through inorganic source @80:80:40 kg/ha produced 20.43 pods/plant. The minimum pod number (13.22 pods/plant) was found in control treatment (no fertilizer).

In case of pod length also, application of 75% NPK through inorganic source + 25% N through vermicompost showed highest pod length (14.38 cm) followed by 75% NPK through inorganic source + 25% N through FYM (13.80 cm) and 50% NPK through inorganic source + 50% N through vermicompost (13.48 cm). Similar trend was also

Table 1 Effect of integrated use of organic and inorganic nutrients on yield attributes and green pod yield of french bean

Treatment	Yield attributes*					Green pod yield (t/ha)		
	Pods/plant (average of 5 plants)	Pod length (cm) (average of 10 pods)	Pod width (cm)	Pod weight (g) (average of 10 pods)	Green pod weight/ plant (g)	2017–18	2018–19	Pooled
100% NPK through inorganic source @80:80:40 kg/ha	20.43	11.92	1.02	3.73	34.24	6.11	6.24	6.17
75% NPK through inorganic source + 25% N through FYM	24.68	13.80	1.21	4.15	39.66	7.17	7.41	7.29
75% NPK through inorganic source + 25% N through vermicompost	25.98	14.38	1.29	4.33	41.67	7.57	7.85	7.71
50% NPK through inorganic source + 50% N through FYM	22.94	12.90	1.11	3.93	37.30	6.67	6.90	6.78
50% NPK through inorganic source + 50% N through vermicompost	23.95	13.48	1.18	4.06	38.92	7.00	7.25	7.12
25% NPK through inorganic source + 75% N through FYM	19.88	11.85	0.99	3.74	33.59	5.81	6.07	5.94
25% NPK through inorganic source + 75% N through vermicompost	21.57	12.42	1.05	3.85	35.59	6.23	6.51	6.37
Control (no fertilizer)	13.22	10.39	0.86	3.14	25.48	4.28	4.31	4.29
SEm±	0.89	0.56	0.45	0.15	1.31	0.26	0.25	0.21
CD (P=0.05)	2.70	1.69	0.14	0.47	3.98	0.80	0.78	0.63

*Pooled data over 2 years.

observed in case of pod width; application of 75% NPK through inorganic source + 25% N through vermicompost recorded the maximum pod width of 1.29 cm. The average single pod weight (4.33 g) and green pod weight/plant (41.67 g) were also recorded highest with the application of 75% NPK through inorganic source + 25% N through vermicompost. The results of the study revealed that the yield attributes of french bean respond well to integrated use of 75% NPK through inorganic source and 25% N through vermicompost or FYM. It might be attributed to the availability of nutrients for crop use. The results are in confirmation with the findings of Masanta and Biswas (2009) and Ramana *et al.* (2011) in french bean, Das *et al.* (2011) and Sharma *et al.* (2015) in cow pea, and Bhathal and Kumar (2016) in cluster bean. Mohanty *et al.* (2017) also reported that when RDF requirement of french bean was met through 75% RDF combined with 25% either one organic source or 12.5% and 12.5% from either FYM or vermicompost the results were comparatively better. Dash *et al.* (2019) stated that integrated application of 75% NPK through inorganic source along with 25% N through vermicompost was the best treatment in terms of growth, yield and yield attributing parameters of french bean.

Effect of integrated use of organic and inorganic sources of nutrients on yield: French bean green pod yield was influenced significantly by different treatments during both years and also in pooled analysis (Table 1). Based on two years' pooled data, application of 75% NPK through inorganic source + 25% N through vermicompost produced highest french bean green pod yield (7.71 t/ha). It was followed by 75% NPK through inorganic source + 25% N through FYM (7.29 t/ha) and 50% NPK through inorganic source + 50% N through vermicompost (7.12 t/ha). However, these three treatments were statistically at par with each other. The 100% NPK through inorganic source @80:80:40 kg/ha produced green pod yield of 6.17 t/ha and minimum green pod yield of 4.29 t/ha was recorded in control treatment (no fertilizer).

As compared to control (no fertilizer), green pod yield of french bean increased significantly in all treatments and the margin of appreciation was highest i.e. 3.42 t/ha or 79.72% in 75% NPK through inorganic source + 25% N through vermicompost and lowest i.e. 1.65 t/ha or 38.46% in 25% NPK through inorganic source + 75% N through FYM. On the other hand, in comparison to 100% NPK through inorganic source @80:80:40 kg/ha, the green pod yield of french bean increased in all combination treatments of organic and inorganic sources except the treatment of 25% NPK through inorganic source + 75% N through FYM but margin of appreciation or reduction varied in different treatments (Table 2). The margin of appreciation was highest i.e. 1.54 t/ha or 24.96% in 75% NPK through inorganic source + 25% N through vermicompost and lowest i.e. 0.20 t/ha or 3.24% in 25% NPK through inorganic source + 75% N through vermicompost whereas, the margin of reduction was lowest i.e. 0.23 t/ha or 3.73% in 25% NPK through inorganic source + 75% N through FYM and highest i.e. 1.88 t/ha or 30.47% in control treatment (no fertilizer). It might be attributed to the availability of nutrients for crop use. FYM (equivalent to 75% N) combined with 25% NPK through inorganic sources could not meet the nutritional need of crop.

Table 2 Effect of integrated use of organic and inorganic sources of nutrients on increase/decrease in yield over control and 100% NPK through inorganic source and economics of french bean

Treatment	Increase in yield over control (no fertilizer)		Increase/decrease in yield over 100% NPK through inorganic source		Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
	t/ha	%	t/ha	%				
100% NPK through inorganic source @80:80:40 kg/ha	1.88	43.82	-	-	40255.0	123480.0	83225.0	3.07
75% NPK through inorganic source + 25% N through FYM	3.00	69.93	(+) 1.12	(+) 18.15	41754.0	145760.0	104006.0	3.49
75% NPK through inorganic source + 25% N through vermicompost	3.42	79.72	(+) 1.54	(+) 24.96	41958.0	154170.0	112212.0	3.67
50% NPK through inorganic source + 50% N through FYM	2.49	58.04	(+) 0.61	(+) 9.89	43253.0	135740.0	92487.0	3.14
50% NPK through inorganic source + 50% N through vermicompost	2.83	65.97	(+) 0.95	(+) 15.40	43658.0	142460.0	98802.0	3.26
25% NPK through inorganic source + 75% N through FYM	1.65	38.46	(-) 0.23	(-) 3.73	44751.0	118720.0	73969.0	2.65
25% NPK through inorganic source + 75% N through vermicompost	2.08	48.48	(+) 0.20	(+) 3.24	45355.0	127340.0	81985.0	2.81
Control (no fertilizer)	-	-	(-) 1.88	(-) 30.47	35050.0	85940.0	50890.0	2.45
SEm±	-	-	-	-	1275.13	4129.07	2863.87	0.11
CD (P=0.05)	-	-	-	-	3867.32	12523.01	8685.79	0.35

Application of vermicompost with inorganic fertilizers might have improved the availability of nutrients for crop use thus yielding higher compared to NPK fertilizer treatment. These results are corroborate to findings documented by Singh *et al.* (2005), Meena *et al.* (2006), Masanta and Biswas (2009), Dubey *et al.* (2012), Meena *et al.* (2013), Narayan *et al.* (2014), Rajiv (2014), Meena *et al.* (2018) and Dash *et al.* (2019). Kumaran *et al.* (1998) also reported that the better response was observed when organic manures + inorganic fertilizers were applied in tomato. Reddy *et al.* (1998) stated that the yield of pea was higher with the application of vermicompost (10 t/ha) along with recommended N, P and K than with the fertilizers alone.

Effect of integrated use of organic and inorganic sources of nutrients on economics: The economics of crop was affected by different treatments (Table 2). Application of 25% NPK through inorganic source + 75% N through vermicompost required highest cultivation cost followed by 25% NPK through inorganic source + 75% N through FYM and 50% NPK through inorganic source + 50% N through vermicompost. It might be attributed to higher cost of organic manures like vermicompost and FYM (Rajiv 2019b). Narayan *et al.* (2014) also reported similar results in potato with respect to cost of cultivation, which was higher in FYM or vermicompost application.

Gross income was worked out highest i.e. ₹1,54,170.0/ha in 75% NPK through inorganic source + 25% N through vermicompost followed by 75% NPK through inorganic source + 25% N through FYM with ₹1,45,760.0/ha and 50% NPK through inorganic source + 50% N through vermicompost with ₹1,42,460.0/ha income. The control treatment (no fertilizer) recorded lowest gross income. The results of the study revealed that the combination of inorganic and organic nutrients increased gross income. These gross income values are attributed to yield of green pods, as it is the only source of income from french bean cultivation.

Net returns were significantly affected by different treatments. The significantly highest net return of ₹1,12,212.0/ha was registered in treatment with 75% NPK through inorganic source + 25% N through vermicompost followed by 75% NPK through inorganic source + 25% N through FYM with ₹1,04,006.0/ha and 50% NPK through inorganic source + 50% N through vermicompost with ₹98,802.0/ha. In all treatment combinations of inorganic and organic nutrients, vermicompost gave higher return in comparison to FYM at the same dose of inorganic fertilizer. It showed the superiority of vermicompost over FYM among organics. Net return is the resultant of gross income and cost of cultivation where gross income dominated over cultivation cost in present study. The B:C ratio of 3.67 was also significantly higher in 75% NPK through inorganic source + 25% N through vermicompost. It might be due to higher gross income under this treatment. Sarkar *et al.* (2011) and Narayan *et al.* (2014) also reported similar findings.

From the present findings, it can be inferred that integrated use of organic and inorganic sources of nutrient package for french bean cv. Azad Rajmah-1 with the application of 75% NPK through inorganic source + 25% N through vermicompost was found suitable for realizing optimum green pod yield and gave highest B:C ratio under Kanpur condition. Hence, it was recommended for agro-climatic condition of Zone-IV by AICRP on Vegetable Crops in its 37th annual group meeting which was held at Tamil Nadu Agriculture University, Coimbatore on 22–25th June, 2019. It will ensure the sustainability in production and soil health along with pollution free environment.

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