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PERFORMANCE OF ORGANICALLY GROWN FRENCH BEAN DURING POST-KHARIF SEASON IN SOUTH CHHOTA NAGPUR PLATEAU OF EASTERN INDIA

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ABSTRACT

The experiment was conducted during *post-kharif* season of two consecutive years (2018 and 2019) in Organic Experimental Farm of ARTD Faculty Centre, Ranchi. Seven varieties *viz.*, V_1: Brunda, V_2: Swarna Priya, V_3: Arka Komal, V_4: HAFB-4, V_5: HAFB-2, V_6: Abhay and V_7: Pant Anupama were grown with their thrice replication by adopting RCBD experimental design. As organic intervention, enriched *Sanjeevani* (10%) was applied and the performance of those varieties was compared with the untreated control condition. Different growth, yield, and quality attributes were considered for the study. Findings revealed higher yield (26.40 tha^{-1}) in HAFB-4 with significant differences ($P \leq 0.05$) among varieties under organic growing condition. Consequently, HAFB-4 emerged as a profitable variety with the higher B:C ratio (3.96) under organic growing condition. Quality traits of the crop performed independently under different varietal situate but showed better performance under organically arbitrated condition. Thereby maximum ascorbic acid was detected in V_6 (327.78 $mg100g^{-1}$) under organic intervention with statistically significant differences ($P \leq 0.05$) among the varieties. From the findings, it may be concluded that the application of enriched *Sanjeevani* may be an alternative approach of farming practice to grow comparatively safer produce of French bean under the south Chhota Nagpur plateau of eastern India.

Keywords: French bean, *Phaseolus vulgaris*, *Sanjeevani*, Yield, B:C ratio.

Introduction

French bean (*Phaseolus vulgaris* L.) also known as green bean or common bean is a herbaceous annual of the 'Fabaceae' family. It is originated in the new world, mostly specified in Central and South America. There are about 2.30 lakh hectares of land under cultivation of French bean in India with an annual production of about 22.49 lakh tons. French bean is important winter season legume vegetable with a potential source of protein for human diet. It is also rich in some essential nutrients such as ascorbic acids, vit. -A, B complexes, calcium with their greater potential to prevent different diseases including diabetes and cardiac breakdowns. As most commercial growers of our country utilize different chemical fertilizers and pesticides for growing the crop so the quality of produce is deteriorating day by day due to the presence of toxic residues of chemicals (even banned pesticides sometimes) that are using in different cycles of crop production. In beans, such evidence has been exposed through the study conducted by Akhtar *et al.* (2009) where they most frequently detected pesticide residues at a level of 21% in tested samples with maximum residue limit (MRL) exceeded in 1.9% cases. Besides, the gradual rise of the input cost of chemical farming makes it nearly impossible to grow the crop by the small and marginal farmers of our country. While, on the other hand, the input cost of production is low in organic farming because of its inherent technology in which locally available resources are utilized to prepare different organic liquid inputs. In organic farming, manure is a special component that is totally made by naturally available raw materials without any chemical synthesis. Bulky organic manures like FYM, vermicompost, cattle manure, *etc.* are the most nutritious organic sources used as plant nutrient containing about 1.5% of nitrogen. However, the requirement of these bulky organic manures is higher than chemical fertilizers to meet the equivalent quantity of nutrients from those. In this particular context, cow dung, cow urine-based organic liquid manures those are believed to be boosted with the huge microbial population with their direct involvement in the process of mineralization within soil ecology as an intrinsic mechanism that ensures greater availability of plant nutrients for their growth, development, and yield or even proximate quality traits expression. As plant nutrients are readily available in liquid organic manures like enriched *Sanjeevani*, *Sasyagavya*, *Panchagavya*, *Beejamrutha*, *Jeevamrutha*, *etc.* so they may be utilized to exploit their potentiality towards more quality products of different crops [Devakumar *et al.* (2014); Mohanta *et al.* (2015); Chatterjee *et al.* (2018)]. Earlier findings revealed that these low-cost organic inputs have a greater role to sustain growth, yield, or even quality trait expressions in different leguminous vegetable crops [Dutta *et al.* (2018); Mahto & Dutta (2018); Dutta & Majee (2021); Mahto & Dutta (2021)]. In this backdrop, different bush type French bean varieties were evaluated through present investigation by utilizing low-cost organic liquid manure '*Sanjeevani*'.

Materials and Methods

Experimental site, materials and design and crop husbandry

The present investigation was conducted in organic experimental farm, Getalsud situated at 23°26'36"N latitude; 85°32'45"E longitude with 508.0 m of altitude under Ranchi district of Jharkhand during two successive post-kharif season of 2018 (Year-I) and 2019 (Year-II). Seven varieties *viz.* V_1: Brunda, V_2: Swarna Priya, V_3: Arka Komal, V_4: HAFB-4, V_5: HAFB-2, V_6: Abhay, and V_7: Pant Anupama were grown with their thrice replication by adopting RCBD experimental design. As an organic amendment, enriched *Sanjeevani* (10%) was used as a major organic source of plant nutrients and its performance was compared with the untreated control condition. As post-kharif crop, seeds were sown during 2nd fortnight of August [2018 (Year-I) and 2019 (Year-II)] by keeping 45 cm inter row and 15 cm intra row spacing in 42 (21 for organic and remaining 21 for untreated control conditions) experimental plots of 3.60 m x 1.80 m sizes each.

Preparation of enriched Sanjeevani

The enriched version of *Sanjeevani* was prepared by mixing cow dung, cow urine, and water at 1:1:2 proportion (w/w basis) along with molasses @ 100 $g.kg^{-1}$ + gram flour @ 100 $g.kg^{-1}$ of mixture plus one handful of garden soil. The above mixture should be stirred by using a bamboo/wooden stick every day (clockwise and anti-clockwise directions) two times during the morning and again during evening hours properly for 7-9 days for fermentation. The end product thus obtained after 7-9 days (based on the prevalent temperature condition) has 50% concentration considering 1 part of cow urine against 2 parts of water [Swami & Ali (2012)] and the required concentration was prepared by using the formula: $V_1S_1=V_2S_2$ where, V_1 & V_2 are volumes of the initial and final (required) amount, and S_1 & S_2 are the strength of the initial and required percentage of the *Sanjeevani*, respectively. Kindly note that the cow dung and cow urine should be of indigenous cow's origin because they provide more nutrients or content maximum microbes than the exotic ones.

Application of organic inputs

As a basal dose, FYM @ 1.0 $kg.m^{-2}$ running area was applied in all experimental plots (including untreated control). Liquid organic manure (*Sanjeevani* 10%) was applied six (6) times at a weekly interval initiated at 21-days after sowing with 250 ml/plant for the initial two times (during vegetative growth phase) and gradually increased to 500 ml/plant for the remaining four times of application (during flowering and pod developmental stages). As a prophylactic measure, mixed leaf extract (10%) was applied against insect-pests two times at 15 days interval started in the fourth week after sowing and against pathogenic infection, whey water mixed with turmeric powder @ 10 g per litre was applied twice at 15 days interval initiated at the fifth weeks after sowing in both of the experimental conditions.

Observation recorded

The performance of seven varieties in terms of their expression of growth (plant height at harvest), yield (pods per plant, average pod weight, and yield), and quality (TSS and ascorbic acid) attributes was compared against the untreated control growing condition. Standard methodologies were adopted to estimate proximate quality attributes like for TSS [by ERMA Hand Refractometer] and for ascorbic acid [as per Highet & West (1942)].

Statistical analysis

Data thus obtained were analyzed as per the standard procedure for Analysis of Variance [Gomez & Gomez (1984)]. The significance of varieties was tested by 'F' test and standard error of mean (SEm±) was computed in all cases. The difference in the mean under different varietal situates was tested by using critical difference (CD) at the level of significance at P≤0.05. Pooled mean values of both year's data were considered for interpretation.

Table 1. *Per se* performance of plant height (cm) of different varieties of French bean

Variety	Plant Height (cm)					
	Organic Growing Condition			Untreated Control Condition		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
V_1: Brunda	61.19	54.18	57.69	59.00	55.09	57.05
V_2: Swarna Priya	74.53	81.84	78.19	74.00	72.51	73.25
V_3: Arka Komal	54.98	51.51	53.25	55.75	51.75	53.75
V_4: HAFB-4	49.99	56.27	53.13	54.24	56.00	55.12
V_5: HAFB-2	50.27	56.00	53.13	53.41	56.45	54.93
V_6: Abhay	48.00	44.61	46.31	53.22	49.27	51.25
V_7: Pant Anupama	46.46	46.66	46.56	52.03	48.03	50.03
SEm (±)	**2.01**	**1.16**	**3.02**	**1.07**	**0.62**	**2.22**
$CD_{p\leq0.05}$	**4.38**	**2.53**	**6.34**	**2.33**	**1.35**	**4.67**

Table 2. *Per se* performance of pods plant^{-1} of different varieties of French bean

Variety	Pods Plant^{-1}					
	Organic Growing Condition			Untreated Control Condition		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
V_1: Brunda	14.00	10.15	12.07	5.46	4.15	4.81
V_2: Swarna Priya	11.01	13.24	12.12	6.75	6.34	6.54
V_3: Arka Komal	13.56	10.57	12.06	5.95	7.00	6.63
V_4: HAFB-4	18.57	21.03	19.80	8.06	7.62	7.84
V_5: HAFB-2	18.19	16.41	17.30	8.03	7.56	7.79
V_6: Abhay	14.18	15.01	14.59	8.65	7.54	8.10
V_7: Pant Anupama	13.78	14.02	13.90	7.59	8.35	7.97
SEm (±)	**0.88**	**0.51**	**0.43**	**0.31**	**0.19**	**0.19**
$CD_{p\leq0.05}$	**1.93**	**1.11**	**0.91**	**0.68**	**0.42**	**0.39**

Table 3. *Per se* performance of average pod weight (g) of different varieties of French bean

Variety	Average Pod Weight (g)					
	Organic Growing Condition			Untreated Control Condition		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
V_1: Brunda	12.04	10.47	11.25	11.79	10.47	11.13
V_2: Swarna Priya	11.99	12.06	12.02	11.67	10.36	11.01
V_3: Arka Komal	10.45	12.04	11.25	11.71	10.15	10.93
V_4: HAFB-4	8.26	9.81	9.03	8.75	9.11	8.93
V_5: HAFB-2	8.38	9.11	8.75	8.42	8.21	8.31
V_6: Abhay	8.41	8.10	8.25	8.25	8.10	8.18
V_7: Pant Anupama	8.59	8.82	8.71	8.07	8.43	8.25
SEm (±)	**0.39**	**0.23**	**0.54**	**0.17**	**0.29**	**0.47**
$CD_{p\leq0.05}$	**0.85**	**0.49**	**1.13**	**0.37**	**0.64**	**0.99**

Table 4. *Per se* performance of yield (tha^{-1}) of different varieties of French bean

Variety	Pod Yield (tha^{-1})					
	Organic Growing Condition			Untreated Control Condition		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
V_1: Brunda	21.06	19.17	20.12	7.76	8.11	7.93
V_2: Swarna Priya	22.37	20.72	21.55	10.61	10.72	10.66
V_3: Arka Komal	19.27	20.93	20.10	10.27	11.20	10.74
V_4: HAFB-4	25.98	26.81	26.40	10.47	10.28	10.37
V_5: HAFB-2	20.99	23.86	22.43	9.96	9.22	9.59
V_6: Abhay	17.34	18.31	17.83	10.31	9.31	9.81
V_7: Pant Anupama	17.64	18.24	17.94	10.68	8.79	9.74
SEm (±)	**0.61**	**0.35**	**1.17**	**0.33**	**0.19**	**1.02**
$CD_{p\leq0.05}$	**1.32**	**0.76**	**2.43**	**0.72**	**0.42**	**2.15**

Table 5. *Per se* performance of TSS content (^{0}Brix) in fresh edible pods of different varieties of French bean

Variety	TSS content (^{0}Brix)					
	Organic Growing Condition			Untreated Control Condition		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
V_1: Brunda	2.83	1.94	2.38	2.43	2.08	2.25
V_2: Swarna Priya	1.97	2.28	2.13	1.67	1.82	1.75
V_3: Arka Komal	3.12	2.91	3.02	2.47	2.29	2.38
V_4: HAFB-4	2.41	2.09	2.25	1.81	1.68	1.75
V_5: HAFB-2	1.54	1.95	1.75	1.54	1.63	1.58
V_6: Abhay	2.87	2.19	2.53	2.27	2.23	2.25
V_7: Pant Anupama	1.91	1.86	1.88	1.61	1.76	1.69
SEm (±)	**0.10**	**0.17**	**0.45**	**0.04**	**0.07**	**0.34**
$CD_{p\leq0.05}$	**0.21**	**0.37**	**0.94**	**0.08**	**0.14**	**0.71**

Table 6. *Per se* performance of ascorbic acid content (mg.100g^{-1}of edible part) in fresh pods of different varieties of French bean

Variety	Ascorbic Acid Content (mg.100g^{-1}of edible part)					
	Organic Growing Condition			Untreated Control Condition		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
V_1: Brunda	287.64	279.03	283.33	273.33	271.10	272.22
V_2: Swarna Priya	277.11	256.22	266.67	226.67	225.66	226.17
V_3: Arka Komal	264.24	291.32	277.78	262.78	251.35	255.56
V_4: HAFB-4	294.34	303.43	298.89	270.89	273.55	272.22
V_5: HAFB-2	274.88	280.69	277.78	265.10	257.13	261.11
V_6: Abhay	351.71	303.86	327.78	287.98	289.79	288.89
V_7: Pant Anupama	329.36	303.99	316.67	281.46	285.19	283.33
SEm (±)	**8.86**	**5.11**	**27.79**	**2.03**	**1.06**	**18.52**
$CD_{p\leq0.05}$	**19.30**	**11.14**	**58.38**	**4.42**	**2.32**	**38.91**

Table 7. Economics of growing French bean under organic growing condition.

Variety	V_1: Brunda		V_2: Swarna Priya		V_3: Arka Komal		V_4: HAFB-4		V_5: HAFB-2		V_6: Abhay		V_7: Pant Anupama	
Growing Condition	Organic	Untreated Control	Organic	Untreated Control	Organic	Untreated Control	Organic	Untreated Control	Organic	Untreated Control	Organic	Untreated Control	Organic	Untreated Control
Total cost of cultivation (Rs. ha^{-1})	100000.00	80000.00	100000.00	80000.00	100000.00	80000.00	100000.00	80000.00	100000.00	80000.00	100000.00	80000.00	100000.00	80000.00
Yield (t ha^{-1})*	20.12	7.93	21.55	10.66	20.10	10.74	26.40	10.37	22.43	9.59	17.83	9.81	17.94	9.74
Farm Gate Price (Rs. kg^{-1})**	15.00													
Total income (Rs. ha^{-1})	301800.00	118950.00	323250.00	158400.00	301500.00	161100.00	396000.00	155550.00	336450.00	143850.00	267450.00	147150.00	269100.00	146100.00
Net income (Rs. ha^{-1})	201800.00	38950.00	223250.00	78400.00	201500.00	81100.00	296000.00	75550.00	236450.00	63850.00	167450.00	67150.00	169100.00	66100.00
B:C ratio (Returns per rupee investment)	**3.02**	**1.49**	**3.23**	**1.98**	**3.02**	**2.01**	**3.96**	**1.94**	**3.36**	**1.80**	**2.67**	**1.84**	**2.69**	**1.83**

**- Pooled mean value of yield & **- average of both year's price were considered*

Results and Discussion

Plant height one of the most important growth attributes of any crop was not greatly influenced by the organic growing condition and in almost all cases plant height surpassed in the untreated control condition (Table 1). Although in both of the growing conditions it showed significant differences (P≤0.05) among varieties. The possible reason behind such an exceptional performance of plant height under the untreated control condition may be due to by default organic status of the experimental plots where more nitrogen may be in available form. On the contrary, in the case of organic growing condition where liquid organic manure (*Sanjeevani*) was applied may be served as plant nutrients provider with their balance proportion and consequently, steadiness expression of both vegetative and reproductive growth phases is sustained. Thereby, pods per plant exceeds in almost all varietal

situates under organic growing condition over its respective untreated control counterpart. This particular yield attribute also recorded significant differences (P≤0.05) under all varietal situates of both growing conditions (Table 2). Liquid organic formulation (*Sanjeevani*) along with its huge microbial load may ensure the supply of necessary plant nutrients as per the need of the plant and this may be the possible cause of the better performance of number of pods per plant under organic growing condition than its respective opposite counterpart.

Fresh pod weight of different varieties was greatly influenced by the application of organic liquid manure and it recorded significant differences (P≤0.05) once again under both of the growing conditions (Table 3). Organic liquid manure '*Sanjeevani*' ensured greater accumulation of dry matter in different varieties of bush-type French bean and this is the probable reason for more pod weight under organic growing condition. Yield is also recorded higher under the organic growing condition with significant differences (P≤0.05) among varieties even under the condition of untreated control (Table 4). The more yield in all varieties as documented in the present study is the consequences of the cumulative effect of the other yield attributes with their better performance under organic growing condition than its respective opposite untreated control growing conditions. Yield is a polygenic trait that is greatly influenced by the genetic makeup of the crop variety as well as its growing environment. Hence, more yield (26.40 tha^{-1}) was documented in the case of V_4 (HAFB-4) under the organic growing condition where the enriched version of *Sanjeevani* (10%) was used as a major source of plant nutrients. Similar, observation was also reported by the previous investigations of Mahto & Dutta (2018); Dutta & Majee (2021); Mahto & Dutta (2021).

Proximate quality traits of the crop were also influenced by the application of organic liquid manure (*Sanjeevani*). Therefore, higher total soluble solids (TSS) were estimated under all varietal situates of organic growing condition (Table 5). Higher accumulation of dry matter in organically grown varieties justified the synchronizing effect of *Sanjeevani* as applied in the present investigation over the expression of the proximate quality traits. Ascorbic acid one of the most important quality attributes having anti-oxidant properties performed extraordinarily well under organic growing or even under untreated control condition with significant differences (P≤0.05) among varieties (Table 6). The current findings of the study are in close corroboration with the previous works [Mahto & Dutta (2018); Mahto & Dutta (2021)]. It has been revealed that a stressed environment is created under the regulated supplying condition of plant nutrients where organic sources of manures are applied which induces synthesis of phytonutrients as a self-defense inherent mechanism of any living entity. Hence, a comparatively higher amount of ascorbic acid was synthesized in all varieties under both of the growing conditions.

The economic aspect of crop production is the prime concern of the growers. Thus, the economics of growing

the crop varieties under organic and by default organic (untreated control) conditions was taken into consideration. In this context, the total cost of cultivation as estimated here was Rs.100000.00 ha^{-1} under organic growing condition but Rs.80000.00 ha^{-1} under by default organic (untreated control) condition (Table 7). From the study, it was also found that cultivation of French bean is possible even on a commercial scale under organic or by default organic growing condition with the possibility of obtaining Rs. 1.49 (minimum: untreated control in V_1: Brunda) to Rs. 3.96 (maximum: organic growing condition in V_4: HAFB-4) per rupee of investment (Table 7). The higher level of profit as documented in the present investigation in all varieties under both growing conditions is primarily due to the lower cost of production besides being the optimum yield potential of the varieties being employed in the present study.

From the above findings, it may be concluded that organic farming is a better alternative for good quality fresh pod production of French bean even on a commercial scale during post-kharif season by applying *Sanjeevani* (10%) as a potential low-cost organic source of plant nutrients under the south Chhota Nagpur plateau region of eastern India.

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