Influence of different low-cost organic inputs on growth, yield and quality of French bean (*Phaseolus vulgaris* L.) cv. Swarna Priya

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**ABSTRACT**

The present investigation was conducted during *rabi* seasons of 2016-17 and 2017-18 in the organic experimental farm of the institute by employing French bean cv. Swarna Priya. The experiment was designed after RCBD considering five organic treatments, *viz.*: *Amritjal* (1%); *Sanjivani* (10%); *Shasyagavya* (10%); *FYM* @ 6 t ha⁻¹ + Vermicompost @ 3 t ha⁻¹; and *T₂*; Absolute Control. Different growth, yield and quality attributes of the crop were highly influenced by different organic treatments. In this context, *T₃*; *Shasyagavya* (10%) emerged as the best treatment with the highest green pod yield of 21.15 t ha⁻¹. However, quality contributing characters performed indifferently under the exposures of organically designed treatment conditions. Though, *T₄* (Shasyagavya 10%) once again materialized as the best treatment with higher amount of dry matter (9.54%), TSS (4.60°Brix), ascorbic acid (65.27 mg 100g⁻¹) and protein content (10.63 %) in edible green pods, respectively.

**Key words:** *Amritjal*, French bean, Growth, Quality, *Sanjivani*, *Shasyagavya*, Yield.

**INTRODUCTION**

French bean (*Phaseolus vulgaris* L.) also known as green bean or common bean is a herbaceous annual of the plant family 'Fabaceae'. It is believed to have been originated in the new world, most specifically in the Central and South America (Kaplan, 1981). French bean is an important cool season legume vegetable grown for its tender pods, shelled green beans as well as dry beans and it is the most important source of protein for direct human consumption (Singh, 2001; Broughton *et al.*, 2003). It is a good source of different essential amino acids (Kelley, 1972) and the crop has the potential to prevent different diseases including diabetes and cardiac breakdowns (Duke, 1981). There are about 2.30 lakh hectares of land under cultivation of beans in India with production tune of about 22.49 lakh tonnes in 2016-17 (NHB-Database, 2017a). However, most of the commercial growing pockets of our country utilize different chemical fertilizers and pesticides for growing the crop (NHB-Horticultural Statistics at a Glance, 2017b). Thereby, the quality of produce is deteriorating day by day due to presence of toxic residues of different banned pesticides or other agrochemicals. In beans such evidence has recently been exposed through the study conducted by the Society for Promotion of Wastelands Development (Tol, 2017). Besides, the gradual rise of input costs in conventional chemical farming makes it nearly impossible to grow this crop by the small and marginal farmers of our country. On the other hand, organic farming is relying on low cost involving production technology in which locally available resources are utilized to prepare different organic liquid inputs for growing the crop as an alternative and sustainable approach of production practices. These low cost involving organic inputs have greater role in growth, yield and quality attributes of different crops (Dutta and Adak, 2016; Nag and Dutta, 2017; Rambuatsaiha and Noyingthung, 2017; Dutta *et al.*, 2018). Different low cost organic liquid formulations have lower amount of plant nutrients especially NPK, but they contain huge number of beneficial microbes those are actively involved in the process of mineralization after their application in soil and thereby improve the soil structure (Swami and Ali, 2012a; Oraon *et al.*, 2015; Mohanta *et al.*, 2015; Mallick, 2016). The microbes’ presence in organic liquid manures also starts to break down the available nutrients into a form that can be easily taken up by plants (Mallick, 2016). A study conducted by Swami and Ali (2012a) documented 0.083-0.086%; 0.113-0.118%; 0.013% and 0.045-0.056%: 0.062-0.088%; 0.0032-0.0077% of available N: P: K in 20% of *Shasyagavya* and *Sanjivani*, respectively. Considering all the above mentioned valuable aspects, the present investigation was conducted with highlighting on the effect of different organic manures and organic liquid formulations over the growth, yield and quality attributes of French bean cv. Swarna Priya.

**MATERIALS AND METHODS**

The details of materials and methodology followed for the present investigation has been emphasized through following sub-sections:

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Experimental site, conditions, design and material: The experiment was conducted in the Organic Experimental Farm of Getalsud (Latitude: 23°26'36"N; Longitude: 85°32'45"E and Altitude: 508.0 m) under Angara block of Ranchi district of Jharkhand during rabi seasons of 2016-17 and 2017-18 by employing French bean cultivar ‘Swarna Priya’. Randomized complete block design (RCBD) was adopted in conducting field experiment by incorporating five (5) organically designed treatments with their four (4) replications in twenty (20) experimental plots each of with 2.25 m x 2.25 m sizes (=50 m²). Seeds were treated with Rhizobium @ 20 g kg⁻¹ before sowing them at 45 cm inter row and 15 cm intra row spacing in the experimental plots.

Details of treatments and their application: T₁: Amritjal (1%); T₂: Sanjivani (10%); T₃: Shasyagavya (10%); T₄: FYM @ 6 t ha⁻¹ + Vermicompost @ 3 t ha⁻¹ (applied as basal dose only); and T₅: Absolute Control. Poultry manure @ 2.5 t ha⁻¹ and wood ash @ 2.5 t ha⁻¹ were applied in all experimental plots as basal dose 7-days before sowing of seeds. Organic liquid manures in the cases of T₁, T₂ and T₃ treatments @ 1 litre m⁻² were applied after 15-days of sowing five times @ 15-days interval as split applications. For preparation of Amritjal, fresh cow dung: cow urine: water @ 1:1:10-proportions (cow dung and cow urine should preferably be of indigenous cow’s origin) were mixed with 50 g of molasses and kept the mixture for 3-days for fermentation. During fermentation, the mixture was stirred twice daily, preferably during the morning and evening hours by using a wooden stick/ladle. Organic input thus obtained after 3-days of fermentation has 10% concentration considering proportion of cow urine used for the purpose as against the quantity of water added to prepare Amritjal. Sanjivani was prepared by mixing fresh cow dung: cow urine: water @ 1:1:2-proportions and kept the mixture for fermentation for 7-days. During fermentation stirred the material twice daily and finally the liquid organic formulation, thus obtained has 50% of its concentration when liquid (cow urine) – liquid (water) ingredients were taken into account as mentioned in the case of Amritjal preparation (Swami and Ali, 2012b). For the preparation of Shasyagavya again fresh cow dung: cow urine: kitchen waste: water @ 1:1:1:2-proportions were mixed and kept 9-days for fermentation. During fermentation, the mixture was used to stir hastily as mentioned in Amritjal preparation. After 9-days of fermentation, the organic liquid formulation with its 50% concentration was obtained (here, the 50% strength of the Shasyagavya arises due to addition of 2 (two) parts of water as against the 1 (one) part of cow urine). The required concentration of organic liquid manures was prepared by using the formula, \( V_{S_1} = V_{S_2} \) (where, \( V_{S_1} \& V_{S_2} \) represent initial and final volume and \( S_1 \& S_2 \) represent initial and final strength of the organic liquid formulation, respectively). The plant nutrients content in different organic liquid formulations as well as organic manures applied as treatments were evaluated before their application. In this context, available N: P in different organic liquid formulations like Amritjal (1%), Sanjivani (10%) and Shasyagavya (10%) were 0.050%:0.0023%:0.069%, 0.048%:0.0019%:0.066% and 0.057%:0.0056%:0.052%, correspondingly. Similarly, different organic manures applied as treatment as well as basal dose namely FYM, vermicompost, poultry manure and wood ash content total available N: P @ 0.51%:0.26%: 0.80%, 1.51%:2.03%: 1.17%, 1.74%:0.82%:0.49% and 0.00%:0.97%:2.59%, respectively.

Organic plant protection measures: Mulching with dry paddy straw at three (3) inch thickness was adopted to prevent weed infestation. Tobacco stalk decoction @ 10% was applied at 15-days interval starting from 15-days after sowing as prophylactic measures against pest infestations. Yellow sticky traps were installed @ one (1) per 10 m² running experimental plot area to check sucking pests. Whey water diluted three (3) times with normal tap water and then mixed with turmeric powder @ 10g litre⁻¹ of diluted solution and finally applied at 15-days interval starting from 21-days after sowing as precautionary measures against pathogenic infections.

Observations recorded and data analyses: Different growth and yield attributes of the experimental crop viz. plant height (at harvest) (cm), number of primary branches plant⁻¹, days required to 50% flowering, pod length (cm), average pod weight (g), and green pod yield (t ha⁻¹) were taken time to time. Similarly, different quality attributes like the dry matter content of green pod (%), TSS (‘Brix), ascorbic acid (mg 100g⁻¹) by the dye titration method and protein (%) of edible pods by Kjeldahl method were analyzed. The data thus obtained were subjected to statistical analysis by the Analysis of Variance method (Gomez and Gomez, 1984) and the significance of different sources of variations were tested by Error Mean Square by Fisher and Snedecor’s ‘F’ test at probability level 0.05. For determination of critical difference at 5% level of significance, Fisher and Yates’ table was consulted.

RESULTS AND DISCUSSION

The findings of the experiment regarding growth and yield attributes as well as quality traits have been categorically represented as per the followings:

Growth and yield attributes: The results illustrated that almost all the growth and yield attributes taken into account in this investigation were greatly influenced by the intervention of different organically designed treatments with statistically significant (Ps0.05) differences among different treatments (Table 1). In this context, higher plant height at first harvest (46.92 cm) was recorded in the case of Shasyagavya (10%) i.e. in T₃ treatment, whereas, the lowest plant height (37.66 cm) was recorded in the case of absolute control (T₅) where no organic input was applied. In the case of trait like days required to 50% flowering there was no


| Treatment                  | 2016-17 T-1 | 2016-17 Mean | 2017-18 T-1 | 2017-18 Mean |
|----------------------------|-------------|--------------|-------------|--------------|
| Plants height (cm)         |             |              |             |              |
| T-1 Sanjivani (10%)        | 43.69±0.07  | 44.87±0.12   | 43.45±0.17  | 44.87±0.12   |
| T-1 Shasyagavya (10%)      | 42.46±0.08  | 43.58±0.17   | 43.61±0.17  | 44.87±0.17   |
| T-2 FYM @ 6 t ha⁻¹ + Vermicompost @ 3 t/ha⁻¹ | 43.87±0.26 | 43.91±0.21 | 43.61±0.17 | 44.67±0.17 |
| T-3 Absolute Control       | 36.52±0.32  | 37.66±0.38   | 37.53±0.34  | 36.53±0.34   |
| Mean                       | 41.65±0.21  | 43.59±0.21   | 43.59±0.21  | 44.47±0.21   |

| Pod length (cm)            |             |              |             |              |
|----------------------------|-------------|--------------|-------------|--------------|
| T-1 Sanjivani (10%)        | 44.67±0.06  | 45.00±0.10   | 44.67±0.10  | 45.00±0.10   |
| T-1 Shasyagavya (10%)      | 44.14±0.08  | 45.00±0.10   | 44.67±0.10  | 45.00±0.10   |
| T-2 FYM @ 6 t ha⁻¹ + Vermicompost @ 3 t/ha⁻¹ | 44.67±0.08 | 44.67±0.09 | 44.67±0.09 | 44.67±0.09 |
| T-3 Absolute Control       | 36.52±0.32  | 37.66±0.38   | 37.53±0.34  | 36.53±0.34   |
| Mean                       | 44.00±0.22  | 45.00±0.10   | 44.67±0.10  | 45.00±0.10   |

| Pods/branch                |             |              |             |              |
|----------------------------|-------------|--------------|-------------|--------------|
| T-1 Sanjivani (10%)        | 6.47±0.11   | 6.67±0.14    | 6.47±0.11   | 6.67±0.14    |
| T-1 Shasyagavya (10%)      | 5.60±0.14   | 5.60±0.14    | 5.60±0.14   | 5.60±0.14    |
| T-2 FYM @ 6 t ha⁻¹ + Vermicompost @ 3 t/ha⁻¹ | 5.67±0.14 | 5.67±0.14 | 5.67±0.14 | 5.67±0.14 |
| T-3 Absolute Control       | 3.88±0.21   | 3.88±0.21    | 3.88±0.21   | 3.88±0.21    |
| Mean                       | 5.60±0.21   | 5.60±0.21    | 5.60±0.21   | 5.60±0.21    |

| No. of primary branches/plant | 5.96±0.15 | 5.74±0.15 | 5.60±0.15 | 5.60±0.15 |
|-------------------------------|-----------|-----------|-----------|-----------|
| T-1 Sanjivani (10%)            | 6.47±0.11 | 6.67±0.14 | 6.47±0.11 | 6.67±0.14 |
| T-1 Shasyagavya (10%)          | 5.60±0.14 | 5.60±0.14 | 5.60±0.14 | 5.60±0.14 |
| T-2 FYM @ 6 t ha⁻¹ + Vermicompost @ 3 t/ha⁻¹ | 5.67±0.14 | 5.67±0.14 | 5.67±0.14 | 5.67±0.14 |
| T-3 Absolute Control           | 3.88±0.21 | 3.88±0.21 | 3.88±0.21 | 3.88±0.21 |
| Mean                          | 5.60±0.21 | 5.60±0.21 | 5.60±0.21 | 5.60±0.21 |

| Dry matter content % (9.54%), TSS (4.60°Brix), ascorbic acid (65.27 mg 100 g⁻¹) and protein (10.63%) | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
|----------------------------------------------------------------------------------------------------------|------------|------------|------------|------------|
| T-1 Sanjivani (10%)                                                                                     | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
| T-1 Shasyagavya (10%)                                                                                   | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
| T-2 FYM @ 6 t ha⁻¹ + Vermicompost @ 3 t/ha⁻¹                                                            | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
| T-3 Absolute Control                                                                                   | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
| Mean                                                                                                      | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |

| Protein (10.63%), TSS (4.60°Brix), ascorbic acid (65.27 mg 100 g⁻¹) and protein (10.63%) | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
|----------------------------------------------------------------------------------------------------------|------------|------------|------------|------------|
| T-1 Sanjivani (10%)                                                                                     | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
| T-1 Shasyagavya (10%)                                                                                   | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
| T-2 FYM @ 6 t ha⁻¹ + Vermicompost @ 3 t/ha⁻¹                                                            | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
| T-3 Absolute Control                                                                                   | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |
| Mean                                                                                                      | 35.85±0.34 | 36.53±0.34 | 35.85±0.34 | 36.53±0.34 |

Quality contributing traits: Different quality contributing characters of French bean of the present investigation showed statistically significant (P≤0.05) differences among different treatments except in the case of TSS which recorded non-significant differences under organically designed treatment conditions (Table 2). The results revealed that all cases T1 treatment performed extraordinarily well over other treatments. In this context, higher amount of dry matter content (9.54%), TSS (4.60°Brix), ascorbic acid (65.27 mg 100 g⁻¹) and protein (10.63%) were estimated in green pods of the samples collected from the T1 treatment (10% Shasyagavya). It has also been revealed from the findings that almost all quality traits performed well under the exposure of organically designed treatment conditions. This is probably due to presence of different micro-nutrients along with plant growth promoting hormones in organic manures (vermicompost) and organic liquid formulations as well. Dry matter and protein content of green pods as recorded in the present investigation showed close conformity with the previous findings of Meena et al., 2017; Kocira et al., 2018.
Table 2: Per se performance of quality attributing traits of French bean cv. Swarna Priya as influenced by different organically designed treatments.

| Treatment | Dry matter content of green pods (%) | TSS (°Brix) | Ascorbic acid (mg 100g⁻¹) | Protein (%) |
|-----------|--------------------------------------|-------------|----------------------------|-------------|
|           | 2016-17 Mean | 2017-18 Mean | 2016-17 Mean | 2017-18 Mean | 2016-17 Mean | 2017-18 Mean |
| T₁: Amritjal (1%) | 7.95 (8.39, 8.17) | 3.17 (5.08, 4.13) | 57.99 (62.34, 60.17) | 7.16 (9.10, 8.13) |
| T₂: Sanjivani (10%) | 7.30 (8.01, 7.71) | 3.71 (4.21, 3.96) | 52.00 (52.66, 52.33) | 9.28 (8.22, 8.75) |
| T₃: Shasyagavya (10%) | 9.23 (9.84, 9.54) | 4.19 (5.00, 4.60) | 64.54 (66.00, 65.27) | 10.34 (10.91, 10.63) |
| T₄: FYM @ 6 t ha⁻¹ + Vermicompost @ 3 t ha⁻¹ | 7.41 (7.76, 7.59) | 3.58 (4.58, 4.08) | 63.56 (65.65, 64.61) | 7.30 (8.32, 7.81) |
| T₅: Absolute Control | 7.59 (7.86, 7.73) | 3.89 (3.89, 3.98) | 58.98 (60.59, 59.79) | 6.80 (8.20, 7.50) |

Note: *- Significant at P≤0.05 and NS: Non-significant.

However, the findings as recorded in the case of protein content in this experiment are not corroborated well with the earlier observations of Devi, (2012); Prakash and Ram, (2014).

CONCLUSION

From the study, it may be concluded that French bean cv. Swarna Priya is highly responsive to organic growing conditions. In this perspective, Shasyagavya (10%) emerged as the best treatment concerning the expression of growth, yield and quality traits of the crop variety. This low cost involving organic production technology may therefore be recommended for even commercial scale cultivation of the crop or at least comparatively safer green beans production in the south Chhotanagpur regions of the Eastern Indian plateau.

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