

Assessment of Ideal Crop Geometry for Yield Improvement of French Bean during Rabi Season under Irrigated Medium Land Situation of Birbhum District

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Abstract

Cultivation of French bean is limited in the State of West Bengal and less work has been done on the cultivation aspects of French Bean. Therefore, it is the right time to give more emphasis on the evaluation of Plant Spacing and Plant Density for growth performance, yield potential and quality improvement. But, there is hardly any precise and conclusive information available on the on various physiological processes and productivity potential in French bean. Hence, the present investigation was carried out to study the effect of different Plant spacing and plant density i.e. the Crop Geometry on the Growth and yield parameters of French Bean. From the present investigation, it has been found out that less Plant population, wider Plant Spacing and less Plant density give a poorer yield of French Bean Green Pods. From the present Experiment, it can be noted that a Plant Spacing of 30 X 15 cm of the French Bean plants i.e. a plant Density of 22 Plants of French Bean per Square Meter may give an optimum Yield and Profit.

Keywords: French Bean, Plant population, Plant Spacing, Plant density.

French bean (*Phaseolus vulgaris* L.), a short duration leguminous vegetable crop belonging to family Fabaceae is known by various names viz., rajma, rajmah, haricot bean, kidney bean, snap bean, navy bean, field bean, dry bean and pole bean. It is grown for its mature dry seeds as well as for immature tender green pods. French bean is a rich source of protein (17.5 to 28.7% in dry seeds, about 1.0 - 2.5% in green pods), carbohydrates (61.4%), mineral content (3.2 - 5.0%), crude fibre (4.2-6.3%), crude fat (1.2-2.0%) and vitamins A and C.

French bean fetches premium price in market compared to other vegetables and is a popular vegetable grown under both rain fed and irrigated conditions almost throughout the year. It is gaining lot of importance due to its short duration and high production potential as well as its high nutritive value. Besides this, it also possesses some medicinal properties useful in diabetes and certain cardiac problems.

French bean is grown in different parts of the world, occupying an area of 25.91 m ha with a total

production of 18.84 m tons. In India, it is cultivated on a area of 9.72 m ha with a production of 4.34 m tons. The productivity in India is about 447 kg seeds per ha as against world average productivity of 669 kg seeds per hectare. In India, it is extensively cultivated in Uttar Pradesh, Maharashtra, Jammu and Kashmir, Himachal Pradesh and its cultivation is gradually extended to West Bengal, Andhra Pradesh and Karnataka.

Cultivation of French bean is limited in the state and less work has been done on the cultivation aspects of French Bean. Therefore, it is the right time to give more emphasis on the evaluation of Plant Spacing and Plant Density for growth performance, yield potential and quality improvement. But, there is hardly any precise and conclusive information available on the on various physiological processes and productivity potential in French bean. Hence, the present investigation was carried out with the following objectives;

1. To study the effect of different Plant spacing and plant density i.e. the Crop Geometry on the Growth and yield parameters of French Bean.

So, Agronomical practices play an important role for obtaining higher yields especially under greenhouse structures. Newly evolved and superior type of varieties/hybrids of French Bean crops needs to be assessed for their optimum Plant Spacing and Density.

MATERIALS AND METHODS

The present investigation was carried out to study the performance of French Bean Hybrid (*Phaseolus vulgaris* L.) Indam - 2 under different Plant spacing and plant Density of the French Bean crop. The experiment was carried out at the Horticultural Farm, Rathindra Krishi Vigyan Kendra, Palli Shiksha Bhavana, Visva-Bharati, Srniketan, West Bengal, India and Bishnubati Village of Bolpur-srniketan Community Development Block in Birbhum District during the period of April, 2009 to March, 2010.

The materials used and the methodology adopted are furnished here under.

Geographical Location

Birbhum being the northern most district of the Burdwan division lies between the latitude 23° 32' and 24° 35' in the northern hemisphere and 80° 01' 40'' and 87° 05' 25'' longitude. On the map the district (Birbhum) looks like an isosceles triangle. The apex is situated at the northern extremely not far south of the point where the Ganges and the hills of Santhal Parganas of Jharkhand beginning to diverge while the river Ajoy forms the base of the triangle. Birbhum is bounded on the north and west by the Santhal Parganas, by the districts Murshidabad and Burdwan on the east, and on the south by Burdwan. The Birbhum is separated from the Burdwan district by the river Ajoy. The district comprises three subdivisions namely- Bolpur, Rampurhat and Suri. Suri is the head quarter of the district and of the Suri (Sadar)-Division as well.

Experimental Details

The study was conducted by laying a single experiment as detailed below

Area of Study: Village Bishnubati in the Community Development Block of Bolpur-Srniketan in the District of Birbhum.

Crop: French Bean

Hybrids: Indam - 2

Cropping Sequence:

1. Vegetable - Fallow - Vegetable

Micro-Farming Situation:

The farmers cultivated French Bean in irrigated medium land in the Rabi Season.

Number of treatments: Three (03)

Type of treatments:

1. Farmers' Practice (FP) - Plant Spacing 45 X 30 cm i.e. Plant Density 7 plants/sq.m
2. Technology Option (TO) I - Plant Spacing 30 X 15 cm i.e. Plant Density 22 plants / sq.m

3. Technology Option (TO) II – Plant Spacing
45 X 30 cm i.e. Plant Density 7 plants/sq.m

Experimental Design: Randomized Block Design

Number of Replications: Ten (10)

Plot Size/Replication: 0.007 ha

Total Area required: 0.21 ha

Supply of Critical Inputs: Krishi Vigyan Kendra
Share: Seed

Farmers' Shares: Land, Labour, Manures, Fertilizers,
Plant Protection Chemicals.

Monitoring Indicators: (a) Growth of the French
Bean and (b) Yield of the French Bean.

Experimental Procedure

The crop was grown in different plots by adopting the recommended package of practices according to the different Plant spacing and Plant Density of the French Bean.

Characters of the French Bean hybrids

Indam - 2 hybrids were developed by Indo-American Hybrid Seeds Private Limited Company. These hybrids were said to have early fruit bearing character, with highest yield during initial 2 to 3 pickings.

Preparation of Land

The land was ploughed and harrowed twice after the harvest of previous crop followed by planking to bring the soil to a fine tilth.

Mulching

To conserve the soil moisture and prevent weed growth, beds were covered with silver coloured mulch having 30 micron thickness.

Seed source and sowing

Seeds were obtained from Healthy and bold seeds were dibbled in the row to a depth of 5 cm on 2009.

Transplanting

The French Bean seedlings were transplanted according to the transplanting time period. The holes were made on each mark by using PVC pipe. Before transplanting, the seedlings were dipped in 0.2% Bavistin and 2% superphosphate solution for two minutes and were transplanted.

Fertilizer Application

The recommended dose of fertilizers, 50 per cent of nitrogen (60 kg/ha), full dose of phosphorus (100 kg/ha) and full dose of potash (75 kg/ha) was applied in the form of urea, single super phosphate and murate of potash, respectively as a basal dose at the time of sowing. The remaining 50 per cent of nitrogen was applied as top dress 30 days after sowing.

Thinning operation

The seedlings were thinned out by maintaining one plant per hill after 10 days of sowing.

After care

Irrigation was given at critical stages of crop growth and earthing up were done at 30 days after sowing. The plots were kept weed free by inter culturing and hand weeding. The crop was sprayed with Endosulfan @ 1.5 ml/l and Dicophal @ 2.5 ml per l in order to protect the crop from diseases and pests.

Harvesting

The pods were harvested when tender pods attained the size of 8-10 cm length. Pods were handpicked at 4 days interval in 4 pickings.

Collection of experimental data

Five plants were selected randomly from each plot for recording various morphological observations at different stages.

Morphological characters

Plant height

The plant height was measured from the lower cotyledonary node to the growing tip and the mean of five plants was taken and expressed in centimetres.

Number of branches

The number of branches present on the main stem was counted and the mean value of randomly selected five plants was taken to express the number of branches per plant.

Yield and yield components

Tagged plants used for recording morphological observations were harvested at physiological maturity and were used for recording various yield components as listed below.

Number of pods per plant

The numbers of pods were counted from five randomly selected plants and mean was worked out.

Weight of green pod (gm)

The weight was measured for all the pods present in the five tagged plants and average pod weight was worked out.

Green pod yield (Quintals/ha)

From the net plot, pods were harvested when they attained the size of 8-10 cm length.

OBSERVATIONS

Vegetative parameters

Plant height (cm)

Five plants were tagged at random in each treatment for recording the plant height at an interval of 30 days starting from the date of transplanting. The plant height was measured from the ground level to

the growing tip of the main stem at 30, 60, 90 and 120 days after transplanting (DAP). The average height was calculated and expressed in centimetres.

Number of branches per plant

Well developed branches were counted at 30, 60, 90 and 120 days after planting from all the plants tagged for recording observations and the mean of number of branches per plant was worked out.

Reproductive parameters

Number of Green Pods per plant

The number of mature Pods that were harvested from the tagged plants in each picking was recorded till the final harvest.

Individual Green Pod weight (gms.)

The fresh French Bean Pods harvested from the labelled plants from each treatment were weighed and recorded in grams.

Yield parameters

Green Pod Yield Per Plant (Kgs.)

The weight of mature Pods harvested from each picking was recorded till final harvest and total yield of Green Pods per plant was recorded in kilograms.

Green Pod yield per ha (Quintal)

The weight of mature Pods harvested from each picking in tagged plants in each replication was recorded till final harvest and the total yield of Pods per hectare was computed and expressed in Quintals per hectare.

Benefit-Cost Economics

Economics of French Bean production under different protected structures was worked out by considering the present price of inputs and produce.

Net returns (Rs.ha⁻¹) =Gross returns (Rs.ha⁻¹) --- cost of cultivation (Rs.ha⁻¹)

$$\text{Benefit: Cost ratio} = \frac{\text{Net returns (Rs.ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs.ha}^{-1}\text{)}}$$

Statistical analysis

The data pertaining to vegetative and reproductive characters were tabulated treatment and replication wise. The data statistically analyzed by software MSTAT-C. Fisher and Yates tables (1957) were referred for knowing the tabulated values at five per cent level of significance at corresponding degree of freedom. Inferences were drawn as revealed by the analysis of tables.

EXPERIMENTAL RESULTS

The experimental results obtained from the present study hybrids are furnished here, under the following sub-headings.

Vegetative characters

Plant height (cm)

The data on plant height at different stages of crop growth as influenced by Plant Spacing are presented in Table 1.

CD at 5 Percent Level of Significance was 2.29.

The plant height of French Bean differed significantly due to the Plant Spacing. In the Table 1 we could find out that the Average Plant Height was highest in the French Bean Crops which had a Plant density of 22 Plants / sq. m and that Average Height was 21.43 cm. As the Plant Density was reduced the Average Plant Height were decreased. The Average Plant Height was lowest in the French Bean Crops having a Plant Density of 7 Plants / sq. m in the Farmers’ Practice and that was 18.95 cm.

Number of Branches per plant

The data on number of Branches per plant at different Plant Spacing of the French Bean seedlings are presented in Table 2.

The Average Number of Branches per Plant of French Bean differed significantly due to the Plant Spacing. In the Table 2 we could find out that the Average Number of Branches per Plant was highest in the French Bean Crops which had a Plant Density of 22 Plants / sq. m and that Average Number of Branches per Plant was 10.95. As the Plant Density got reduced the Average Number of Fruits per Plant were decreased. The Average Number of Branches per Plant was lowest in the French Bean Crops having a Plant Density of 7 Plants / sq. m in the Farmers’ Practice and that was 7.48.

Table 1. Average Plant Height (cms.) Per Plant

Sl. No.	Treatment	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀	Total	Average
01.	FP	17.8	16.8	16.8	17.0	15.5	16.8	17.0	17.2	16.8	17.0	168.7	16.87
02.	TO I	20.5	19.0	19.9	22.5	20.8	23.5	22.5	21.0	21.8	22.8	214.3	21.43
03.	TO II	20.2	18.2	19.8	18.0	17.2	17.8	20.0	18.8	19.2	20.5	189.5	18.95

Table 2. Average Number of Branches per Plant

Sl. No.	Treatment	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀	Total	Average
01.	FP	7.2	7.5	7.8	7.8	8.2	8.0	7.8	6.8	6.5	7.2	74.8	7.48
02.	TO I	10.2	10.5	9.8	11.8	12.2	11.8	10.8	10.0	10.2	12.2	109.5	109.5
03.	TO II	8.5	8.2	9.0	9.2	9.5	9.2	8.5	9.0	9.4	9.5	90.0	9.00

CD at 5 Percent Level of Significance was 1.57.

Yield Characters

Average Number of Green Pods per Plant

The Data on Average Number of Green Pods per Plant are presented in the Table 3.

The Average Number of Green Pods per Plant of French Bean differed significantly due to the Plant Spacing. In the Table 3 we could find out that the Average Number of Green Pods per Plant was highest in the French Bean Crops which had a Plant Density of 22 Plants / sq. m and that Average Number of Green Pods per Plant was 24.56. As the Plant Density decreased the Average Number of Green Pods per Plant were decreased. The Average Number of Green Pods per Plant was lowest in the French Bean Crops having a Plant Spacing of 45 X 30 cm as in the case of the Farmers' Practice and that was 17.46.

Average Green Pod Weight in Each Plant

The Data on Average Green Pod (Gms.) in each Plant are presented in the Table 4.

The Average Green Pod Weight in each Plant of French Bean differed significantly due to the differences in the Plant Spacing and Plant Density. In

the Table 4 we could find out that the Average Green Pod Weight in each Plant was highest in the French Bean Crops having a Plant Density of 22 Plants / sq. m and that Average Green Pod Weight in each Plant was 63.59 Gms. As the Plant Density decreased the Average Green Pod Weight in each Plant were decreased. The Average Green Pod Weight in each Plant was lowest in the French Bean Crops having a Plant Density of 7 Plants / sq. m as practiced by the farmers and that was 46.41 Gms.

Average Green Pod Yield per Plant (kgs.)

The Data on Green Pod Yield per Plant in kilograms are presented in the Table 5.

The Average Green Pod Yield per Plant of French Bean differed significantly due to the differences in the Plant Density. In the Table 5 we could find out that the Average Green Pod Yield per Plant was highest in the French Bean Crops having a Plant Density of 22 Plants / sq. m and that Average Yield per Plant was 1.57 Kilo Grams. As the Plant Density of the French Bean Crop decreased, the Average Green Pod Yield per Plant was decreased. The Average Green Pod Yield per Plant was lowest in the French bean Crops having a Plant density of 7 Plants / Sq. m and that was 0.81 Kilo Grams.

Table 3. Average Number of Green Pods per Plant

Sl. No.	Treatment	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀	Total	Average
01.	FP	18.5	17.8	16.8	17.5	18.0	16.8	17.5	16.2	18.0	17.5	174.6	17.46
02.	TO I	24.8	26.5	25.5	21.5	25.2	24.5	23.8	24.8	26.0	23.0	245.6	24.56
03.	TO II	22.0	23.2	20.2	19.2	20.2	20.0	21.0	21.5	23.0	19.2	209.5	20.95

CD at 5 Percent Level of Significance was 3.09.

Table 4. Average Green Pod Weight (Gms.) in Each Type of French Bean Plant

Sl. No.	Treatment	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀	Total	Average
01.	FP	45.5	48.0	49.2	47.2	48.0	45.0	40.5	46.0	48.2	46.5	464.1	46.41
02.	TO I	60.8	65.2	66.0	65.2	63.5	62.5	59.0	63.5	66.0	64.2	635.9	63.59
03.	TO II	52.3	60.0	62.5	59.2	55.8	58.2	48.2	57.2	59.5	56.8	569.7	56.97

CD at 5 Percent Level of Significance was 7.08.

Table 5. Average Green Pod Yield Per Plant in Kgs.

Sl. No.	Treatment	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀	Total	Average
01.	FP	0.84	0.86	0.83	0.83	0.87	0.76	0.71	0.75	0.87	0.81	8.13	0.81
02.	TO I	1.52	1.73	1.69	1.40	1.60	1.53	1.41	1.58	1.72	1.48	15.66	1.57
03.	TO II	1.15	1.40	1.26	1.14	1.13	1.17	1.01	1.23	1.37	1.10	11.96	1.20

Average Green Pod Yield per Hectare(Quintals)

The Data on Green Pod Yield per Hectare in quintals are presented in the Table 6.

The Average Green Pod Yield per Hectare of land under French Bean Crop differed significantly due to the differences in the Plant Density. In the Table 6 we could find out that the Average Green Pod Yield per Hectare was highest in the French Bean Crops having a Plant Density of 22 Plants / sq. m and that Average Yield per Hectare was 131.08 Quintals. As the Plant Density of the French Bean Crop decreased, the Average Green Pod Yield per Hectare was decreased. The Average Green Pod Yield per Hectare was lowest in the French bean Crops having a Plant density of 7 Plants / Sq. m and that was 109.87 Quintals.

Benefit-Cost economics

The data of benefit-cost economics was presented in the Table 7.

The Ten Numbers of TO I Treatment plots gave the maximum yield of 131.08 Quintals per Hectare followed by TO II plots which gave a Yield of 121.86 Quintals per Hectare. FP Plots gave a poor Yield of 109.87 Quintals per Hectare.

Table 7 clearly showed us that the cost of cultivation was highest in the TO I Plots which were Rs. 14,480.00 per Hectare. This was because higher amount production needed to be harvested and that required higher labour cost for plucking the French Bean Green Pods. The cost of cultivation was lowest in the FP Plots which were Rs. 12,370.00 per Hectare.

Table 6. Average Green Pod Yield Per Hectare in Quintals

Sl. No.	Treatment	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀	Total	Average
01.	FP	110.2	105.0	111.0	112.5	115.0	108.0	112.0	106.0	109.0	110.0	1098.7	109.87
02.	TO I	122.8	120.0	135.0	129.5	137.5	129.0	133.0	131.5	138.0	134.5	1310.8	131.08
03.	TO II	120.2	113.5	123.0	117.2	126.2	118.0	123.5	123.0	131.0	123.0	1218.6	121.86

CD at 5 Percent Level of Significance was 9.42.

Table 7 pointed out that the Gross Income from the TO I Plots was highest and that was Rs. 78,648.00 per Hectare followed by TO II Plots where the Gross Income was Rs. 70,678.00 per Hectare. The per hectare Gross Income was lowest in the FP Plots where it was only Rs. 60,830.00.

Table 8 also revealed that Net Profit per Hectare was highest in the TO I Plots which were Rs. 64,168.00 followed by the TO II Plots which was Rs. 57,003.00. The per Hectare Net Profit was lowest in the FP Plots which were only Rs. 48,460.00.

From the Benefit: Cost (B: C) Ratio Analysis, we found out that the B: C Ratio was highest in the TO I Plots where it was 5.43 followed by the TO II Plots where it was 5.17. The Benefit: Cost Ratio was lowest in the FP Plots.

Table 7. The Benefit-Cost Economics of French Bean Cultivation

Sl. No.	Treatment type	Yield (Quintals/ Hectare)	Cost of Cultivation (Rs. / Hectare)	Gross Income (Rs. / Hectare)	Net Profit (Rs. / Hectare)	Benefit: Cost (B:C) Ratio
01.	FP	109.87	12,370.00	60,830.00	48,460.00	4.92
02.	TO I	131.08	14,480.00	78,648.00	64,168.00	5.43
03.	TO II	121.86	13,675.00	70,678.00	57,003.00	5.17

Pest Disease Infestation Profile

There was no heavy infestation of pest and diseases in the treatment Plots. The observation in this regard was as follows:

1. Infestation of Pod Borer was low.

CONCLUSION

From the above experiment, we can safely conclude that less Plant population, wider Plant Spacing and less Plant density give a poorer yield of French Bean Green Pods. From the present Experiment, it can be noted that a Plant Spacing of 30 X 15 cm of the French Bean plants i.e. a plant Density of 22 Plants of French Bean per Square Meter may give an optimum Yield and Profit.