



Influence of mulching and plant spacing on growth and yield of french bean (*Phaseolus vulgaris* L.)

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Abstract

A field experiment was conducted at the Horticulture Farm of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh to investigate the effect of mulching and plant spacing on the growth and yield of French bean during the period from November 2014 to January 2015. The experiment consisted of three types of mulching namely (i) control (without mulch), (ii) water hyacinth and (iii) black polythene mulch and three levels of spacing viz., (i) 30 cm x 25 cm (ii) 30 cm x 20 cm and (iii) 30 cm x 15 cm. The experiment was laid out in randomized complete block design with three replications. Results showed that both mulching and plant spacing significantly influenced the growth and yield components of French bean. Black polythene mulch produced the highest yield (5.82 t/ha) and the lowest yield (4.92 t/ha) was recorded from no mulch treatment. The maximum yield (6.22 t/ha) was obtained from 30 cm x 15 cm plant spacing and the lowest (4.58 t/ha) was obtained with 30 cm x 25 cm plant spacing. The combined effects of mulching and plant spacing were statistically significant. The combination of black polythene mulch with 30 cm x 15 cm spacing gave the highest yield (6.97 t/ha) and the lowest yield (3.94 t/ha) was received from without mulching at spacing of 30 cm x 25 cm treatment combination. Considering the above findings the black polythene mulch with 30 x 15 cm plant spacing may be recommended for French bean cultivation.

Key words: Mulch, polythene sheet, plant spacing, growth, yield, french bean

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Introduction

French bean (*Phaseolus vulgaris* L.) is one of the most important vegetable crops belongs to the family Leguminosae which originated in the Central and South America (Swiaderet *al.*, 1992). It is extensively grown commercially as well as in the home garden. In Bangladesh, it is known as "Farashi shim" (Rashid, 1993) and are mainly used as green vegetables. Its edible immature pods supply protein, carbohydrate, fat, fiber, thiamin, riboflavin, Ca and Fe (Shanmugavelu, 1989) and the seed contains significant amount of thiamine, niacin, folic acid as well as fiber (Rashid, 1999). Major French bean

growing districts in Bangladesh are Sylhet, Cox's Bazar, Chittagong Hill Tracts. Recently cultivation of French bean is going popularity in Bangladesh mainly because of its demand as a commodity for export.

Production of French bean depends on many factors such as quality of seed, variety, fertilizer management, soil moisture, plant spacing and proper management practices. Among them, soil moisture is one of the most important determinants which affect crop growth and yield to a great extent. In

Bangladesh, French bean is grown in winter season (October-April) when rainfall is scarce. The rainfall pattern during this period is erratic and evapotranspiration is high. As a result, most of the time crop suffers from water stress. Water stress limits French bean growth and development and this stress is one of the reasons of low pod yield of French bean in the country (Mostarinet *al.*, 2005). Therefore, irrigation becomes essential for providing sufficient moisture to the growing crop. Since irrigation water is costly and its judicious application is essential which can be adjusted through standardizing the frequency of irrigation. But where irrigation facilities are not available mulching could be an effective cultural practice to increase soil moisture status thus helps in increase French bean production in a sustainable way. With the help of mulching materials such as crop residues or plant species or polythene sheet soil surface is covered and these are generally practiced in the production of horticultural crops (Wilhoitet *al.*, 1990). Mulching conserves soil moisture and helps to improve soil physical conditions by enhancing biological activity (Mann and Chakor, 1989).

Plant spacing is another factor that affects the yield contributing characters and yield which can be manipulated to maximize yield. With higher spacing vegetative growth enhances because of less competition of nutrients, light, moisture and space but yield potential decreases. Population density modifies the canopy structure and influence light interception, dry matter production and yield of the crop (Parwaret *al.*, 2007; Fukaiet *al.*, 1990). Optimum plant spacing is essential for attaining desired yield because high planting density results in reduction in number of pods per plant and seeds per pods reported by Kuenemanet *al.* (1979). Optimization of plant density is essential for maximizing yield of good quality French bean and thus the yield potential of French bean could be increased through the suitable combination of mulching and plant spacing. Information regarding mulching and plant spacing on French bean is scanty in scientific literature. The present study, therefore, was undertaken to test the influence of mulching and plant spacing on the growth and yield of French bean.

Materials and Methods

The research work was conducted at the Horticulture Farm of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh to investigate the effect of mulching and plant spacing on the growth and yield of French bean during the period from November 2014 to January 2015. Plant material of variety BARI Zharshim-1 was used in the study. The seeds were collected from the Vegetable Division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. The two-factor experiment had three different mulching and three different spacings such as, Factor A: mulching materials, *viz.*, (i)M₀: No mulch (control), (ii)M₁: water hyacinth mulch, (iii) M₂: black polythene mulch; and Factor B: plant spacing namely (i)S₁: 30 cm x 25 cm, (ii)S₂: 30 cm x 20 cm, (iii)S₃: 30 cm x 15 cm. The experiment was laid out in randomized complete block design with three replications. There were nine treatment combinations. Each block consisted of nine unit plots. The size of each unit plot was 1.8 m x 1.5 m. Spacing of 1.0 m x 0.5 m were provided between the blocks and plots, respectively.

At first the land was ploughed with a power tiller and kept open to sunlight. Afterwards the experimental plot was prepared by several ploughing and cross ploughing followed by laddering. The land was fertilized with cow dung 10 t/ha, urea 50 kg/ha, Triple Super Phosphate (TSP) 160 kg/ha and Muritae of Potash (MoP) 160 kg/ha (BARC, 2012). The entire amount of well decomposed cow dung, TSP, MoP and half of urea were applied during final land preparation. Rest amount of urea were applied at two installments at 15 and 30 days after sowing. Black polythene and water hyacinth were placed on the respective plots as per treatments before seed sowing. Dried water hyacinth was cut into small pieces and black polythene sheet with small openings were made at proper plant to plant and row to row spacing on the respective plots as per layout. The thickness of mulch maintained for water hyacinth was 8-10 cm. Two seeds were sown in each hill at a depth of 3 cm according to treatment. When the plants got established, one healthy plant per hill was kept

and remaining one was plucked. Weeding and mulching were done as and when necessary.

Ten plants were randomly selected from inner side of each plot to avoid border effect. For data collection green pods were harvested at tender stage when they were nearly full with the seeds still small (about one-quarter developed) with firm flesh (Swaideret al., 1992). Collected data on yield and yield controlling characters under study statistically analyzed to find out the significance of difference among treatment means. The means for all the treatments were calculated and analysis of variances for most of the characters under consideration was performed by F variance test. The significance of the difference between pairs of means was evaluated by least significant difference test (LSD) (Gomez and Gomez, 1984).

Results and Discussion

Plant height: Different mulching materials significantly influenced the plant height. The maximum plant height attained with black polythene mulch (M_2) was 54.96 cm at 45 days after sowing

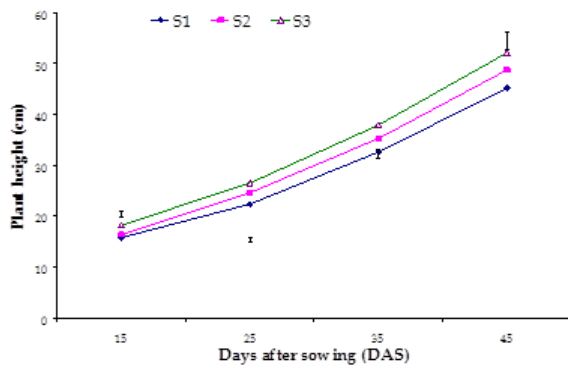


Figure 1. Effect of mulching on the plant height of French bean at different DAS. Vertical bars represent LSD at 0.01 level of probability. M_0 = No mulching, M_1 = Water hyacinth mulching and M_2 = Black polythene mulching.

Number of flowers per plant: The variation in number of flowers produced per plant under different mulch was found statistically significant (Table 2). The maximum number of flowers (22.65) was

produced by the plant grown with black polythene followed by water hyacinth mulch which was statistically similar. The minimum number of flowers (17.77) was obtained in no mulch (Table 2). (DAS). The minimum plant height 43.26 cm was found where nomulch was applied (Figure 1). This is due to mulching may be attributed to higher plant height caused by favorable condition utilized by plants as reported by Safiullahet al.,1996. Variation due to the effect of different plant spacing on plant height at 15, 25, 35 and 45 DAS was found significant. The closest plant spacing i.e. 30 x 15 cm produced the tallest plant (52.15 cm) whereas 30 x 25 cm plant spacing produced the shortest plant (45.23 cm) (Figure 2). Similar trend was reported by Singh (2011) who reported that at lower spacing produced higher plant height. The interaction effect of mulching and spacing was found to be significant at different days after sowing. The tallest plant (57.50 cm) was found at 45 DAS from the treatment combination of M_2S_3 (black polythene mulch with shortest spacing of 30 cm x 15 cm) and the smallest plant (39.67 cm) produced by the treatment combination of M_0S_1 (no mulch with highest spacing of 30 cm x 25 cm) (Table 1).

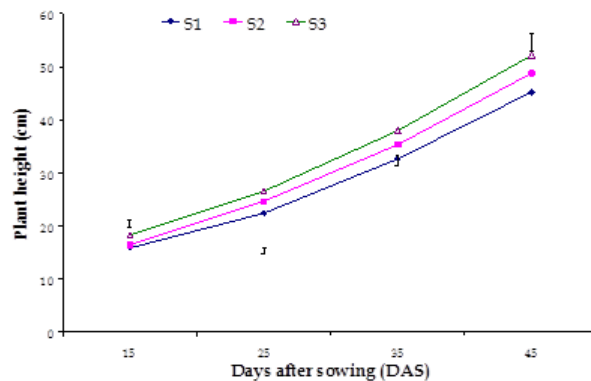


Figure 2. Effect of plant spacing on the plant height of French bean at different DAS. Vertical bars represent LSD at 0.01 level of probability. S_1 = 30 cm x 25 cm, S_2 = 30 cm x 20 cm and S_3 = 30 cm x 15 cm.

Mulching and plant spacing on yield of french bean

Table 1. Combined effect of spacing and mulching on plant height of French bean at different days after sowing

Treatments	Plant height (cm) at			
	15 DAS	25 DAS	35 DAS	45 DAS
M ₀ S ₁	14.70	20.15	27.50	39.67
M ₁ S ₁	15.37	22.44	32.69	43.77
M ₂ S ₁	17.42	24.55	37.69	52.25
M ₀ S ₂	15.42	22.26	30.26	42.91
M ₁ S ₂	16.33	24.66	35.49	48.33
M ₂ S ₂	17.50	26.93	40.18	55.14
M ₀ S ₃	17.33	25.11	33.26	47.19
M ₁ S ₃	17.70	26.33	38.44	51.75
M ₂ S ₃	19.70	28.14	42.15	57.50
LSD _(0.05)	0.295	0.219	0.465	0.787
LSD _(0.01)	0.406	0.302	0.640	1.082
Level of significance	**	**	**	**

M₀, M₁ and M₂ indicate no mulching (control), water hyacinth mulching and black polythene mulching, respectively; S₁, S₂ and S₃ indicate at a spacing of 30 cm x 25 cm, 30 cm x 20 cm and 30 cm x 15 cm, respectively; ** indicates significant at 1% level of probability.

Plant spacing had significant effect on number of flowers per plant. The highest number of flowers (22.44) per plant was obtained from plants sown at the closest spacing of 30 cm x 15 cm which was similar to 30 x 20 cm and the lowest number of flowers (18.47) per plant was produced at spacing of 30 x 25 cm (Table 3).

flowers per plant (Table 4). The highest number of flowers (25.14) was observed from the treatment combination M₂S₃ (black polythene mulch with closest spacing of 30 cm x 15 cm) and the lowest (16.55) was found in M₀S₁ (no mulch with wider spacing of 30 cm x 25 cm) treatment combination (Table 4).

The combined effect of different mulching and spacing was significantly influenced the number of

Table 2. Main effect of mulching on yield contributing characters and yield of French bean

Mulching	Number. of flowers plant ⁻¹	Number of pod plant ⁻¹	Length of pod (cm)	Diameter of pod (cm)	Number. of seeds pod ⁻¹	Fresh pod weight plant ⁻¹	Fresh pod yield (t ha ⁻¹)
M ₀	17.77	15.47	11.40	1.09	4.65	53.81	4.92
M ₁	20.28	16.48	12.39	1.17	4.90	56.83	5.23
M ₂	22.65	18.70	13.45	1.22	5.67	58.65	5.82
LSD _{0.05}	0.210	0.253	0.176	0.110	0.100	0.313	0.200
LSD _{0.01}	0.290	0.350	0.243	0.151	0.138	0.433	0.276
Level of significance	**	**	**	**	**	**	**

M₀, M₁ and M₂ indicate no mulching (control), water hyacinth mulching and black polythene mulching, respectively; ** indicates significant at 1% level of probability.

Number of pods per plant: There was a marked influence due to the effect of different mulches on the number of pods per plant (Table 2). Higher number of pods per plant (18.70) was obtained from black polythene mulch on the other hand in case of the plant grown with no mulch treatment had lower number of pods (15.47) per plant.

The on main effect of plant spacing on the number of pods have been presented in (Table 3). The highest number of pods per plant was obtained (18.02) in closest spacing of (30 cm x 15 cm) used and the lowest number of pods per plant was found (15.60) in the widest spacing of (30 cm x 25 cm).

The combined effect of different mulch and spacing was significantly influenced on the number of pods per plant (Table 4). However numerically the highest number of pods (20.14) was observed from the treatment combination M₂S₃ (black polythene mulch with closest spacing of 30 cm x 15 cm) and the lowest number of pods (14.20) was found in M₀S₁ (no mulch with wider spacing of 30 cm x 25 cm) treatment combination.

Length of pod: The length of pod was influenced significantly with the different mulching materials used. The longest pod (13.54 cm) was obtained from M₂ (black polythene mulch). While the shortest pod (11.40 cm) was found from no mulch treatment (Table 2). The results on main effect of plant spacing on the number of pods have been presented in (Table 3). The highest number of pods per plant was obtained (13.54 cm) in closest spacing of (30 x 15 cm) and the lowest number of pods per plant was found (11.42 cm) in the widest spacing (30 cm x 25 cm).

The combined effect of different mulch and spacing significantly influenced the length of pods per plant (Table 4). However, the longest length of pods (14.63 cm) was observed from the treatment combination M₂S₃ (black polythene mulch with closest spacing of 30 cm x 15 cm) and the lowest length of pods (10.11 cm) was found in S₁M₀ (no mulch with wider spacing of 30 cm x 25 cm) treatment combination (Table 4).

Table 3. Main effect of spacing on yield contributing characters and yield of French bean

Spacing	No. of flowers plant ⁻¹	Number of pod plant ⁻¹	Length of pod (cm)	Diameter of pod (cm)	No. of seeds pod ⁻¹	Fresh pod weight(gm) plant ⁻¹	Fresh pod yield (t ha ⁻¹)
S ₁	add	15.60	11.42	1.08	4.72	54.69	4.58
S ₂	missing	17.03	12.28	1.16	4.97	56.20	5.17
S ₃	data	18.02	13.54	1.23	5.52	58.40	6.22
LSD _{0.05}		0.253	0.176	0.110	0.100	0.313	0.200
LSD _{0.01}		0.350	0.243	0.151	0.138	0.433	0.276
Level of significance		**	**	**	**	**	**
S ₁ , S ₂ and S ₃ indicate spacing of 30 cm x 25 cm, 30 cm x 20 cm and 30 cm x 15 cm, respectively;							**
indicates significant at 1% level of probability.							

Diameter of green pod: Mulching had significant influence on diameter of green pod. The thickest (1.22 cm) pod was obtained in plants grown with black polythene and lowest diameter (1.09 cm) was found at no mulch (Table 2). The results on main effect of plant spacing on the diameter of green pods have been presented in (Table 3). The highest diameter of pods per plant was obtained (1.23 cm) in

closest spacing of 30 cm x 15 cm and the lowest diameter (1.08 cm) was found in the widest spacing of 30 cm x 25 cm.

The combined effect of different mulch and spacing significantly influenced on the diameter of pods per plant (Table 4). The highest diameter of pods (1.30 cm) was observed from the treatment combination

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M₂S₃ (black polythene mulch with closest spacing of 30 cm x 15 cm) and the lowest diameter of pods (1.01 cm) was found in (no mulch with wider spacing of 30 cm x 25 cm treatment combination.

Number of seeds per pod: There was significant variation among different mulch materials for number of seeds per pod. The maximum number of seeds per pod (5.67) was obtained from plants grown with (M₂) black polythene mulch (Table 2). The minimum number of seeds per pod (4.65) was found from plant grown with no mulch (M₀).

There was significant variation among different plant spacing for number of seeds per pod. There was an increasing trend in number of seeds per pod with the decrease in spacing (Table 3). The maximum number of seeds per pod (5.52) was obtained in pods from crops sown at closest spacing of (30 cm x 15 cm). The minimum number of seeds per pod (4.72) was found in pods from crops sown at the widest spacing of (30 cm x 25 cm).

The combined effect of mulching and spacing had significant influenced for the number of seeds per pod (Table 4). The highest number of seeds per pod (6.25) was found from the treatment combination of M₂S₃ (black polythene mulch with closest spacing of 30 cm x 15 cm). The lowest number of seeds per pod (4.25) was obtained from the treatment combination of M₀S₁ where no mulch and widest spacing of 30 cm x 25 cm were used.

Fresh weight of pod per plant: The fresh weight of pod was influenced significantly due to different mulching treatment (Table 2). The highest fresh weight of pod per plant (58.65 g) was produced by the black polythene mulch treatments and the lowest (53.81 g) was found from no mulch material applied.

Significant variation was observed in respect of fresh weight of pod per plant due to different plant spacing (Table 3). The maximum weight of fresh green pod (58.40 g) was obtained in pods from crops sown at closest spacing of (30 cm x 15 cm). The

Table 4. Combined effect of spacing on yield contributing characters and yield of French bean

Treatment	No. of flowers plant ⁻¹	Number of pod plant ⁻¹	Length of green pod (cm)	Diameter of green pod (cm)	No. of seeds pod ⁻¹	Fresh pod wt. plant ⁻¹	Fresh pod yield (t ha ⁻¹)
M ₀ S ₁	16.55	14.20	10.11	1.01	4.25	51.57	3.94
M ₁ S ₁	18.67	15.33	11.67	1.08	4.67	55.17	4.81
M ₂ S ₁	20.18	17.28	12.47	1.16	5.25	57.33	5.01
M ₀ S ₂	17.29	15.89	11.50	1.10	4.60	53.40	4.90
M ₁ S ₂	19.47	16.50	12.09	1.17	4.80	56.77	5.13
M ₂ S ₂	22.63	18.69	13.24	1.21	5.50	58.44	5.50
M ₀ S ₃	19.48	16.33	12.59	1.15	5.10	56.47	5.94
M ₁ S ₃	22.69	17.60	13.40	1.25	5.22	58.55	5.75
M ₂ S ₃	25.14	20.14	14.63	1.30	6.25	60.17	6.97
LSD _{0.05}	0.364	0.439	0.305	0.190	0.173	0.543	0.347
LSD _{0.01}	0.500	0.603	0.420	0.261	0.238	0.746	0.476
Level of significance	**	*	**	**	*	**	**

M₀, M₁ and M₂ indicate no mulching (control), water hyacinth mulching and black polythene mulching, respectively; S₁, S₂ and S₃ indicate at a spacing of 30 cm x 25 cm, 30 cm x 20 cm and 30 cm x 15 cm, respectively; * and ** indicate significant at 5% and 1% levels of probability, respectively.

minimum weight of fresh green pod (54.69 g) was found in pods from crops sown at the widest spacing of (30 x 25 cm). The interaction effects of

mulching and spacing were significant on fresh weight of pod per plant (Table 4). The highest fresh weight of pod per plant (60.17 g) was found the

treatment combination M₂S₃ (black polythene mulch with closest spacing of 30 cm x 15 cm). The lowest (51.57 g) was obtained from M₀S₁ (no mulch with wider spacing of 30 cm x 25 cm) treatment combination.

Fresh pod yield: The different mulching was found to influence significantly the pod yield per hectare at harvest (Table 2). It is apparent from table that the highest pod yield (5.82 tha⁻¹) per hectare was found from black polythene mulch (M₂) and the lowest (4.92 tha⁻¹) per hectare was obtained in no mulch treatment.

Plant spacing had significant influence on fresh pod yield per hectare (Table 3). A wide variation was observed among the different plant spacing. The highest fresh pod yield (6.22 tha⁻¹) was obtained from (30 cm x 15 cm) plant spacing. On the other hand, the lowest fresh pod yield (4.58 t ha⁻¹) was found from widest spacing of (30 cm x 25 cm) (Table 3).

The interaction effects of mulching and spacing had significant effect on fresh pod yield per hectare (Table 4). The highest fresh pod yield (6.97 t ha⁻¹) was found the treatment combination M₂S₃ (black polythene mulch with closest spacing of 30 cm x 15 cm). The lowest (3.94 t ha⁻¹) was obtained from M₀S₁ (no mulch with wider spacing of 30 cm x 25 cm) treatment combination.

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