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Research Article

FLOWERING BEHAVIOUR AND SEED YIELD OF FRENCH BEAN AS AFFECTED BY VARIETY

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Abstract

The effect of flowering pattern and floral abscission on the yield and yield attributed characters of French bean varieties were studied in a field of Bangladesh Agricultural Research Institute, Gazipur. There nine varieties were treated- (1) BARI Jharsheem-1 (2) BARI Jharsheem-2 (3) Sylhet local-1 (4) Sylhet local-2 (5) Sylhet local-3 (6) Sylhet local-4 (7) Sylhet local-5 (8) Sylhet local-6 and (9) Sylhet local-7. Among the treatments, the highest number of flower was recorded within 5 to 8 days in BARI Jharsheem-2 although, the maximum flower opened within 5 to 8 days and following ceased within 15 to 20 days after first flowering. The total number of flowers per plant varied between 19.36 to 45.06 and 22.0 to 47.20 in two consecutive years while percentage of pod abscission varied between 70.53 to 82.26 and 73.46 to 80.75 in two consecutive years. The maximum yield of French bean was obtained from BARI Jharsheem-1, however identical yield was obtained from BARI Jharsheem-2 treatment. The flowering pattern and percent abscission as well greater number of pod were found to be the influential character for the highest yield of French bean. In addition, seed yield was strongly correlated to the number of opened flowers as well as number of mature pods.

Keywords: Flower production; Abscission; Opened flower; Ceased flower

Introduction

French bean (*Phaseolus vulgaris* L.) is a newly introduced high yielding legume crop and can also be used as pulse and vegetable all over the world. In Bangladesh, it is known as "Farashi Sheem" (Rashid, 1993). Its edible green pods and ripe seeds supply protein, carbohydrate, fat, thiamin, riboflavin, Ca, Fe and niacin as well as fibre (Pierce, 1987; Rashid, 1999). In Bangladesh the crop is grown in Sylhet, Cox's Bazar, Chittagong Hill Tracts and some other parts of the country on limited scale during *Rabi* season (FAO, 1999). This crop is also valuable in Bangladesh mostly for exporting of tender bean to the European market. Although, to play an important role in the economy of Bangladesh and increasing popularity in vegetable consuming, the yield of French bean in Bangladesh is lower than world average. In this context, the yield of French bean has become an important component of vegetable production and cash income. The French bean generally produces lots of flowers but only a small number of flower give rises to mature pods (Tanaka and Fujita, 1979; Miah, 2001). The main reason of such lower yields is abscission of flowers and immature pods. If abscission could be prevented or decreased, yields of leguminous crops like as French bean would be increased. Moreover, genotypic characters which produced more flowers within a short time had a greater likelihood of setting pods and retaining until maturity (Fakir, 1997; Biswas *et al*., 2005; Mondal, 2007). Plants that produce maximum flowers within two to three weeks after flowering also show higher pod yields in mungbean and groundnut (Mondal and Hamid 1998; Mondal, 2007). Apart from the magnitude, duration of flowering is equally important since more than seventy per cent of pods plant^{-1} originate from the first 10-15 days of flowering in soybean (Yoshida *et al*., 1983; Nahar and Ikeda, 2002; Islam *et al*., 2010), *Vicia faba* (Clifford et al., 1990), pigeonpea (Fakir, 1997), and mungbean (Mondal *et al*., 2009). Pod yield is determined basically by the number of flowers that set in to the pods. Therefore, not only the intensity of flower (sink) production but also the degree of their sustainability determines pod yield (Fakir, 1997). This suggests that understanding of flowering pattern is useful in the selection of high yielding varieties. However, little information on flowering behavior in French bean is available. Apart from reproductive abscission, the rate and duration of seed growth also contribute largely to the yield of French bean. Therefore, the present study was undertaken to investigate the effect and to develop a relationship with the flowering pattern and total

flower production as well as floral abscission on French bean.

Materials and Methods

The experiment was conducted on agronomy research field of Bangladesh Agricultural Research Institute (BARI), Joydebpur under Gazipur districts of Bangladesh during the period from November 2009-10 and 2010-11. The experiment site was located Chhiata Series under Agro-Ecological Zone-28 (AEZ-28) latitude $23^0$59/ N and longitude $90^0$24/ E. The soil was clay loam and acidic in nature (pH 6.1). The rainfall during the period was 42.0 mm in first year and 189 mm in second year, respectively. There were nine varieties in the experimental treatments following BARI released two developed varieties as BARI Jharsheem-1 and BARI Jharsheem-2 having seven local varieties as Sylhet local-1, Sylhet local-2, Sylhet local-3, Sylhet local-4, Sylhet local-5, Sylhet local-6 and Sylhet local-7. The seeds of different varieties were sown in the field on 20 and 24 November of 2009 and 2010, respectively. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 4.8m × 3m and experimental plots were kept fixed during the entire period of the experiment. Each unit plot was uniformly fertilized during final land preparation @ 150-44-60-20-2 N-P-K-S-Zn through urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate (Kaiser *et al*., 2007 and Mozumder *et al*., 2003). The total amount of TSP, gypsum, zinc sulphate and 50% of urea were mixed with the soil during final land preparation and the rest urea was top dressed at 35 days after sowing (DAS). Seeds were treated with vitavax and sown continuously in 30 cm apart from rows. The plant to plant distance was maintained at 15 cm. Weeding was done with hand at 25 and 40 DAS. For uniform germination, a light irrigation was given by sprinkler method after sowing of seeds. Three irrigations were given at 25, 40 and 60 DAS. The crops were attacked by cutworm (*Agrotis ipsilon*) and hairy caterpillar (*Spilarctia obliqua*) at early growth (vegetative) stage. The cutworm was controlled through hand picking and hairy caterpillar was successfully controlled by spraying Perfecthion 40EC @ 2.0 ml L^{-1} of water at an interval of 7-10 days for two to three times. Five plants from each replication were randomly tagged for daily count of opened flowers. Flower counts began from the date of opening of the first flower and were continued daily until flowering ceased. Total flower production and duration were calculated at 4 day intervals from the data. Mature pods were counted at harvest and pod abscission percentage was calculated as the formula given by Saha (2003).

$$Pod\ abscission\ (\%) = \frac{(Total\ open\ flowers - Total\ matured\ pods)}{Total\ open\ flowers} \times 100$$

The yield component data from each plot was collected from 10 randomly selected plants prior to harvest. At harvest, the yield data was recorded plot wise and analyzed statistically with the help of a computer package program MSTATC and means were separated using DMRT. The computation and preparation of r value were done following the Microsoft EXCEL 2003.

Results and Discussion

Flower Production and Flowering Pattern

The floral parameter and yield of French bean was varied significantly due to variety (Table 1). It was observed that flowering pattern is the most important character to influence yield during both growing seasons of 2009-10 and 2010-11. The duration of flowering was dependent to growing periods and varieties. All local varieties started flowering at 37-40 DAS and high yielding variety BARI Jharsheem-1 and BARI Jharsheem-2 took 5-6 days more than local variety (Table 1). In both the years, the longest duration of flowering (range 17-20 days) was observed in BARI Jharsheem-1 and BARI Jharsheem-2 while the shortest one (range 13-16 days) was observed in all local varieties for two consecutive years, respectively. There was no flowering in the case of local variety Sylhet local-6 at 13 to 16 days after flowering on 1st year and a few was observed on 2nd year, respectively (Table 1). These results indicated that yield might be dependent on flowering duration. It was also observed that the varieties, which produced higher number of flowers within 5 to 8 days after commencement of flowering (DAF) produced higher seed yield. In all duration of flowering pattern was significantly higher in BARI Jharsheem-2 followed by BARI Jharsheem-1 than all local varieties on 1st and 2nd year, respectively. Generally first formed flowers could have a better chance of development into pods because they establish as relatively more powerful sinks (flower) (Subhadrabandhu *et al*., 1978; Bunting and Elston, 1980). They suggested that later immature pods are lost because of a large proportion of available assimilates is sequestered in old pods. Chung (1989) observed that the highest flower production occurred 5 and 8 days after the beginning of the first flowering and the highest pod was set at 5 days after anthesis and obtained 90% pod yield at 5-6 DAF. Izquierdo and Hosfield (1987) reported that flower and pod abscission in French bean reached peak rates at 17-22 days after 50% flowering, respectively. The highest number of flowers per plant (av. 46.14) was found in BARI Jharsheem-2 followed by BARI Jharsheem-1, Sylhet local-4, Sylhet local-3, Sylhet local-2, Sylhet local-1, Sylhet local-5, Sylhet local-7 and Sylhet local-6 (av. 20.68) in both the years (Table 1). In 2009-10, Sylhet local-4 displayed the highest pod abscission (82.26%) which was followed by BARI Jharsheem-1, BARI Jharsheem-2, Sylhet local-2, Sylhet local-3 and Sylhet local-6. In 2010-11, Sylhet local-6 produced the highest pod abscission (80.80%) which was followed by BARI Jharsheem-1, BARI Jharsheem-2, Sylhet local-1, Sylhet local-2 and Sylhet local-7 (Table 1). In earlier woks, 18.69 to 50.26% (Kalita and Shah, 1985) and 31 to 46 %

(Suryavanshi *et al*., 1997) flower drop has been observed in different cultivars of mungbean. Abscission data indicated that there was more abscission in all the varieties might be attributed to greater variations in the field conditions such as moisture stress, heat, wind, paste and diseases. Degree of abscission in the present study (71.99-81.50%) was partially in agreement with Tanaka and Fujita (1979) who observed 65-80% abscission in flowers. In general, possible factors that cause high percentages of floral abscission in legumes including biotic and abiotic stresses (Van Schaik and Probst, 1958), hormones (Clifford *et al*., 1992), deficiency of carbohydrates or mineral nutrients (Pandey and Singh, 1981) and competition for photosynthesis between vegetative and reproductive sinks (Clifford , 1981). These results indicate that pod production depends not only on the total number of flower but also on percentage of floral abscission. Therefore, not only the intensity of pod (sink) production (number of flower production) but also the magnitude of pod setting and percent abscission has affected on final pod production and as thus on yield. The results from this study also revealed that there was a negative correlation between percent abscission and seed yield (r =-0.04 and -0.14). Such relationship was also observed in mungbean, pigeonpea and French bean (Hamid, 1989; Fakir, 1998; Subhadrabandhu *et al*., 1978, respectively). From the above discussion, it was found that abscission could hardly controlled till to date since hormones and some other factors may control it by unknown physiological mechanisms. But there is a hope that varietal variation in floral abscission exists and therefore there is an opportunity of selecting varieties with reduced percentage of abscission for increased yield in French bean.

Yield and Yield Contributing Characters

Yield and yield contributing characters of French bean were significantly affected by variety in both the years (Table 2). The number of pods per plant was significantly affected by variety in both the years (Table 2). Among the tested varieties, BARI Jharsheem-2 showed the highest number of pods per plant (9.63 in 2009-10 and 10.20 in 2010-11, respectively) which was followed by BARI Jharsheem-1 (8.75 in 2009-10 and 8.81 in 2010-11, respectively) and all other local varieties (4.25-7.04 in 2009-10 and 4.19-6.81 in 2010-11, respectively). Among the varieties, BARI Jharsheem-1 gave the highest number of seeds per pod (4.37 in 2009-10 and 4.33 in 2010-11) followed by Sylhet local-6, Sylhet local-7 and BARI Jharsheem-2 in 2009-10 and BARI Jharsheem-2, Sylhet local-2, Sylhet local-5 and Sylhet local-6 in 2010-11. A similar result was also reported by Rana *et al*., (2003) but the lowest number was found from Sylhet local-1 in 2009-10 and Sylhet local-1 in 2010-11. The pod was the longest in BARI Jharsheem-1 (13.27 cm in 2009-10 and 12.73 cm in 2010-11, respectively) but it was the shortest in BARI Jharsheem-2 (9.80 cm in 2009-10 and 10.03 cm in 2010-11, respectively). Seed yield per plant significantly varied due to variety in both the years. In 2009-10, Sylhet local-1 exhibited the highest seed yield plant^{-1} (7.91 g) which was followed by BARI Jharsheem-1, Sylhet local-3, Sylhet local-4 and Sylhet local-7. In 2010-11, BARI Jharsheem-1 produced the highest (8.19 g) seed yield plant^{-1} which was followed by BARI Jharsheem-2 , Sylhet local-1, Sylhet local-3 and Sylhet local-4 and the lowest (5.50 g in 2009-10 and 5.88 g in 2010-11) was recorded in Sylhet local-6. The largest seeds (42.75 g in 2009-10 and 41.07 g in 2010-11, respectively) were observed in Sylhet local-4 followed by Sylhet local-1 and Sylhet local-3. However, BARI Jharsheem-2 produced the lowest 100 seed weight (20.88 g in 2009-10 and 21.13 g in 2010-11, respectively). There was a highly significant variation in the seed yields of French bean varieties in both the years (Table 2). BARI Jharsheem-1 produced the highest grain yield (1467.65 kg ha^{-1} in 2009-10 and 1521. 85 kg ha^{-1} in 2010-11, respectively) which contributed the superior values of respective yield components (number of pods plant^{-1} and seeds pod^{-1}). On the other hand, BARI Jharsheem-2 and Sylhet local-3 produced the similar yield to BARI Jharsheem-1. Sylhet local-3 produced higher seed yield due to contribution of higher 100 seed weight. On the contrary, Sylhet local-6 gave the lowest yield (986.30 kg ha^{-1} in 2009-10 and 929.01 kg ha^{-1} in 2010-11, respectively) due to lower number of pods plant^{-1}. Number of pods per plant is again a function of pod size, seed size (Dwivedi *et al.*1995) and number of seeds per pod. Pod length and pod width determine pod size. Seed yield showed significant and positive correlations with flowers per plant (r=0.69** and 0.67**) and pods number (r=0.82** and 0.81**) pod length (0.87** and 0.94**). These result suggests that longer pod along with larger number of seeds should be used as selection index for improved yield. The present results were similar with the report of Miah (2001) in French bean. In contrast, seed yield had negative association with (100 seed weight) seed size (r =-0. 39 and -0.39). Number of pods is the principal yield determinant in mungbean and other pulses (Ahmed *et al*., 1993). Earlier studies made by several workers also revealed varietal differences in the seed yield of French bean (Ahlawat, 1995; Saini and Negi, 1998; Ghodake, 2002; Surekha, 2006; Mallikarjun, 2004). Harvest index (HI) is the ratio of grain yield (economic yield) to the total dry matter (or biological yield) yield. The HI showed almost similar trend to seed yield. Dhanjal *et al.* (2001) pointed out that HI is highly related to yield of French bean.

Table 1: Flowering pattern and flower production of French bean varieties

Variety	Days to 1st flower initiation	Flowers plant^{-1} (no.)		Flowering pattern (days)									
				(1-4)		(5-8)		(9-12)		(13-16)		(17-20)	
		1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr
BARI Jharsheem-1	42.67ab	35.28b	38.00b	8.00a-c	9.70ab	13.67b	15.43b	7.00ab	6.50b	5.12b	4.03a	1.50c	2.33b
BARI Jharsheem-2	44.37a	45.07a	47.20a	10.00a	11.43a	17.00a	19.33a	7.90a	8.33a	7.17a	5.10a	3.00a	3.00a
Sylhet local-1	38.73bc	22.10c-e	26.43c	5.00d	8.83bc	10.47cd	11.33c	3.83d	4.40cd	2.80d	1.87b	0.00b	0.00bc
Sylhet local-2	470.07a-c	27.80b-d	26.90c	8.13ab	9.00bc	11.20b-d	12.23c	4.73cd	3.67cd	3.73c	1.33cd	0.00b	0.67bc
Sylhet local-3	37.67c	28.38b-d	27.33c	6.70b-d	8.87bc	12.43bc	11.33c	4.15cd	4.80c	3.00cd	2.33bc	2.10b	0.00bc
Sylhet local-4	37.67c	29.63bc	22.33c	9.23a	7.27c	12.50bc	10.23c	5.77bc	3.67cd	2.13e	1.17d	0.00b	0.00bc
Sylhet local-5	40.20a-c	21.67de	24.20c	6.54b-d	8.00bc	11.00b-d	10.33c	3.47d	3.43d	0.67e	1.43cd	0.00b	1.00b
Sylhet local-6	38.50bc	19.36e	22.00c	6.53b-d	6.73c	9.23d	10.00c	3.60d	4.67c	0.00e	0.60cd	0.00b	0.00bc
Sylhet local-7	39.00bc	21.20de	25.33c	5.60cd	8.67bc	10.33c	11.00c	3.37d	4.83c	1.90e	0.40d	0.00b	0.43c
CV (%)	4.59	10.78	11.72	12.90	9.78	8.99	9.73	14.48	9.62	8.49	8.33	10.81	8.70
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Log transformation
In a column figures having common letter(s) do not differ significantly whereas the figures with dissimilar letter differ significantly as per DMRT
CV = Co efficient of variation
1st year=2009-10, 2nd year=2010-11

Table 2: Yield contributing characters and yield of French bean varieties

Variety	Pod abscission (%)		Pod plant^{-1} (no.)		Seeds pod^{-1} (no.)		Pod length (cm)		100 seed weight (g)		Seed yield plant^{-1} (g)		Seed yield (kg ha^{-1})		Harvest index (%)	
	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr
BARI Jharsheem-1	75.20a-c	76.74b-d	8.75ab	8.81a	4.37a	4.33a	13.27a	12.73a	22.37cd	22.89cd	7.35ab	8.19a	1467.65a	1521.85a	41.48a	42.13a
BARI Jharsheem-2	78.82ab	78.36ab	9.63a	10.20a	4.01ab	3.87a-c	9.80e	10.03e	20.88d	21.13d	6.20bc	6.73a-c	1401.91ab	1454.94ab	38.6 7bc	39.22b
Sylhet local-1	72.93bc	78a-c	6.02cd	5.81bc	2.67d	2.72de	11.71b-d	12.36ab	40.87a	40.44a	7.91a	7.74ab	1003.58d	1068.70d	39.3 3a-c	39.36b
Sylhet local-2	76.05ab	75.71b-d	6.62c	6.52b	3.45c	3.92ab	11.50cd	12.13b	29.73b	27.30b-d	6.21bc	6.39bc	1271.98bc	1340.62bc	39.04 a-c	39.70b
Sylhet local-3	75.17a-c	74.73cd	7.04bc	6.81b	3.38c	3.27cd	12.23b	12.40ab	40.34a	39.68a	7.39ab	7.63ab	1440.36ab	1488.30ab	38.98a-c	38.63b
Sylhet local-4	82.26a	73.64d	5.28cd	5.82bc	3.15cd	2.55e	11.47cd	12.13b	42.75a	41.07a	6.73a-c	7.90ab	1129.81cd	1041.67d	39.72ab	39.03b
Sylhet local-5	70.53c	73.46d	6.38cd	6.30b	3.63bc	3.81a-c	11.58b-d	11.40c	28.78b	29.17bc	5.92c	6.43bc	1263.46bc	1274.69c	37.59bc	39.04b
Sylhet local-6	77.37ab	80.75a	4.25d	4.19c	4.29a	4.03a	11.21d	10.77d	27.40bc	27.84b-d	5.50c	5.88c	986.30d	929.01d	36.92c	38.19b
Sylhet local-7	73.44bc	77.68a-c	5.43cd	5.67bc	4.13ab	3.40bc	12.08bc	12.17ab	29.83d	31.37b	6.60a-c	6.63bc	1194.69c	1018.52d	39.56a-c	38.81b
CV (%)	2.95	2.78	12.70	12.02	6.36	6.88	2.34	2.04	7.07	9.37	11.46	12.82	6.16	5.51	2. 64	2.31
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.01	0.01	0.01	0.01

CV = Co efficient of variation

In a column figures having common letter(s) do not differ significantly whereas the figures with dissimilar letter differ significantly as per DMRT

1st year=2009-10, 2nd year=2010-11

Conclusion

The varieties of French bean had significant effect on the yield parameters and yield. The maximum number of flower was recorded within 5 to 8 days in BARI Jharsheem-2. The highest seed yield was obtained from BARI Jharsheem-1, however identical to BARI Jharsheem-2 which produced reduced percent of abscission. The number of pod per plant and seed per pod contributed to the greater yield of French bean in BARI Jharsheem-1. So, selection of varieties with greater number of flower and reduced abscission may, therefore, contribute to develop a high yielding variety in French bean.

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