



Growth and Yield Performance of French Bean (*Phaseolus vulgaris* L.) Germplasm under Sub-Montane Zone of Maharashtra

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ABSTRACT

The present investigation was undertaken in randomized block design with two replications during *rabi*-2018 at Instructional-cum-Research Farm, RCSM College of Agriculture, Kolhapur. A set of 15 germplasm of French bean *viz.* Phule Suyash, Phule Surekha, Contender, Sevil, Arka Suvidha, Arka Komal, IC-039081, IC-28008, EC-28304, EC-500354, EC-500377, Selection 9, Falguni, Vaishnavi and EC-530909 was evaluated. The data indicated the significant differences with respect to growth and yield among the various germplasm of french bean. The earliest 50% flowering was seen in Contender (33.13 days) whereas the maximum number of days required for 50% flowering was in IC-0339081 (45.60 days) closely followed by Falguni (42.20). As far as the numbers of primary branches per plant, Arka Suvidha had 2.70 at 30 DAS and 3.80 at 45 DAS while the germplasm IC-28008 recorded the highest number of secondary branches per plant (6.80 and 8.60) at 45 and 60 DAS, respectively. The tallest plants were observed in Phule Surekha (22.90 cm) at 30 DAS while at 45 and 60 DAS, taller plants were noticed in IC-28008 (78.70 and 93.75cm, respectively). The number of pod cluster per plant was found to range from 28.60 (EC-28304) to 12.00 (Selection-9). The highest pod length and width were noticed in Selection-9 and Phule Surekha (14.29 cm and 1.51cm, respectively) whereas the least pod length was found in Phule Surekha and Vaishnavi (9.21cm and 0.69cm, respectively). The highest number of pods per plant (162.40), individual pod weight (3.85 g) and number of seeds per pod (7.60) were higher in EC-500354 which resulted in higher yield per hectare (34.73 t) followed by Arka Komal (24.22 t) and Phule Surekha (21.42 t).

Key words: French bean germplasm, Growth and yield performance, Sub-montane.

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) is a leguminous crop, belongs to family Fabaceae with chromosome number of $2n = 22$. It is known as Snap bean, Kidney bean, Common bean, Rajma bean, Haircot bean, Dwarf bean, Pole bean, Navy bean, Pinto bean and String bean. French bean provides direct economic returns to the growers in the form of pods used as a vegetable and grain for human beings as well as fodder for animals. Most of the genotypes growing in the hills are introduced in India from China. Pole beans are also cultivated or intercropped with maize as a rain-fed crop in the hills (Pandey *et al.*, 2011 and Kumar *et al.*, 2014). In India, it is mainly grown in Himachal Pradesh, Jammu & Kashmir, Punjab, Uttar Pradesh, Haryana, Bihar, Madhya Pradesh, Gujarat, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Total area under cultivation of all beans including french bean was 228 and 5.50 thousand hectares and production was 2277 and 55.48 thousand metric tons during 2017-18 in India and Maharashtra, respectively (Anonymous, 2018). It is considered to be a very rich source of proteins and vitamins which provides carotenoids like beta-carotene, neoxanthin, lutein and violaxanthin for proper body health. It also contains antioxidant capacity and hence helps our body to rid away of harmful radicals and also benefits our cardio vascular system. They are rich source of dietary fiber which protects the mucosa in the colon by reducing exposure to toxins. It is rich source of Zea-Xanthin, a dietary carotenoid

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which gives protective UV filtering function. It should be an important supplement of our diet. It is mainly grown in the temperate and tropical regions of India and shows higher productivity around temperature of 21°C and an optimum temperature of around 16 to 24°C is better for its greater yield. It is flexible in terms of soil and can be grown in a wide range of soil ranging from light sand to heavy clay soil. Although it can be grown in wide range of soils, it gives best results in well drained loamy soils (Thamburaj, 2018).

French bean can be harvested in pod stage as well as can be harvested for its seeds. The pods are harvested in immature and tender stage, which are ready for harvest within 7-12 days after flowering and used as vegetable and also as a fodder to animals. A lot of variation is available in growth habit, color of leaves and pods, shape and size of the pod. The germplasm has been collected from different parts of Maharashtra for evaluation under different agro-climatic conditions. Therefore, the present investigation was undertaken to study the growth and yield performance of french bean germplasm under Sub-montane zone of Maharashtra.

MATERIALS AND METHODS

A field experiment was conducted at the Instructional-cum-Research Farm of Horticulture Section, Rajarshi Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur during *rabi*-2018 with 15 germplasm of french bean such as Phule Suyash (T₁), Phule Surekha (T₂), Contender (T₃), Sevil (T₄), Arka Suvidha (T₅), Arka Komal (T₆), IC -039081 (T₇), IC -28008 (T₈), EC-28304 (T₉), EC-500354 (T₁₀), EC-500377 (T₁₁), Selection-9 (T₁₂), Falguni (T₁₃), Vaishnavi (T₁₄) and EC-530909 (T₁₅) in randomized block design (RBD) with three replications. The recommended package of practices was followed. Plant protection measures were taken up as and when required. French bean pods were harvested at tender stage. Five plants were randomly selected from each plot and pods from the same plant were used for recording the observations.

The observations such as number of days to 50% flowering, number of primary and secondary branches per plant at 30 and 45 DAS, plant height (cm) at 30, 45 and 60 DAS and morphological characters such as growth habit (Bush and Viney), flower colour, pod shape (Flat and semi-round), pod colour (light green, dark green and pale green) and seed colour were recorded. The yield and yield attributing characters such as number of pod clusters per plant, numbers of pods per plant, pod length (cm), pod width (cm), individual pod weight, number of seeds per pod, days to first harvest, number of harvests, crop duration (Days), green pod yield per ha (t) were recorded as per the standard procedure. The data was analyzed as per the method given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth parameters

Number of days to 50% flowering

The mean number of days required for 50% flowering significantly differed among the germplasm of french bean (Table 1). The data revealed that lesser mean number of days required to 50% flowering was noticed in Contender (33.13 days) closely followed by Phule Suyash (33.72 days) and Vaishnavi (34.55 days) whereas higher number of days required for 50% flowering was noticed in IC -039081 (45.60 days) followed by Falguni (42.20 days) and Phule Surekha

(41.82 days). The variation in days to 50% flowering in french bean germplasm might be due to season or photoperiod and temperature prevailing during growing period. The results of present findings are in close conformity with the results reported by Pandey *et al.* (2011) who also noticed variation in 50 % flowering from 37 days (Makwapur) to 47 days (Mandir).

Number of primary and secondary branches per plant

The number of primary branches per plant at 30 and 45 DAS significantly differed among the germplasm of french bean under study (Table 1). Higher number of primary branches per plant was recorded in Arka Suvidha (2.70 and 3.80) followed by Phule Surekha (2.50 and 2.60) at 30 and 45 DAS, respectively. Lesser number of branches per plant was recorded in Contender (1.50) followed by IC-039081 (1.60) and Sevil (1.70) at 30 DAS. At 45 DAS, lesser number of primary branches per plant was recorded in EC-28304 (1.90) followed by Selection-9 (2.00). The plant growth including the number of branches is the result of varieties genetic potential interacting with the environment and farming practices. The variation in number of branches per plant in germplasm of french bean might be due to genetical variation among the germplasm. The results of the present findings are in close conformity with findings reported by Pandey *et al.* 2011).

The highest number of secondary branches per plant was recorded in EC-530909 (7.50) which was at par with IC-28008 (6.80) and Phule Surekha (6.60) whereas the least number of branches per plant was observed in EC-500354 (4.20) followed by EC-28304 (4.30) and Contender and Sevil (5.00) at 30 DAS (Table 1). At 45 DAS, the germplasm IC-28008 recorded the highest number of secondary branches per plant (8.60) which was at par with EC-530909 (7.70) and Falguni (7.50) whereas the lowest number of secondary branches per plant was recorded in EC-28304 (5.10) followed by IC-039081 (5.20) and Selection-9 (5.50). The variation in number of secondary branches per plant might be because of the genetical difference among the germplasm. The results also showed that, the number of branches per plant in different germplasm of french bean was affected by the growing environment. It was also found that, average number of branches per plant was greater in viney growth habit as compared to bush type beans. Similar findings were also recorded by Pandey *et al.* (2011) and Das *et al.* (2018).

Plant height at 30, 45 and 60 DAS

It is clearly evident from the data presented in Table 1 that, significant differences were noticed in plant height among the germplasm of french bean under study at 30, 45 and 60 DAS. The maximum plant height was recorded in Phule Surekha (22.90 cm) followed by EC-500377 (20.86 cm) and IC-039081 (20.85 cm) whereas the minimum plant height was noticed in EC-28304 (13.65 cm) followed by Contender (14.80 cm) and Falguni (15.51 cm) at 30 DAS. The germplasm IC-28008 recorded the highest plant height

Table 1: Growth parameters of french bean germplasm under sub- mountane zone of Maharashtra.

Name of the germplasm	No. of days to 50% flowering	No. of primary branches per plant at		No. of secondary branches per plant at		Plant height (cm)		
		30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	60 DAS
Phule Suyash	33.72	2.30	2.40	4.80	5.70	16.50	31.05	37.20
Phule Surekha	41.82	2.50	2.60	6.60	6.90	22.90	56.42	82.40
Contender	33.13	1.50	2.30	5.00	5.80	14.80	29.53	37.20
Sevil	38.20	1.70	2.30	5.00	6.40	18.55	31.15	43.90
Arka Suvidha	36.55	2.70	3.80	5.30	6.25	17.16	28.30	44.50
Arka Komal	38.10	2.30	2.45	5.90	6.90	18.54	39.35	41.00
IC-039081	45.60	1.60	2.20	5.00	5.20	20.85	60.85	91.65
IC-28008	41.30	2.30	2.40	6.80	8.60	15.00	78.70	93.75
EC-28304	41.65	1.80	1.90	4.30	5.10	13.65	53.70	86.70
EC-500354	41.60	2.10	2.50	4.20	6.60	19.50	40.60	79.90
EC-500377	36.00	2.20	2.30	5.90	5.70	20.86	29.50	39.00
Selection-9	39.90	1.90	2.00	5.30	5.50	18.45	39.35	41.40
Falguni	42.20	1.80	2.20	5.50	7.50	15.51	29.20	42.10
Vaishnavi	34.5	2.40	2.50	5.40	6.50	15.63	21.93	40.40
EC -530909	41.60	2.50	2.80	7.50	7.70	20.80	52.80	74.50
S. E. ±	0.90	0.21	0.27	0.50	0.55	1.42	2.90	4.18
CD at 5%	2.74	0.64	0.83	1.52	1.67	4.32	8.81	12.70

of 78.70 cm and 93.75 cm at 45 and 60 DAS, respectively whereas the least plant height was observed in Vaishnavi (21.93 cm) followed by Arka Suvidha (28.30 cm) and Falguni (29.20 cm) at 45 DAS. The least plant height of 37.20 cm was noticed in Phule Suyash and Contender followed by EC-500377 (39.00 cm) and Vaishnavi (40.40 cm) at 60 DAS. The variation in plant height might be due to genetic differences among the germplasm since they were grown under same environmental conditions. The results of present findings are in agreement with the results reported by Zeliang *et al.* (2018) who observed the taller plants in Arka Anoop (46.6 cm) and the shortest in Local cultivar (33.4 cm).

Morphological characters

Growth habit

The data presented in Table 2 indicated that, bushy and viney are types of growth habit observed among the germplasm under study. The bushy growth habit was noticed in Phule Suyash, Contender, Sevil, Arka Suvidha, Arka Komal, EC-500377, Selection-9, Falguni and Vaishnavi and the germplasm such as Phule Surekha, IC-039081, IC-28008, EC-28304, EC-500354 and EC-530909 recorded viney growth habit. Variation in growth habit of french bean germplasm might be due to genetic variation in germplasm. Results of the present findings were in close conformity with results reported by Pandey *et al.* (2011) who recorded the two types of french bean types in Western mid hills of Nepal was highly diverse and could be considered as the secondary center of genetic diversity. Solomon (2012) also reported two types of growth habits in haircot bean such as determine type *i.e.* bushy and indeterminate type *i.e.* viney among the genotypes studied and this result lend support the present finding.

Flower colour

The data revealed that, the different flower colours such as white, light pink and dark pink were noticed among the French bean germplasm under study (Table 2). White colour flowers were noticed in Contender, Sevil, Arka Suvidha, IC-039081, EC-28304, EC-500377, Falguni, Vaishnavi and EC-530909 while light pink colour flower in Phule Suyash, Arka Komal and Selection-9. Dark pink colour flowers were noticed in Phule Surekha, IC-28008 and EC-500354. These results were in close conformity with the previous results reported by Pandey *et al.* (2011) in which they reported that, the flower colour was directly related to color of seed and most genotypes with brown or white seeds produced white flowers. The genotypes such as Arka Suvidha, Trishuli and Arka Komal with brown colored seeds produced white colour flower. They also reported that the colour of flowers, pods and seed varied among the genotypes (white, violet and light pink) under study.

Pod shape

The data shown in Table 2 revealed two types of pod shapes in french bean germplasm under study. The germplasm such as Phule Suyash, Contender, IC-039081, EC-500377, Selection-9, Falguni, Vaishnavi and EC-530909 recorded semi-round pod shape while flat pod shape was observed in Phule Surekha, Sevil, Arka Suvidha, Arka Komal, IC-28008, EC-28304, EC-500354. These results were in agreement with the result reported by Meena *et al.* (2017) who recorded round, flat and straight pod shape among the genotypes of french bean. Pandey *et al.* (2011) noticed that the pod curvature in french bean was straight, slightly curved and curved and reported that the curvature of pods of french bean germplasm varied among genotypes.

Table 2: Morphological characters of french bean germplasm under sub- mountane zone of Maharashtra.

Name of the germplasm	Growth habit	Flower colour	Pod shape	Pod colour	Seed colour
Phule Suyash	Bushy	Light pink	Semi-round	Light green	Off white
Phule Surekha	Viney	Dark pink	Flat	Light green	Black
Contender	Bushy	White	Semi-round	Light green	Light brown
Sevil	Bushy	White	Flat	Light green	White
Arka Suvidha	Bushy	White	Flat	Light green	Light brown
Arka Komal	Bushy	Light pink	Flat	Dark green	Mottled brown
IC-039081	Viney	White	Semi-round	Light green	Black
IC-28008	Viney	Dark pink	Flat	Pale green	Black
EC-28304	Viney	White	Flat	Dark green	Gray
EC-500354	Viney	Dark pink	Flat	Light green	Black
EC-500377	Bushy	White	Semi-round	Dark green	Mottled brown
Selection-9	Bushy	Light pink	Semi-round	Light green	Pale brown
Falguni	Bushy	White	Semi-round	Dark green	White
Vaishnavi	Bushy	White	Semi-round	Dark green	White
EC-530909	Viney	White	Semi-round	Dark green	Dark brown

Pod colour

Pod colour is the most important character for market acceptance. The pods of french bean germplasm showed different colours such as light green, dark green and pale green (Table 2). Light green colour of pods was noticed in majority of the germplasm such as Phule Suyash, Phule Surekha, Contender, EC-500354, Selection, IC-039081, Sevil and Arka Suvidha. Only one germplasm pale green colour in IC-28008 whereas Arka Komal, EC-28304, EC-50037, Falguni, Vaishnavi and EC -530909 exhibited dark green pod colour. The results of the present findings were in parallel with the results reported Pandey *et al.* (2011) who noticed variation in pod colours of among the french bean genotypes and they recorded the pod colours like dark green, normal green, light green or other colours. Meena *et al.* (2017) recorded variation in pod colours among the french bean genotypes and they also found that on the basis of colour Falguni, Cosmo, Sevil and IHR-909 were found to be the best and had dark green colour pods as compared to other genotypes.

Seed colour

The data revealed that the different germplasm produced different coloured seeds such as white, off white, dark brown, mottled brown, gray and pale brown in french bean germplasm under study (Table 2). The germplasm such as Phule Surekha, IC-039081, IC 28008 and EC-500354 produced black coloured seeds, Falguni, Vaishnavi and Sevil recorded white seed colour, off white in Phule Suyash, pale brown in Selection-9, gray in EC-28304, light brown in Contender and Arka Suvidha, mottled brown in EC-50037 and Arka Komal and dark brown in EC-530909. These results are in accordance with the previous results reported by Pandey *et al.* (2011) in which they observed that the seed colour was directly related to the colour of flowers. Most genotypes with lilac flowers produced black coloured seeds, genotypes with white flowers produced brown or white seeds and white coloured flowers produced white flowers. Similarly

Stoilova *et al.* (2005) reported the variability in terms of seed colour in common bean was brown, red, white and red, bicolor and brownish.

Yield and yield attributes

Number of pod clusters per plant

The germplasm EC-28304 recorded significantly higher number of pod clusters per plant (28.60) followed by EC-500354 (28.40), Arka Komal (27.30), Phule Surekha (27.10) and Falguni (22.30) while the lowest number of pod clusters per plant was observed in Selection-9 (12.00) followed by IC-039081 (13.00), Contender (13.60) and Arka Suvidha (13.90) (Table 3). The results of present findings are parallel with the findings of Arora *et al.* (2011) who recorded the number of clusters per plant from 5.13 to 11.10. The number of clusters per plant is an important character to be considered to select cluster bean genotype exhibiting high yield indirectly (Muthuselvi *et al.*, 2018).

Number of pods per plant

The number of pods per plant directly influences the yield of green pods. The highest number of pods per plant was recorded in EC-500354 (162.4) whereas the lowest number of pods per plant was recorded in Contender and Selection-9 (59.4 and 72.0, respectively) (Table 3). Difference in growth characters might be due to genetic variability within genotype itself or due to the environmental effects. The significant differences among the genotypes with respect to number of pods per plant were also reported by Muthuramu *et al.* (2015) and Santhi *et al.* (2015) in genotypes of french bean.

Pod length (cm)

Significantly higher pod length was recorded in Selection-9 (14.29 cm) which was at par with Sevil (14.21 cm) and Falguni (13.43 cm) whereas the lowest pod length was recorded by Phule Surekha (9.21 cm.) closely followed by EC-530909 (10.54 cm) and EC-500377 (10.60 cm) (Table 3).

The pod length in french bean germplasm differed significantly due to variation in genetic makeup of the plant. Similar findings were reported by Pandey *et al.* (2011) who noticed that Chinese Long produced the longest (20.27 cm) pods and the shortest pods in Syangja (7.67 cm) and genetic variability of germplasm might be responsible for this variation. Muthuramu *et al.* (2015) reported that the significantly higher length of green pod was noticed in Arka Anoop (17 cm) followed by Arka Suvidha (15.32 cm). The results of present findings are in line with the results reported by Kumar *et al.* (2014) and Zealing *et al.* (2018) in french bean germplasm.

Pod width (cm)

The data on pod width presented in Table 3 showed significant difference among the germplasm of french bean under study. Higher pod width was recorded by Phule Surekha (1.51 cm) while lesser pod width was noticed in Vaishnavi (0.69 cm) followed by Falguni (0.86 cm) and EC-530909 (0.96 cm). The present findings are in close conformity with the results reported by Sarangi *et al.* (2010), Kumar *et al.* (2014), Devi *et al.* (2015) and Das *et al.* (2018) in french bean. Neupane *et al.* (2008) reported that, the pod width was influenced by the genotype and they also reported that, the pod width ranged from 10 to 30 mm in different genotypes. Pandey *et al.* (2011) observed that pod width among the genotypes differed significantly and the widest pods (33.53 mm) and narrowest pods were recorded in Makwanpur (8.37 mm) for bush bean while in pole type beans, the widest pods in Mandir (9.30 mm) and narrowest pods in Mallika (7.37 mm) were noticed.

Individual pod weight (g)

Higher weight of the individual pod was noticed in EC-

500354 (3.85 g) followed by Arka Komal (3.70 g) while lower weight was in EC-530909 (2.44 g) followed by IC-28008 (2.55 g) (Table 3). The variation in individual pod weight might be due to genetic variation among the germplasm of french bean under study. Getachew *et al.* (2014) found that individual pod weight was affected by the interaction effects of the factors like variety and time of sowing. Accordingly, variety Melka-5 showed the highest pod weight (6.50 g) and the lowest in Melka-1 (3.60 g) when sown on 2nd August and 17th August. The results of present findings were in accordance with the results reported by Ramana *et al.* (2010), Kumar *et al.* (2014) and Panchbhaya *et al.* (2017) in french bean.

Number of seeds per pod

The data presented in Table 3 indicated that the highest number of seeds per pod was recorded in EC-500354 (7.60) which was on par with IC-28008 (6.90) and Phule Surekha (6.70) whereas, the lowest number of seeds per pod was recorded in EC-500377 (4.80) and EC-530909 (4.90). The variation in number of seeds per pod might be due to genetic variability in different germplasm. The results of this study collaborate with the findings of Sarangi *et al.* (2010) who reported that the number of seeds per pod was the highest in Kentucky Wonder (7.77) whereas the lowest in Contender and Pusa Parvati (5.58). Similar findings were also reported by Roy (2003) and Kumar *et al.* (2014) in French bean.

Days to first harvest

Significant difference was noticed with respect to number of days to first harvest among the germplasm of french bean (Table 3). First picking of pods was done very early in germplasm Contender (41.40 days) followed by Phule Suyash (41.60 days) and Arka Suvidha (45.80 days) whereas harvesting was late in EC-28304 (60.70 days) followed by

Table 3: Yield attributes, days to first harvest and number of harvests in french bean germplasm under sub- montane zone of Maharashtra.

Name of the germplasm	No. of pod clusters/ plant	No. of pods/ plant	Pod length (cm)	Pod width (cm)	Individual Pod Weight	No. of seeds/ pod	Days to first harvest	No. of harvests	Crop duration (Days)	Yield (t/ha)
Phule Suyash	17.10	79.9	12.45	1.02	3.36	5.10	41.60	8.80	90.5	14.93
Phule Surekha	13.00	92.6	9.21	1.51	3.51	6.70	54.00	8.80	94.0	21.42
Contender	13.60	59.4	11.49	1.13	3.52	5.60	41.40	6.80	89.5	11.51
Sevil	15.80	103.0	14.21	0.90	2.56	5.00	50.40	8.80	92.5	13.18
Arka Suvidha	13.90	118.0	11.50	1.04	3.34	5.10	45.80	9.00	89.0	17.77
Arka Komal	18.10	106.1	11.37	1.08	3.70	5.10	50.20	9.00	88.5	24.22
IC-039081	22.30	103.6	10.95	1.08	2.90	6.00	55.10	8.70	90.5	17.01
IC-28008	17.20	87.5	9.35	0.96	2.55	6.90	55.20	8.80	92.5	13.07
EC-28304	28.60	118.0	11.47	1.11	3.66	6.40	60.70	9.00	92.0	19.33
EC-500354	28.40	162.4	10.38	1.01	3.85	7.60	49.30	9.00	93.5	34.73
EC-500377	20.71	83.9	10.60	1.20	3.26	4.80	49.10	7.80	88.0	15.12
Selection-9	12.00	72.0	14.29	1.04	3.46	5.20	50.60	9.00	89.5	15.75
Falguni	27.10	94.4	13.43	0.86	3.48	6.30	56.50	9.00	90.5	16.68
Vaishnavi	21.30	94.0	12.64	0.69	3.45	6.20	55.40	8.80	89.5	19.52
EC-530909	27.30	83.6	10.54	0.96	2.44	6.10	55.30	8.90	93.0	12.84
S. E. ±	2.93	10.9	0.86	0.05	0.18	0.38	2.85	0.04	0.5	0.68
CD at 5%	8.90	33.0	2.60	0.16	0.55	1.17	8.65	0.12	1.5	2.08

Falguni (56.50 days) and Vaishnavi (55.40 days). The variation in days to first harvest might be due to genetical differences among the germplasm. These results were parallel with findings reported by Sarangi *et al.* (2010) who stated that the days to first harvest varied from 50 days in case of Selection-9 to 59 days in case of variety Kentucky Wonder. Similar observations were also recorded by Panchbhैया *et al.* (2017) while working with genetic analysis of french bean germplasm.

Number of harvests

French bean germplasm differed significantly with respect to number of harvests (Table 3). The highest number of harvests was noticed in Arka Komal, Arka Suvridha, Selection-9, Falguni and EC-28304 (9.00 each) which was at par with, EC -500354, EC-530909 (8.90 each), Phule Suyash, Phule SSurekha, Sevil, Vaishnavi and IC-28008 (8.80 each) whereas, the number of harvests was recorded in Contender (6.80) and EC-50037 (7.80). The variation in number of harvesting might be due to genetical difference among the germplasm under study.

Crop duration

Significant differences were noticed in crop duration among the germplasm of french bean under study (Table 3). The data revealed that, the maximum crop duration was recorded in Phule Surekha (94 days) statistically on par with EC-500354 (93.5 days) whereas minimum crop duration was recorded in Arka Komal (88.5 days) followed by EC-500377 (88.0 days). The variation found in crop duration might be due to genetic variability in different germplasm of french bean. These findings were close in conformity with the results reported by Dahiya and Malhotra (2002) who reported that distribution of positive and negative genes in the parents more towards symmetrical number of primary branches, duration of availability of pods and market yield per plant. Pod yield in french bean was enhanced by simultaneous improvement in yield contributing characters, which mostly are under additive gene control by using transgressive segregation.

Yield

The yield differed significantly among the germplasm of french bean under study (Table 3). The highest yield was recorded in germplasm EC-500354 (34.73 t/ha) followed by Arka Komal (24.22 t/ha) and Phule Surekha (21.42 t/ha) while the least yield was recorded in Contender (11.5 t/ha) followed by EC-530909 (12.84 t/ha). The results of present findings are in concurrence with the finding of Muthuramu *et al.* (2015) who reported that, the maximum yield of green pods per hectare was recorded in Arka Anoop (18.5 t/ha) followed by Arka Suvridha (18.00 t/ha). Similar results were also reported by Zeliang *et al.* (2018) in french bean genotypes at different locations.

CONCLUSION

Sufficient variation with respect to growth, yield, yield

contributing attributes and morphological characters were observed among the germplasm of french bean. On the basis of growth and yield and yield contributing characters, the germplasm EC-500354, Arka Komal and Phule Surekha are found suitable for cultivation in sub-montane zone of Maharashtra.

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