Evaluation of Strawberry (*Fragaria x ananassa Duch.*) Cultivars for Growth, Flowering and Fruiting Behavior under Farmer's Field Condition (Baadi) in Chhattisgarh Plain Region

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Strawberry (*Fragaria* x *ananassa* Duch.) is one of the most important soft fruits belongs to the family Rosaceae. A research trial was conducted in farmer's field condition (Baadi) at village-Bharregaon, (dist.-Rajnandgaon, Chhattisgarh) and the research farm of College of Horticulture and Research Station, Rajnandgaon (C.G.) during the winter spring season of the year 2017-18 to evaluate different strawberry cultivars for growth, flowering and fruiting behavior under farmer's field condition (Baadi) in the plain region of Chhattisgarh. The experiment was conducted with two best performing strawberry cultivars namely Nabila and Camarosa replicated four times using student's t-test. The

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results of the research trial revealed that the strawberry cv. Nabila recorded maximum vegetative growth *i.e.*, plant height, number of leaves, plant spread, number of runners per plant and length of runners, while the minimum were recorded under the cultivar Camarosa. Earliest flowering, fruit setting and fruit ripening was exhibited under the cultivar Nabila, whereas the cultivar Camarosa had too late in flowering, fruit setting and ripening of the fruits under farmer's field condition (Baadi).

1. INTRODUCTION

Strawberry (*Fragaria* x *ananassa* Duch.) is a temperate fruit belongs to the family Rosaceae. Due to availability of thermo sensitive varieties now it can be grown in tropical and sub-tropical climate too. Nutritionally, strawberry contains low calorie carbohydrate and a potential source of vitamin C and fibers. It contains ascorbic acid (64.0mg), water (91.75g), protein (0.61g), fat (0.37g), carbohydrate (7.02g), fiber (2.3g), calcium (14.0mg), potassium (166.0 mg/160g) and vitamin-A (27 IU). Also known as wholesome fruit having 98 % edible portion with maximum fruit weight and size. Traditionally, people have enjoyed strawberries for its flavor, taste, fresh use, freezing, and processing. It is highly sought after for table purpose as well as for jam making, canning, creating ice cream, beverages, wine, soft drinks, and other high-quality products. Fourteen cultivars of strawberry have been evaluated at College of Horticulture and Research Station, Pendri Farm, Rajnandgaon in the year 2017-18. Among which two cultivars *i.e.*, Nabila and Camarosa were found most suitable cultivars for this region. The work on varietal evaluation was not done earlier in Chhattisgarh plain region under farmer's field condition (Baadi), therefore, the present study was conducted to evaluate best performing strawberry cultivars under farmer's field condition for growth parameters and fruit quality attributes.

2. MATERIALS AND METHODS

The field trial was carried out during the winter spring season of the year 2017-18 in three farmer's field condition (Baadi) at village-Bharregaon (dist.-Rajnandgaon, Chhattisgarh) and the research farm of College of Horticulture and Research Station, Rajnandgaon (C.G.). The soil of experimental field was sandy-loam having pH 7.7. In the experiment student's t-test was used with 4 replications. The experiment was conducted with 2 cultivars viz. Nabila and Camarosa. Healthy tissue cultured plants were procured from Mahabaleshwar (Maharashtra). The vigorous, healthy, diseases & pest free and well rooted saplings of all 2 varieties of Strawberry were planted in field at 45 cm x 30 cm distance with application of recommended dose of fertilizers. All the experimental plants were uniformly maintained and same cultural practices were provided *i.e.,* fertilization, irrigation and plant protection measures during whole period of investigation. Under growth parameters the observations *i.e.*, plant height, number of leaves, plant spread, number of runners per plant and length of runners were recorded and data were analyzed statistically. plant height, plant spread and length of runners were recorded with the help of measuring tape.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

The data on plant height during plant growth stages were recorded at 30, 60, 90, 120 and 150 days after planting are presented in Table 1 and graphically depicted in Fig. 1. At 30 days after planting, no significant differences were observed between both the varieties in respect to plant height. The maximum plant height (9.25 cm) was recorded under Nabila (V_1) and the minimum plant height (8.88 cm) was observed under Camarosa (V_2). At 60, 90, 120 and 150 days after planting, the maximum plant heights (18.99, 24.97, 29.09 and 33.12 cm) respectively were recorded under Nabila (V_1). However, the minimum plant heights (15.79, 19.99,23.96 and 27.49 cm respectively) were observed under Camarosa (V_2) in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. It is clear from the results that in the climatic conditions prevalent at subtropical conditions in Chhattisgarh, plants of all cultivars were observed to be taller than plants raised in other states. The reason for the variation in these cultivars could be that the genes responsible for plant height did not express themselves fully as they do in other places due to differences in agro-climatic conditions. Varietal differences in plant height were also noted by Singh et al. [1], Sharma et al. [2], Negi and Upadhyay [3], Gaikwad et al. [4], Neetu and Sharma [5] and

Panigrahi et al. [6], which supports the present observation.

3.2 Plant Spread (cm) (East-West & North-South Directions)

Observations on plant spread were recorded at 30, 60, 90, 120 and 150 days after planting in both directions *i.e.,* E-W and N-S are presented in Table 1 and illustrated in Fig. 1. At 30 days after planting, no significant differences were observed between both the varieties in respect to plant spread in E-W direction. The maximum plant spread (10.10 cm) was recorded under Nabila (V_1) and the minimum plant spread (10.01 cm) was observed under Camarosa (V_2). The data pertaining to plant spread in E-W direction observed at 60, 90, 120 and 150 days after planting revealed that the maximum plant spread (23.45, 28.52, 33.75 and 36.95 cm respectively) was recorded under Nabila (V_1). The minimum plant spread (17.65, 21.71, 25.72 and 29.15 cm) was noted under Camarosa (V_2) at different growth stages *i.e.,* 60, 90, 120 and 150 days after planting respectively in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station.

As per data observed on plant spread in N-S direction at 30 days after planting, no significant differences were observed. The Nabila (V_1) obtained maximum plant spread (11.13 cm) and the minimum plant spread (11.03 cm) was noticed under Camarosa (V_2). The data recorded at 60, 90, 120 and 150 days after planting in N-S direction the superiority of treatment Nabila (V_1), registered maximum plant spread (24.47, 29.42, 34.77, 37.97 cm respectively). However, the minimum plant spread (18.67, 22.69, 26.76 and 30.18 cm) was recorded under the treatment Camarosa (V_2) at different growth stages i.e., 60, 90, 120 and 150 days after planting, respectively in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station.

The results clearly show that plant spread was more prevalent in the North-South direction than the East-West direction. This can be the result of the constant moisture variations in North-South directions. The aforementioned finding is consistent with those of Sharma et al. [2] who proposed that that "the genes responsible for the plant spread did not express them fully with the same degree as it does at other places because of different agro-climatic conditions". These results are in close agreement with the findings of Negi and Upadhyay [3], Gaikwad et al. [4],

Neetu and Sharma [5] and Panigrahi et al. [6] in Strawberry.

3.3 Number of Leaves per Plant

The data on number of leaves per plant were recorded at 30, 60, 90, 120 and 150 days after planting are presented in Table 1 and graphically depicted in Fig. 1. At 30 days after planting, no significant differences were observed between both the varieties in respect to number of leaves per plant. The maximum number of leaves per plant (7.10) was recorded under Nabila (V_1) and the minimum number of leaves per plant (6.52) was observed under Camarosa (V_2). The data pertaining to number of leaves per plant observed at different growth stages *i.e.,* 60, 90, 120 and 150 days after planting revealed that the maximum number of leaves per plant (21.87, 32.01, 41.09 and 49.07, respectively) was recorded under the superiority of Nabila (V_1). However, the minimum number of leaves per plant (17.82, 28.31, 34.46 and 40.08) was recorded under Camarosa (V_2) at 60, 90, 120 and 150 days after planting, respectively in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. The results show that the variation in leaf number per plant can be attributed to the fact that various cultivars may react differently to photoperiod, light, temperature, soil nutrient status, available metabolites, and their allocation to above ground plant parts. Increased number of leaves was exhibited by the plants in the experiment. The number of leaves per plant recorded in the present studies was on higher side as reported earlier by Sharma et al. [2] Negi and Upadhyay [3], Gaikwad et al. [4], Neetu and Sharma [5] and Panigrahi et al. [6] in Strawberry.

3.4 Number of Runners per Plant

The data gathered on number of runners per plant was very much influenced by both the strawberry cultivars been presented in Table 1 and illustrated in Fig. 2. It is obvious from the data that significantly maximum number of runners per plant (9.10) was noticed under Nabila (V_1), which was followed by Camarosa (V_2) recording minimum number of runners per plant (6.12) in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. The plants only produced a small number of runners due to the constrained and short favorable agro-climatic conditions. These results are in close agreement with the findings of Negi and Upadhyay [3], Gaikwad et

al. [4], Neetu and Sharma [5] and Panigrahi et al. [6] in Strawberry.

3.5 Length of Runners (cm)

The data pertaining to length of runners (cm) is presented in a Table 1 and graphically depicted in Fig. 2. Length of runners was significantly influenced by different strawberry cultivars. Between both the cultivars the longest runners (91.20 cm) were noticed under Nabila (V_1) and the shortest runners (74.33 cm) were observed under Camarosa (V_2) in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. Length of the runners was longer might be due to irrigation by flood or channel system, which confined the moisture to root zone and nearby surface areas had resulted in the longer runners, because the emerged runners were feasible to grow in length [7]. The present findings are in close agreement with the finding of Negi and Upadhyay [3], Gaikwad et al. [4], Neetu and Sharma [5] and Panigrahi et al. [6] in Strawberry.

3.6 Days to First Flowering

The data pertaining to days to first flowering is presented in a Table 1 and illustrated in Fig. 2. Days to first flowering was significantly influenced by different strawberry cultivars. Between both the cultivars the minimum days to first flowering (42.07 days) was noticed under Nabila (V_1) and the maximum days to first flowering (49.98 days) was observed under Camarosa (V_2) in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. Early inflorescence emergence was significantly altered by the different strawberry cultivars. "This might be attributed to its short crop period as observations made" by Montero et al. [8]. "Variability in flowering period in different varieties might also be due to differences in their chilling requirement as suggested" by Joolka and Badiyala [9]. Similar findings are also reported by Negi and Upadhyay [3], Gaikwad et al. [4], Neetu and Sharma [5] and Panigrahi et al. [6] in Strawberry.

3.7 Number of Flowers Produced Per Plant

The data gathered on number of flowers produced per plant was very much influenced by various strawberry cultivars are presented in Table 1 and graphically depicted in Fig. 2. The number of flowers per plant varied between 31.73 and 43.61. The maximum number of flowers per plant (43.61) was noticed under Nabila (V_1) which was followed by Camarosa (V_2) recording minimum number of flowers produced per plant (31.73) in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. This comes in accordance with the findings of Islam et al. [10]. "The increment in the number of flowers per plant may be due to more light intensity in the region. Increased number of flowers per plant was observed in all treatments over the reports" of many researchers viz., Jamul Uddin et al. [11], Negi and Upadhyay [3], Gaikwad et al. [4], Neetu and Sharma [5]) and Panigrahi et al. [6] in Strawberry.

3.8 Days to Fruit Setting

The observation recorded for days to first fruiting from planting showed significant variations between strawberry cultivars tested in the present investigation are presented in Table 1 and illustrated in Fig. 2. It is evident from the data, days to first fruiting from planting was significantly influenced by different strawberry cultivars under the present investigation. The minimum days to first fruiting (53.03 days) from planting was noted under Nabila (V_1) and the maximum days to first fruiting (62.99 days) from planting was observed under Camarosa (V_2) in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. "This might be attributed to its short crop period as observations made" by Montero et al. [8]. "Variability in fruit setting period in different varieties might also be due to differences in their chilling requirement as suggested" by Joolka and Badiyala [9]. Similar opinion was also put forwarded by Das et al. [12], Negi and Upadhyay [3], Gaikwad et al. [4], Neetu and Sharma [5] and Panigrahi et al. [6] in Strawberry.

3.9 Berry Set (%)

The data with respect to percent berry set (%) in different strawberry cultivars under the present investigation are presented in Table 1 and graphically depicted in Fig. 2. Significant difference was observed between both the strawberry cultivars regarding the percent berry set. The percentage of fruit set ranged from 81.60 to 88.82 %. The maximum percent berry set (88.82 %) was noticed under Nabila (V_1), followed by Camarosa (V_2) which recording minimum percent berry set (81.60 %) in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. This variation may be due to genetic makeup of the

cultivars and adaptation to climatic condition [13]. The above finding comes in accordance with the findings of Negi and Upadhyay [3], Gaikwad et al. [4], Neetu and Sharma [5] and Panigrahi et al. [6] in Strawberry.

3.10 Days to Start Fruit Ripening

The data pertaining to days to start fruit ripening from planting influenced significantly by strawberry cultivars. These results are presented in Table 1 and illustrated in Fig. 2. As per the data, the minimum days to start fruit ripening (66.11 days) from planting was observed under Nabila (V_1), followed by Camarosa (V_2) which recording maximum days (76.37 days) to start

fruit ripening from planting in both the farmer's field condition (Baadi) and Research farm of Horticulture Research Station. This earliness in the ripening may be due to the varied agro-climatic conditions (temperature and light intensity differences). In the climatic conditions prevalent at subtropical conditions of Chhattisgarh, the plants of all the cultivars were observed earlier to fruit ripening in comparison to plants raised in other parts of different states reported by many researchers. These results are in close agreement with the findings of Das et al. [12], Jamal Uddin et al. [11], Negi and Upadhyay [3], Gaikwad et al. [4], Neetu and Sharma [5] and Panigrahi et al. [6] in strawberry.

Table 1. Evaluation of strawberry cultivars for growth parameters under farmer's field condition (Baadi) in the Chhattisgarh plain region

S.N.	Parameters	Nabila (V_1)	Camarosa (V_2)	P(T<=t) two-tail
1.	**Plant height (cm)**			
	30 DAP (cm)	9.25	8.88	0.199 (NS)
	60 DAP (cm)	18.99	15.79	0.035*
	90 DAP (cm)	24.97	19.99	0.040*
	120 DAP (cm)	29.09	23.96	0.037*
	150 DAP (cm)	33.12	27.49	0.027*
2.	**N-S Plant spread (cm)**			
	30 DAP (cm)	11.13	11.03	0.689 (NS)
	60 DAP (cm)	24.47	18.67	0.029*
	90 DAP (cm)	29.42	22.69	0.018*
	120 DAP (cm)	34.77	26.76	0.010*
	150 DAP (cm)	37.97	30.18	0.013*
3.	**E-W Plant spread (cm)**			
	30 DAP (cm)	10.10	10.01	0.686 (NS)
	60 DAP (cm)	23.45	17.65	0.028*
	90 DAP (cm)	28.52	21.71	0.017*
	120 DAP (cm)	33.75	25.72	0.009*
	150 DAP (cm)	36.95	29.15	0.011*
4.	**Number of leaves per plant**			
	30 DAP	7.10	6.52	0.205 (NS)
	60 DAP	21.87	17.82	0.001*
	90 DAP	32.01	28.31	0.009*
	120 DAP	41.09	34.46	0.001*
	150 DAP	49.07	40.08	0.002*
5.	**Number of runners per plant**	9.10	6.12	0.0001*
6.	**Length of runners (cm)**	91.20	74.33	0.0235*
7.	**Days to first flowering**	42.07	49.98	0.0031*
8.	**Number of flowers per plant**	43.61	31.73	0.0015*
9.	**Days to fruit setting**	53.03	62.99	0.0078*
10.	**Berry set (%)**	88.82	81.60	0.0453*
11.	**Days to start fruit ripening**	66.11	76.37	0.0451*

Significant at 5% level of significance
DAP = Days after planting
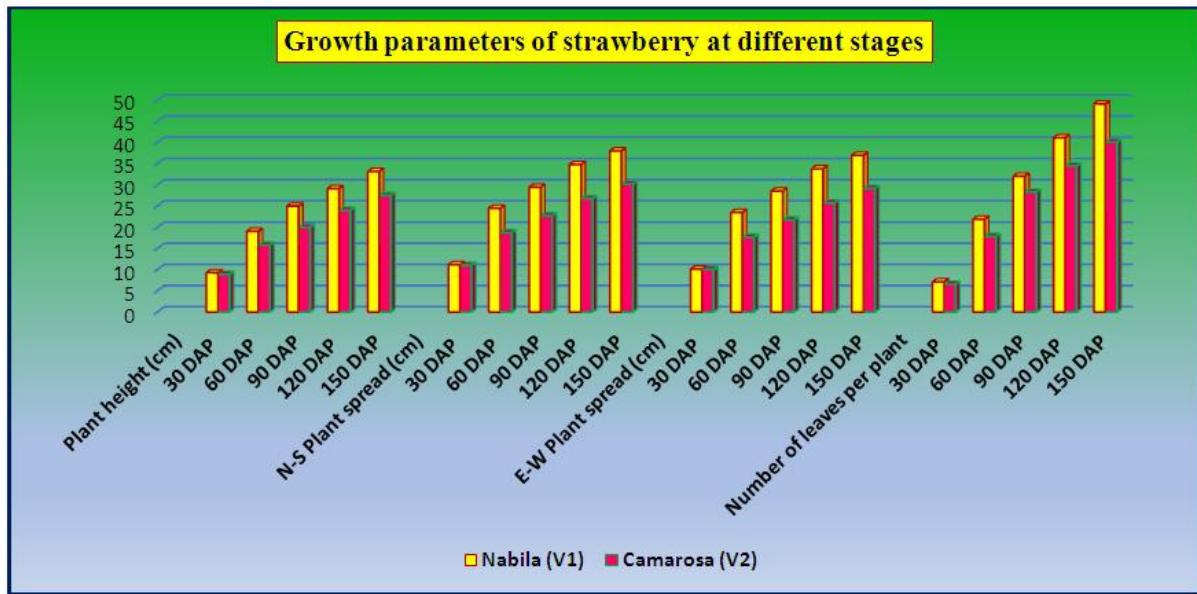*N-S = North-South*
E-W = East-West

Fig. 1. Plant height (cm), plant spread (cm) and number of leaves per plant of strawberry cultivars at different growth stages under farmer's field condition (Baadi) in the chhattisgarh plain region
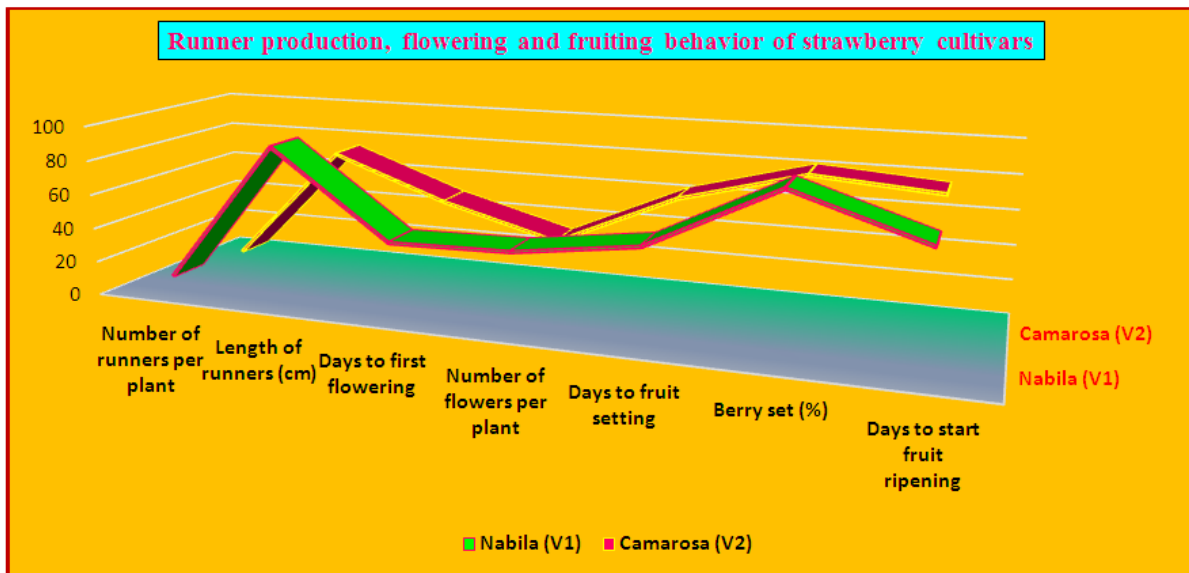

Fig. 2. Runner production, flowering and fruiting behavior of strawberry cultivars under farmer's field condition (Baadi) in the chhattisgarh plain region

4. CONCLUSION

Based on the experimental results it can be concluded that performance of cultivar Nabila (V_1) was found to be best for growth parameters with increase in plant height, plant spread and number of leaves per plant, number of runners per plant, length of runners as compared to cultivar Camarosa (V_2) under both the farmer's field (Baadi condition) and Research farm of Horticulture Research Station. The observations related to days to first flowering, days to fruit setting and days to fruit ripening from planting is concerned, the cultivar Nabila (V_1) advanced the flowering, fruit setting and fruit ripening by 7.91, 9.96 and 10.26 days, respectively as compared to cultivar Camarosa (V_2). The maximum number of flowers per plant and percent berry set in

strawberry was recorded under cultivar Nabila (V_1) as compared to cultivar Camarosa (V_2) under both the farmer's field (Baadi condition) and Research farm of Horticulture Research Station.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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