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Evaluation of promising strawberry genotypes under Garhwal Himalayan conditions

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ABSTRACT

The performance of 17 strawberry genotypes was evaluated under Garhwal agro-climatic conditions. The results revealed that the genotypes Chandler (190.70 g) and Senga Sengana (165.80 g) for yield per plant, berry length and berry width; Belrubi (16.80) and Gorella (15.10) for number of fruit per plant; Dana (26.03 cm) and Chandler (23.22 cm) for plant height; Chandler (1134 cm^2) and Belrubi (1118 cm^2) for leaf area per plant and number of leaves per plant; were found superior as compared to other genotypes. On the basis of crop duration, genotypes could be categorized as early (Senga Sengana, Confictura and Shasta), mid (Red Coat, Brighton, Gorella, Addie, Osolana, Larson, Missionary and Seascape) and late (Pajaro, Howard, Catskill, Chandler, Belrubi and Dana).

Key words: *Fragaria* × *ananassa*, evaluation, mid hills, yield.

INTRODUCTION

Strawberry is one of the most attractive and acceptable soft fruits of the world, which belongs to the family Rosaceae and is a native of America. It is in high demand for table purpose as well as jam making, canning and ice cream preparations. It is preferred by the growers because of its high returns per unit area, coupled with low cost of cultivation. In India, it is cultivated to a limited extent in plains and sub-mountainous areas of Himachal Pradesh, Uttarakhand, Uttar Pradesh, Maharashtra, Karnataka, Punjab, Haryana and Madhya Pradesh regions where irrigation facilities are available.

In North India, area under strawberry is increasing rapidly due to its remunerative prices. In Uttarakhand, it is grown in Dehradun, Udham Singh Nagar and Nainital districts. Evaluation of the suitability of different strawberry genotype for a specific area is of paramount importance for their successful cultivation. Although, some work on strawberry cultivation has been reported in temperate and sub-tropical conditions of the country (Asrey and Singh, 2; Das *et al*., 9; Singh *et al*., 12), still the work on identification of suitable genotype for agro-climatic conditions of Garhwal Himalayas remains scanty. Keeping in view the importance of such a study, the present investigation was undertaken to evaluate different genotypes for their growth and yield characters.

MATERIALS AND METHODS

The present investigation was carried out at Research Block of the Department of Horticulture, College of Forestry and Hill Agriculture, G.B. Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Tehri Garhwal, Uttarakhand, during 2006-07 at 1,843 m above msl (mid hill conditions of Central Himalayas). Runners of 17 strawberry genotypes were procured from Sher-e-Kashmir University of Agricultural Sciences & Technology (S), Shalimar, Srinagar (J&K). Experiment was laid out in randomized block design (RBD) with three replications. The runners were planted on raised (15 cm) double-rowed beds in third week of October, using black polythene mulch. Twenty plants of each of the genotypes were planted in 3 m × 1.2 m raised bed. Individual rows were spaced at 60 cm and plant to plant distance was kept at 30 cm. During the course of experimentation, uniform cultural practices were followed. Data on vegetative characters like plant height, plant spread, number of leaves per plant, leaf area per plant, petiole length, root length, number of roots per plant, floral characters like duration of flowering, opening of first flower and last flower, days to flowering, number of flowers per plant and fruit characters like berry length, berry width, number of achenes per fruit, days to fruit maturity, number of fruits per plant, berry weight, yield per plant, marketable yield were recorded as per the standard method. Statistical analysis of the data was carried out by the method of analysis of variance as outlined by Gomez and Gomez (3).

RESULTS AND DISCUSSION

The plants of cultivar Dana were significantly taller to others, followed by Chandler and Seascape, both of which were at par with each other (Table 1). The

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minimum plant height was found in cv. Catskill which was significantly lower compared to other cultivars. Cultivar Chandler was found to have maximum plant spread which was significantly higher than all other cultivars (Table 1). The plant spread in cvs. Belrubi and Catskill was found to be at par. Cultivars Brighton, Pajaro and Red Coat exhibited minimum plant spread. The results regarding height and spread of plants of cultivars Dana and Gorella observed are in line with the results of Roudeilac *et al*. (11). Since the plant size is influenced by different environmental and edaphic factors, the differences in plant height and spread in some of the cultivars may be attributed to this factor. A number of workers have used various leaf characters such as size, shape, colour, apex, base, margins and pubescence as important parameters in the varietal evaluation in different fruit crops. In the present investigation also, the foliage characters were found to show significant variations with regard to size of the leaves, foliage density and petiole length. Cultivar Dana had significantly lower number of leaves compared to all cultivars under study, except Osolana (Table 1). The cultivars Chandler, Belrubi and Addie were found to possess dense foliage. The higher leaf area in these cultivars might be due to more available metabolites and their allocation to the above ground parts of the plants through roots and genetic attributes of respective cultivars. The leaf area per plant was highest in cv. Chandler followed by Belrubi and Addie and it was significantly higher from the remaining cultivars. The minimum leaf area was recorded in Confictura which was significantly lower than other cultivars (Table 1). Variation with respect to leaf area among different cultivars could be attributed to influence different photoperiod, temperature and soil nutrient status (Tanaka and Mizuta, 14). Cultivar Belrubi had the longest petiole which was at par with Addie and Confictura, whereas, the shortest petiole length was recorded in cultivar Missionary than other cultivars (Table 1). Stahler *et al.* (13) also reported long and moderately long petioles in Red Crest cultivar. The roots were significantly longer in cv. Confictura followed by Gorella, Dana and Red Coat and these were at par (Table 1). The root length was found minimum in cv. Senga Sengana, which was at par with Howard and was significantly lower from all other cultivars under study. The number of primary root per plant ranged from 12.00 in cv. Red Coat to 26.00 in Gorella (Table 1). The cultivar Gorella differed significantly from other cultivars under study.

Table 1. Growth performance of strawberry genotypes grown in mid hills of Garhwal Himalayas.

Cultivar	Plant height (cm)	Plant spread (cm)	No. of leaves/ plant	Leaf area/ plant (cm^2)	Petiole length (cm)	Root length (cm)	No. of roots / plant
Senga Sengana	21.97	25.41	9.853	532.2	7.693	17.50	24.00
Red Coat	21.36	23.34	14.65	713.3	9.350	22.00	12.00
Confictura	20.74	29.16	9.690	362.1	11.47	25.00	16.00
Brighton	20.94	22.13	11.39	858.4	11.21	21.00	22.00
Gorella	22.53	28.17	9.610	532.8	11.25	23.00	26.00
Pajaro	21.23	23.17	11.98	866.0	9.177	20.00	23.00
Shasta	19.25	32.19	15.12	812.9	11.22	21.00	24.00
Howard	20.97	32.71	13.37	958.7	9.517	18.50	14.00
Catskill	17.14	33.11	12.71	713.8	9.167	19.00	15.00
Chandler	23.22	34.55	16.66	1134	9.543	21.10	22.13
Addie	21.61	30.35	16.22	1113	12.02	20.20	21.13
Osolana	18.97	24.41	8.877	402.9	9.267	19.21	22.30
Larson	21.56	31.05	9.860	701.9	11.34	18.70	21.21
Belrubi	20.27	33.57	16.25	1118	12.16	19.83	22.70
Missionary	20.77	31.21	13.07	951.3	6.777	19.50	21.80
Seascape	22.57	28.85	9.950	444.1	10.72	21.24	21.24
Dana	26.03	29.54	8.127	473.4	9.327	22.40	23.20
$CD_{0.05}$	2.243	0.947	1.104	23.129	0.711	1.100	1.002

Significant differences were observed for flowering duration among cultivars undertaken for the study (Table 2). The flowering duration was found to be significantly longer in Howard as compared to all other cultivars except for Dana, Seascape and Shasta (Table 2). However, cultivar Belrubi showed shortest period of flowering. The length of flowering period in different strawberry cultivars under present study was found to vary from 50.20 to 77.20 days, thus enabling the characterization of cultivars into short (< 80 days), medium (80-90 days) and long (> 90 days) duration of flowering. Flowering season was observed to be short in all the cultivars and there was no one of medium and late flowering. Almost similar findings were also observed by Kidmose *et al.* (6). Earliest flowering was recorded in cv. Pajaro, which was closely followed by Howard, Catskill and Seascape. All of them took significantly less time for flowering than other cultivars except for Senga Sengana. Cultivar Addie took maximum number of days to flowering (Table 2). Cultivar Belrubi produced maximum number of flowers and minimum were recorded in Howard. Number of flowers per plant produced by cultivars Gorella and Chandler were also significantly higher than other genotypes (Table 2). Many workers have reported the importance of various plant characters, such as size, vigour and growth habit in the determination of extent of variability and evaluation of different strawberry cultivars and species (Joolka and Badiyala, 5).

Cultivar Chandler had the longest berry followed by Senga Sengana which was significantly higher to others, whereas the cultivar Shasta recorded shortest berry length (Table 3). Significant differences among cultivars were recorded for berry width. The maximum berry width was recorded in cultivar Chandler followed by Senga Sengana which was significantly higher in comparison to other cultivars (Table 3). Cultivar Shasta showed significantly lower berry width followed by Brighton and Belrubi, which were similar to each other. Berry size showed marked variation among different cultivars tested during the course of present study. Hancock and Bringhurst (4) also determined sufficient variation for fruit size in different strawberry cultivars. In the present study, the berries of Chandler were observed to be largest in size followed by those of Senga Sengana. These results are in conformity with the findings of Recupero *et al.* (10) who reported larger berries in Chandler, Pajaro and Selva. According to Moore *et al.* (8) these differences in berry size are primarily due to plant vigour, competition among fruits

Table 2. Flowering performance of strawberry genotypes grown in mid hills of Garhwal Himalayas.

Cultivar	Flowering duration (days)	Flowers /plant	Days to flowering	Date of opening of first flower	Date of opening of last flower
Senga Sengana	54.00	14	116.5	13.02.07	08.04.07
Red Coat	65.85	12.20	117.7	14.02.07	10.04.07
Confictura	67.13	13.82	118.7	15.02.07	23.04.07
Brighton	68.23	14.81	124.0	20.02.07	29.04.07
Gorella	55.49	17.20	125.0	21.02.07	17.04.07
Pajaro	64.04	13.68	115.0	11.02.07	16.04.07
Shasta	70.23	12.20	123.0	19.02.07	30.04.07
Howard	77.20	10.60	115.5	12.02.07	30.04.07
Catskill	64.14	12.50	116.0	12.02.07	17.04.07
Chandler	55.93	14.96	119.5	16.02.07	12.04.07
Addie	52.04	13.60	128.3	24.02.04	17.04.07
Osolana	59.08	13.20	126.7	22.02.07	22.04.07
Larson	61.04	11.20	125.8	21.02.07	23.04.07
Belrubi	50.20	19.20	128.0	25.02.07	16.04.07
Missionary	60.60	14.58	124.7	20.02.07	21.04.07
Seascape	72.20	13.70	116.0	13.02.07	26.04.07
Dana	76.20	13.40	119.0	15.02.07	02.04.07
$CD_{0.05}$	6.974	0.428	1.046	-	-

Table 3. Fruiting and yield performance of strawberry genotypes grown in mid hills of Garhwal Himalayas.

Cultivar	Berry length (cm)	Berry width (cm)	Number of achenes / fruit	Days to maturity	No. of fruits/plant	Berry wt. (g)	yield/plant (g)	Marketable yield (g/ plant)
Senga Sengana	3.30	2.80	425	35.70	11.50	14.41	165.80	132.60
Red Coat	2.62	1.76	249	42.70	10.60	8.63	91.50	72.28
Confictura	2.64	1.80	257	39.70	12.20	9.46	115.50	92.40
Brighton	2.60	1.64	230	48.33	13.20	7.31	96.50	75.27
Gorella	2.64	1.74	239	43.80	15.10	8.37	126.50	101.00
Pajaro	2.78	1.80	263	55.00	11.30	9.95	112.80	89.96
Shasta	2.60	1.62	229	37.33	9.20	7.11	65.50	52.00
Howard	2.92	1.80	285	52.00	8.60	10.76	92.60	74.00
Catskill	2.70	1.76	252	52.00	10.20	9.16	93.50	74.20
Chandler	3.59	2.86	430	51.33	12.30	15.50	190.70	152.00
Addie	2.80	1.80	265	41.00	11.50	8.93	102.80	82.00
Osolana	2.92	1.82	297	45.85	10.20	10.35	105.60	84.00
Larson	2.85	1.82	272	43.70	8.60	10.41	89.60	71.20
Belrubi	2.62	1.64	236	54.33	16.80	7.33	123.20	98.10
Missionary	2.95	1.68	259	42.70	11.75	8.80	103.50	82.80
Seascape	2.85	1.85	284	45.20	10.80	9.95	107.50	86.00
Dana	2.92	1.80	281	53.67	9.50	10.80	102.70	82.00
$CD_{0.05}$	0.045	0.019	1.711	0.834	0.016	0.024	0.043	0.854

in the inflorescence, number and size of developed achenes, differences in activity among the achenes in the production of growth material, climatic conditions, irrigation and plant nutrients. The number of achenes is an important character closely associated with berry size. Maximum number of achenes per fruit was recorded in Chandler and Senga Sengana which was significantly higher to all other cultivars. Number of achenses per fruit present in cultivar Shasta was exhibited significantly least to all other cultivars which were at par with Brighton (Table 3). The data pertaining to number of days taken by various cultivars to attain maturity revealed significant differences among genotypes. Cultivar Senga Sengana took least number of days for maturation as compared to all other cultivars. However, Pajaro took maximum days to mature though it was at par with Belrubi (Table 3). Yield and fruit quality are greatly influenced by a number of factors including the interaction of photoperiod and temperature, length of rest period, disease resistance, soil conditions, winter hardiness and inherent vigour and growth. The number of fruits produced by a plant revealed significant differences among cultivars. The data on number of fruits per plant are given in Table 3. Maximum number of fruits per plant was found in cultivar Belrubi and number of fruits per plant was significantly lesser in Howard and Larson than other cultivars. Fruit yield is directly related to average berry weight. The data on berry weight showed significant differences among various strawberry cultivars (Table 3). The fruits of Chandler and Senga Sengana were significantly heavier than other cultivars. Cultivar Shasta exhibited least fruit weight followed by Brighton and Belrubi which were at par. These results are in accordance with the findings of Lal and Seth (7). They also observed a strong interaction of fruit number per plant and weight with fruit yield. Highest cumulative yield was recorded in Chandler followed by Senga Sengana (Table 3). Both the cultivars were significantly superior to all other cultivars. Minimum yield was recorded in cultivar Shasta. The highest marketable yield was recorded in cultivars Chandler followed by Senga Sengana, which was significantly higher than other cultivars (Table 3). Minimum marketable yield was recorded in cultivar Shasta followed by Larson. The time and duration of flowering were found to be important traits in the classification of different strawberry cultivars (Kidmose *et al.*, 6). In the present study, a considerable variation was observed in flowering time in different cultivars. The flowering in Pajaro and Howard terminated very early but late in Addie and Belrubi. These results have substantiated the findings of Joolka and Badiyala (5). These variations in the time of flowering among strawberry cultivars may be possibly due to the fact

that different cultivars differ significantly in their chilling requirements. According to the ripening period, the strawberry cultivars under probe were classified into different categories, *i.e.* early, mid and late. To determine appropriate ripening period in fruits of different cultivars, the number of days from full bloom to harvest has been found to be the most reliable criterion. A considerable variability was observed for ripening period in the present study. Cultivars Senga Sengana, Confictura and Shasta were classified as early ripening, while Pajaro, Belrubi, Dana, Howard, Chandler and Catskill as late ripening, whereas, the rest of the cultivars were classified as mid season as they took <40, >50 and 40-50 days, respectively to reach horticultural maturity. Several workers have too found a wide range of variation to the extent of 18 to 60 days in different strawberry cultivars with respect to fruit ripening period from full bloom (Wilson and Giamalva, 15). These differences in ripening period from full bloom to mature berries is based on the length of time of flower bud formation in different regions due to temperature and photoperiod differences (Avidov, 1). On the basis of fruit yield and quality it can be concluded that out of 17 cultivars evaluated Chandler and Senga Sengana were found to be promising under agro-climatic conditions of Garhwal Himalayas.

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