



Short communication

Performance of exotic strawberry varieties under temperate conditions of north-western Himalayas

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ABSTRACT

Present study was carried out in the experimental farm, Division of Fruit Science, SKUAST-Kashmir, Srinagar to evaluate the performance of seven exotic varieties of strawberry viz., Camarosa, Anthea, Missionary, Red Cross, Fiana, Majestic and Confitura under temperate conditions of Kashmir valley. Among different varieties, maximum plant height (16.00 cm) was recorded in cultivar Majestic and minimum in cultivar Anther (8.50 cm). Maximum plant spread (23.50 cm), leaf area (39.80 cm²), number of leaves per plant (18.23), and petiole length (10.43) was observed in variety Camarosa. Maximum number of runners per plant was recorded in cultivar Missionary (7.30) however the length of runner was highest (98.50 cm) in cultivar Fiana. Flower initiation in all the varieties under study occurred from 6th to 20th of April and the flower initiation was earliest in cultivar Fiana. Peak bloom was earliest in cultivar Camarosa and fruits were ready for picking earliest in cultivar Confitura. Fruits were ready for harvesting upto 30th June in cultivar Anthea. Fruits of all the varieties were prolate spheroid in shape. Maximum number of pickings (11) occurred in cultivar Camarosa. Maximum number of fruitlets per plant (22.61) were recorded in cultivar Camarosa. Maximum fruit length (4.20 cm), fruit diameter (3.50 cm), fruit weight (19.90 g), yield per plant (352.02 g), total soluble solids (7.50°B), titrable acidity (0.95%), total sugars (6.81%) and organoleptic score (4.33) was also recorded in cultivar Camarosa in comparison to other varieties under study. As the cultivar Camarosa excelled in most of the characteristics studied in comparison to other varieties, thus can be recommended for commercial cultivation in temperate conditions of Kashmir valley.

Key words: *Fragaria* × *ananassa*, morphological, floral, fruit physical and chemical characters

Strawberry (*Fragaria* × *ananassa* Duch.) an aggregate fruit, belongs to family Rosaceae and which has been developed in France in the seventeenth century (Sharma and Yamdagni, 18). Strawberry has gained the status of being one of the most important soft fruit of the world after grapes (Rana, 16). Among the fruits it gives quick economic returns in short time, as its fruit is the first of the season's home-grown supplies to reach the market. Strawberry is a favoured food in the diet of millions of people around the globe (Bhat *et al.*, 4) due to its distinct and pleasant aroma and delicate flavour. It is also a rich source of vitamin C (40-120 mg per 100 g of berries), vitamin B, protein and minerals like phosphorus, potassium, calcium and iron. Strawberry is essentially a temperate fruit but has adopted well under various agro-climatic conditions. Strawberry fruits are in great demand for fresh market as well as in processing industries for use in preserves and confectionaries. Strawberry cultivation has been practiced in Kashmir valley since long. The area

under strawberry cultivation in Kashmir valley is 171 hectares with a production of 387 MT (Anonymous, 1). The expansion of strawberry is gaining popularity in the valley owing to the fact that it is commonly grown as an intercrop in the initial years of apple and pear orchards for utilization of spaces and light and to get maximum remuneration per unit area till the main plant reach to its bearing stage. The agro-climatic conditions of the Kashmir valley offer congenial conditions for growing this high value and short duration crop over longer periods. Several strawberry varieties are being grown in the Kashmir valley. However cultivar Chandler has high potential. In order to boost production of strawberry in Kashmir valley, it is imperative to select and evaluate the new varieties for various characters viz. morphological, floral and other physico-chemical. Therefore a study was undertaken to understand the behavior of six exotic varieties of strawberry viz., 'Camarosa', 'Anthea', 'Missionary', 'Red Cross', 'Fiana', 'Majestic' with 'Confitura' as check under the agro-climatic conditions of the Kashmir valley for finding their suitability for commercial cultivation.

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The present studies were carried out at the Experimental block of Division of Fruit Science, Sher-e-Kashmir University of Agriculture Sciences and Technology of Kashmir, Shalimar, Srinagar (Jammu & Kashmir). Runners of strawberry varieties Camarosa, Anthea, Missionary, Red Cross, Fiana, Majestic and Confitura with uniform vigour were planted in well prepared 1.5 × 1.5 meter raised beds. The planting was done in the month of November with the spacing of 30 cm × 30 cm. All the experimental plants were given uniform cultural operations including recommended plant protection measures. Data on average plant height and plant spread was measured with a measuring scale. The leaf area of three representative leaves per plant was measured with the help of leaf area meter (Systronics, 211 model) and average leaf area was expressed in square centimetres. Number of leaves per plant was recorded on the basis of average number of leaves per plant at peak fruiting time. Petiole length was measured from the base of the petiole to its conjunction with the lamina and expressed in centimetres. Runner length was measured in centimetres. The date of initiation of flowering (i.e. opening of first flower) was recorded when at least 5 plants in each cultivar exhibited flowering. The date of peak bloom was recorded when 80 per cent of the total flowers were in bloom. Total numbers of pickings were counted from first picking to last picking. Number of fruitlets was recorded by calculating the per cent fruit set per plant with the formula given by Westwood (19).

$$\text{Per cent fruit set} = \frac{\text{Number of fruits (berry) set}}{\text{Total number of flowers}} \times 100$$

Average fruit length and diameter were measured with digital Vernier Caliper and fruit weight was taken using electronic balance. Fruit yield per plant was recorded at the time of harvesting the fruit. Total soluble solids of fruits were determined using a hand refractometer. The readings were corrected

at ±20°C and result was expressed as degree Brix. Fruit titrable acidity and total sugars content was determined as per the methods described by AOAC (2). For organoleptic evaluation, the freshly harvested fruits were coded and served to a panel of judges for evaluation with respect to colour, flavour, texture and taste on five point hedonic scale i.e. 1=extremely poor, 2= poor, 3= fair, 4 = good, 5=excellent. Data recorded was analyzed by the procedure as described by Gomez and Gomez (8).

The results of the present investigation clearly indicate that all the strawberry varieties exhibited significant variation with respect to plant height, plant spread, leaf area, leaf number per plant, petiole length, number of runners per plant and runner length (Table 1). Plant height ranged from 8.50 to 16.00 cm in different varieties with maximum in Majestic (16.00 cm) followed by varieties Camarosa (14.33 cm), Fiana (14.20 cm) and Missionary (13.86 cm) and minimum in Anthea (8.50 cm) over standard check Confitura (11.23 cm). Plant spread ranged from 14.20 to 23.50 cm in different varieties. Maximum plant spread was observed in cultivar Camarosa (23.50 cm) followed by Confitura (21.90 cm). Lowest plant spread was recorded in cultivar Anthea. Plant height and spread provide an idea of the vigour of the plant and also provide information on surface available for fruit production (Darrow, 6). Variations differences in plant height and spread among strawberry varieties have also been reported by Beniwal *et al.* (3).

Maximum leaf area of 39.80 cm² was observed in cultivar Camarosa which was statistically at par with standard check Confitura (37.50 cm²). However, cultivar Majestic also showed significantly more leaf area than rest of the varieties and was at par with standard check. Least leaf area was recorded in cultivar Anthea (14.70 cm²) followed by Missionary (20.25 cm²), Red Cross (22.70 cm²) and Fiana (27.60 cm²). Highest mean number of leaves per plant was observed in varieties Camarosa (18.23) and Majestic

Table 1. Morphological characters of exotic strawberry varieties.

Cultivar	Plant height (cm)	Plant spread (cm)	Leaf area (cm ²)	Leaf number per plant	Petiole length (cm)	Number of runners per plant	Runner length (cm)
Camarosa	14.33	23.50	39.80	18.23	10.43	3.25	90.40
Anthea	8.50	14.20	14.70	9.33	6.40	7.00	94.50
Missionary	13.86	16.13	20.25	8.43	7.26	7.30	92.10
Red Cross	8.70	16.40	22.70	11.50	8.60	5.60	93.40
Fiana	14.20	15.50	27.60	9.23	8.30	6.50	98.50
Majestic	16.00	20.40	36.14	16.60	9.50	4.50	80.25
Confitura (Check)	11.23	21.90	37.50	14.50	7.50	4.46	70.50
CD _(0.05)	1.58	1.00	2.24	1.25	1.06	0.65	1.47

(16.60) which were statistically superior to 14.50 leaves per plant in cultivar Confitura. Lowest number of leaves were recorded in cultivar Missionary (8.43). Variation in leaf area and leaf numbers per plant may be attributed to genetic make up of these varieties as has also been reported by Beniwal *et al.* (3).

Runners are the only means of propagation in strawberries. Mean number of runners recorded among the varieties varied significantly and ranged between 3.25 to 7.30 runners per plant. Maximum number of runners per plant was observed in cultivar Missionary (7.30) followed by Anthea (7.00), Fiana (6.50) and Red Cross (5.60). Least number of runners per plant was observed in cultivar Camarosa (3.25) followed by Majestic (4.50) and Confitura (4.46). However maximum length of runners was observed in cultivar Fiana (98.50 cm) followed by Anthea (94.50 cm), Red Cross (93.40 cm), Missionary (92.10 cm), Camarosa (90.40 cm) and Majestic (80.25 cm). All the varieties under study were significantly superior with respect to the average length of runners observed in Confitura (70.50 cm). This variation in runner number and length in strawberry varieties have been observed under temperate agro-climatic conditions. The variation in runner production may be attributed to varied response of varieties to photoperiod and chilling requirement and the results are inconformity with the findings of Dhaliwal and Singh (7), Kumar *et al.* (11) and Moshiur *et al.* (13).

Flower initiation, peak bloom, date of first picking, date of last picking and number of pickings was different in the studied varieties however the shape of the fruit was prolate spheroid in all the varieties (Table 2). Flower initiation occurred earliest in cultivar Fiana (6th April) followed by cultivar Red Cross. Cultivar Camarosa was the last to start flower initiation (20th April). Other varieties initiated flowers between April 12-18. Cultivar Camarosa was the earliest to attain peak bloom (8th May) however cultivar Confitura was last to attain peak bloom

(18th May). In rest of the varieties the gap of peak bloom was quite narrow. The results obtained are in conformity with the finding of Piringer and Scot (15) who reported that flowering in strawberry depends on day length and as well as temperature required by a particular cultivar.

Fruits of cultivar Confitura were ready for first picking very early (10th May) as compared to other varieties. In cultivar Anthea fruits were ready for first picking quite late (27th May) followed by cultivar Red Cross (22nd May). First picking in cultivar Majestic and Camarosa occurred on 14th and 18th of May, respectively. Last picking was on 30th June in cultivar Anthea followed by cultivar Camarosa (26th June). In cultivar Missionary the last picking was on 15th of June followed by varieties Red Cross and Confitura each on 20th of June. In rest of the varieties a difference of 3 to 4 days was observed as compared with Confitura. Fruits of cultivar Camarosa were harvested in maximum number of times (11 pickings) followed by Majestic (9 pickings) and Fiana (8 pickings). Minimum number of pickings was recorded in cultivar Missionary (only 4 pickings) followed by cultivar Anthea (6 pickings). In cultivar Confitura total number of pickings were 9 followed by varieties Fiana (8 pickings) and Red Cross (7 pickings). Maturity of fruits at different times resulting in varied number of pickings might be due to the genetic behaviour of the varieties. Similar results were also reported by Darrow (6), John and Dane (10) and Dhaliwal and Singh (7).

Physico-chemical characteristics of different strawberry varieties is presented in Table 3. Data recorded reveal that maximum number of fruits per plant were observed in cultivar Camarosa (22.61) followed by cultivar Majestic (20.21). Other varieties were at par with cultivar Confitura (18.25 fruits per plant). Significantly maximum fruit length was recorded in cultivar Camarosa (4.2 cm) followed by cultivar Majestic (3.79 cm). Cultivar Confitura recorded the fruit length of 3.49 cm which was higher than cultivar

Table 2. Floral characters of exotic strawberry varieties.

Cultivar	Flower initiation (date)	Peak bloom (date)	Date of first picking	Date of last picking	Fruit shape	Number of pickings
Camarosa	20 th April	8 th May	18 th May	26 th June	Prolate spheroid	11
Anthea	12 th April	16 th May	27 th May	30 th June	Prolate spheroid	6
Missionary	13 th April	14 th May	17 th May	15 th June	Prolate spheroid	4
Red Cross	9 th April	10 th May	22 th May	20 th June	Prolate spheroid	7
Fiana	6 th April	12 th May	20 th May	24 th June	Prolate spheroid	8
Majestic	18 th April	12 th May	14 th May	23 th June	Prolate spheroid	10
Confitura	17 th April	18 th May	10 th May	20 th June	Prolate spheroid	9

Table 3. Fruit physico-chemical characters of exotic strawberry varieties.

Cultivar	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit yield per plant (g)	Total soluble solids (%)	Titration acidity (%)	Total sugars (%)	Organoleptic rating (1-5 scale)
Camarosa	22.61	4.20	3.50	19.90	352.02	7.50	0.95	6.81	4.33
Anthea	10.52	3.25	2.40	10.40	104.03	6.00	0.74	4.10	2.50
Missionary	15.68	3.50	2.60	15.50	201.52	7.00	0.79	6.40	2.86
Red Cross	12.78	3.25	2.65	15.00	177.58	6.00	0.65	5.40	3.00
Fiana	14.51	3.10	2.50	11.50	142.47	6.10	0.60	6.29	3.03
Majestic	20.21	3.79	3.25	18.50	323.94	6.30	0.87	6.73	3.40
Confitura (Check)	18.25	3.49	3.00	17.50	254.15	7.10	0.84	6.47	3.30
CD _(0.05)	0.79	0.06	0.07	1.05	27.53	0.52	0.09	0.09	0.41

Fiana, Red Cross and Anthea. Cultivar Missionary recorded the fruit length of 3.5 cm. Minimum fruit length (3.10 cm) was recorded in cultivar Fiana. Fruit diameter was highest (3.50 cm) in cultivar Camarosa followed by cultivar Majestic (3.25 cm). Minimum fruit diameter was recorded in cultivar Anthea (2.40 cm). These results are in harmony with those of Dhaliwal and Singh (7) and Lal and Seth (12) in strawberry. Significantly higher fruit weight (19.90 g) was recorded in cultivar Camarosa followed by cultivar Majestic (18.50 g). However minimum fruit weight was recorded in cultivar Anthea (10.40 g). Significant variation in fruit yield was also recorded among all the varieties under study. Maximum yield per plant was recorded in cultivar Camarosa (352.02 g) followed by cultivar Majestic (323.94 g). Cultivar Anthea recorded minimum fruit yield (104.03 g). These variations in fruit yield might be due to varied number of fruits and fruit weight in different varieties. The results are in tune with Islam *et al.* (9) and Sharma *et al.* (17).

Significantly highest total soluble solids was recorded in cultivar Camarosa (7.50 %) which was at par with the total soluble solids in cultivar Confitura (7.10 %) and Missionary (7.0 %). However lowest TSS (6.0 %) was recorded in cultivar Anthea. Maximum acidity was recorded in cultivar Camarosa (0.95%) followed by cultivar Majestic (0.87%) both being significantly higher than the acidity recorded in cultivar Confitura (0.84%) which was significantly higher than rest of the varieties. Lowest titration acidity was recorded in cultivar Fiana (0.60%). Maximum total sugars content was recorded in cultivar Camarosa (6.81%) followed by cultivar Majestic (6.73%). Cultivar Confitura recorded a sugars content of 6.47 per cent which was at par with cultivar Missionary and significantly higher than rest of the varieties. Least total sugars content was recorded in cultivar Anthea (4.10%). The variations

in chemical composition among the cultivar may be due to varietal character, climatic conditions and stage of maturity. These findings are in agreement with those of Paul (14), Dhaliwal and Singh (7) and Chandel and Badiyala (5) in different strawberry varieties.

The varieties under study varied significantly in respect of organoleptic ratings. Cultivar Camarosa was significantly superior to rest of the varieties and attained maximum score of 4.33 on 5 point scale followed by cultivar Majestic (3.40). Cultivar Confitura recorded the score of 3.30 which was at par with rating of Majestic and Fiana but higher than rest of the varieties (Anthea and Missionary). Least score was recorded by cultivar Anthea (2.50).

From the above discussion, it is concluded that cultivar Camarosa excelled in most of the characters studied followed by Majestic and Confitura cultivars and can be recommended for commercial cultivation in temperate climate of Kashmir valley.

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