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PERFORMANCE OF STRAWBERRY (*FRAGARIA* × *ANANASSA* DUCH) CULTIVARS IN NICRA ADOPTED VILLAGE PAIYONG UNDER KALIMPONG DISTRICT OF NORTH BENGAL INDIA

N. Chamling*, M.W. Moktan, Pranab Barma, M.H. Khan, Snehlata lama and B.D. Kharga

Krishi Vigyan Kendra, Uttar Banga Krishi Viswavidyalaya, Kalimpong, Darjeeling - 734 301, West Bengal, India.

*Corresponding author E-mail : novinchamling354@gmail.com

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ABSTRACT

Present study was conducted during 2021-2023 at NICRA adopted village Paiyong, under the aegis of Krishi Vigyan Kendra, Kalimpong to evaluate strawberry (*Fragaria* × *ananassa* Duch.) cultivars under the sub-temperate condition of Kalimpong. According to the results obtained, we found that cultivar Camarosa significantly exhibited maximum plant height, plant spread, number of leaves, number of runners and flowers per plant, recorded minimum days taken for 50 % flowering and flowering to harvest days, maximum berry weight, highest yield per plant, Total soluble solid, Total sugar and Ascorbic acid respectively followed by cv.Festival whereas, cv. Winter dawn exhibited lowest plant height, plant spread, number of fruits and flowers per plant, recorded maximum days taken for flowering and harvest shown significant decline of yield per plant, pertained minimum Total soluble solids (TSS), Total sugar and Ascorbic acid. As the results indicated that the performance of cv. Camarosawas significantly better in terms of vegetative, yield and yield attributing characters.

Key words : Cultivars, Performance, Strawberry, Yield and Yield attributes.

Introduction

Strawberry (*Fragaria* × *ananassa* Duch.) is one of the herbaceous fruit crops that belongs to the family Rosaceae which is octaploid having chromosomes number (2n=8x=56). Botanically Strawberry is an aggregate fruit called *etario of achenes*. The fruit is cultivated in tropical, subtropical and temperate region up to an elevation of 3000 mean sea level (Sharma, 2002). The fruit crop is commercially propagated by tissue culture for its mass multiplicatio, n whereas in general it is usually propagated through vegetative means *i.e.* runners. In India, the fruit is popular for its production among states like Himachal Pradesh, Uttarakhand, West Bengal, Punjab, Maharashtra (Pune), Karnataka (Sharama and Yamdagni, 2000). Due to its contentment of nutrition with abundant source of Vitamins A, B, C and niacin, minerals like phosphorous, potassium, calcium and iron, it is often regarded as one of the most important fruit crops (Oszmianski and Wojdylo, 2009). The area under strawberry cultivation is 1000 ha with production of 5000 MT which is declining with impacts of climate change (Anonymous, 2016). The cultivation of strawberry is significantly influenced by the effect of climatic condition adaptability of the particular region which is being used for its cultivation because of critical photoperiod and temperate requirement of a cultivar and further depends on the cultural practices (Sharma and Sharma, 2003). There are three types of strawberry cultivars available *i.e.* day neutral, long day and short day based on the sensitivity of photoperiod where only day neutral and short-day varieties are commercial. Being bestowed with a wide range of agroclimatic condition, hills of North Bengal (Kalimpong and Darjeeling) offers an immense potentiality for strawberry production. The considerable variation in varieties can be exploited for the benefits of fruit grower of Kalimpong and Darjeeling hills as this

region has rich fertile soil and well distributed rainfall that favors strawberry cultivation. Due to its potential for economic returns, the farmers of Kalimpong and Darjeeling hills are involved in its cultivation. Thus, evaluation of different strawberry cultivars gives an idea of its potential for commercial cultivation in this region. Similar works have also been reported by various workers (Diwedi *et al*., 2004; Das *et al*., 2007). Since the cultivation of strawberry is new to this region, NICRA adopted village (Paiyong), Kalimpong, no work has been done till date. Considering above facts, the present study was undertaken with a view to determine the performance of Strawberry cultivar in NICRA adopted Village, Paiyong, Kalimpong.

Materials and Methods

The present experiment was carried out at NICRA adopted Village, Paiyong under the agies of Krishi Vigyan Kendra, Kalimpong, during the year 2021-23 to study the performance of strawberry cultivars. The experiment site is situated at an elevation of 1007 m above sea level and lies between 27º08' N latitude and 88º 56' E longitudes. The climate of the site is sub-temperate with minimum and maximum temperature between 6ºC and 30ºC. Soil of this region is acidic soil with pH range from 4.8-7. Three strawberry cultivars *viz*. winter dawn, Festival and Camarosa were procured from Center for Floriculture and Agri-business Management (COFAM). The runners were planted under double row hill system in an open field conditions in first week of November at a spacing of 30 cm × 45 cm × 20 cm raised bed using silver polyethene mulch.The experiment was laid out in Randomized Block Design, which consists of three treatments with seven replications. Ten plants from each replication was randomly selected from each treatment and tagged the plants to record the data of plant growth parameters. Plant height was taken using a scale and the average was calculated and expressed in centimeters. Plant spread was recorded in E-W and N-S direction by measuring the total length and then average of plant spread were worked out and expressed in centimeters. Numbers of flowers and fruits per plant were recorded during every alternate day by observing the fully opened flowers and harvested fruit from each cultivar. The days taken for 50 % flowering number were determined when 50 % plants in a plot had at least one open flower and the average was calculated. The ripe fruits from ten randomly selected tagged plants from each treatment were harvested and then analyzed for their physio-chemical properties. Fruit size was recorded by measuring the length and breadth using Vernier caliber, whereas fruit weight was determined using digital weighing balance. The total soluble solids (TSS) were determined with hand held Refractometer (0-32º Brix). Total Sugar was estimated by the standard method described by Rangana (1994) and Ascorbic acid content was determined by AOAC (1980) method. The data were analyzed by Statistical analysis using ANNOVA with Opstat Software.

Results and Discussion

Vegetative characters

Plant height (cm) : The data presented in Table 1 showed that cv. Camarosa recorded maximum plant height (15.01 cm) followed by cv. Festival (14.43 cm), whereas minimum plant height was obtained with cv. Winter dawn (14.21 cm), which also statistically at par with cv. Festival. It may be due to increase in length of epidermal and parenchyma cells, higher rate of cell elongation and also due to the influence of environmental factors which might be the reason of differences among plant heights of cultivars (Sahu and Chandel, 2014; Uddin *et al*., 2018). The probable reasons may be due to the fact that polymulching enhances the significant water retention and nutrient availability to the plants (Singh *et al*., 2007).

Plant spread (cm): The maximum plant spread in North-south direction was found in cultivar Festival (26.9cm) whereas the minimum plant spread was exhibited in cultivar Winterdawn (25.7cm). However, the maximum plant spread in East-West direction was also found in cultivar Camarosa (28.63 cm) whereas minimum was exhibited in cultivar Winter dawn (19.60 cm). The possible reasons for plant spread in N-S and E-W direction may be due to the application of mulching and cultivar ability, which led to better development of strawberry plant due to lower weed population, water retention, nutrient availability and favorable soil conditions. The present results are also in conformity with the reports of Das *et al*. (2007), Sharma *et al*. (2004), Maheshgowda (2016) in strawberry.

Number of leaves per plant : The data presented in table 1 shows that the maximum number of leaves were found in cultivar Camarosa (22.00) whereas the minimum leaf number was shown in cv. Festival (19.60) which was also found to be statistically at par with cv. Winter dawn (19.80). This may be due to the genetic factor and acclimatization of cultivars to particular region. Similar results are in line with the findings of Kachwaya and Chandel (2015), Uddin *et al*. (2018).

Number of flowers per plant : Among the cultivars, significant variation was observed in regard to number

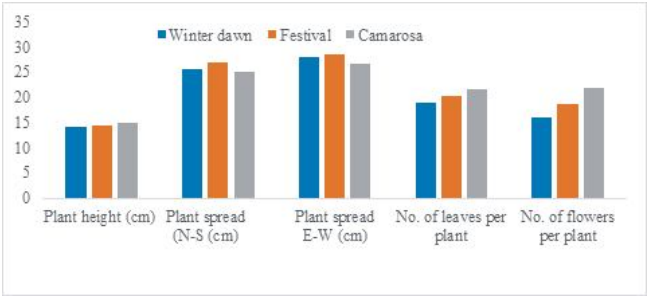

Fig. 1 : Performance of strawberry cultivars for growth parameters.

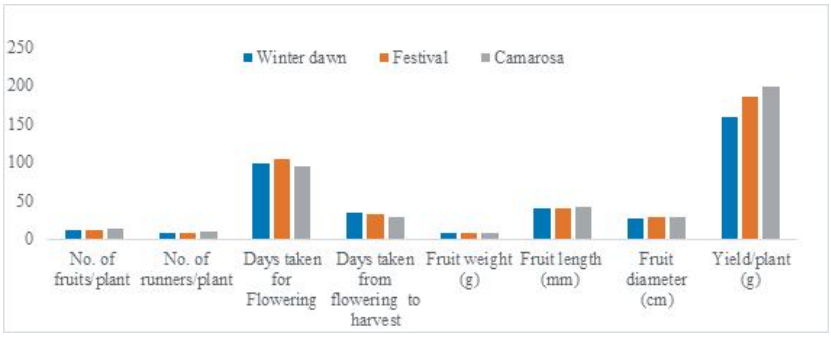

Fig. 2 : Performance of Strawberry cultivars for yield and yield attributes.

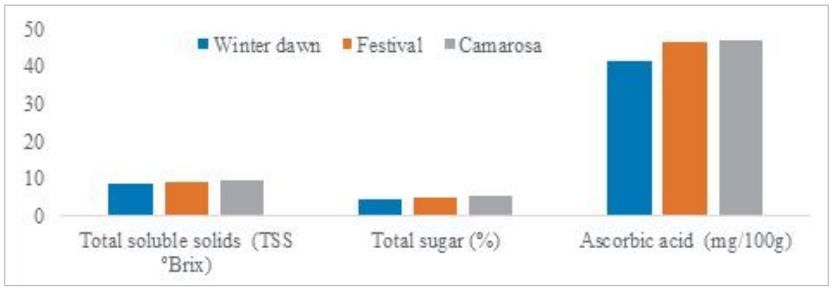

Fig. 3 : Performance of Strawberry cultivars for fruit quality attributes.

of flowers per plant. The cv. Camarosa (21.80) recorded maximum number of flowers per plant followed by cv. Festival (18.80) and cv. Winter dawn (16.6). The possible reason for maximum number of flowers per plant and earliness in flower set may be due to the positive effect of cultivars and also effects of mulching which provides adequate soil moisture and temperature that might have enhanced the development of inflorescences and stimulated flowering under the influence of different environment factors as reported by Sharma *et al.* (2021), Singh and Singh (2009).

Yield and Yield attributing characters

Number of fruits per plant : The number of fruits per plant varied significantly among the cultivars. The data shown in table1. depicted that the maximum number of fruits per plant was found in cv. Camarosa (13.4) followed by cv. Festival (11.8) and cv. Winter dawn (11) which were significantly at par with each other. The maximum number of fruits may due to the favorable cultivar that led increase flowering and more fruit set percentage. The results are in accordance with the observation of Karimi *et al*. (2013); Kumar *et al*. (2014).

Number of runners per plant : The data depicted in table 1. that cv. Camrosa 8. (9.00) recorded maximum number of runners which was also significantly at par with cv. Winter dawn (8.20) and cv. Festival (8.00). This may be due to the variation in allocation of photosynthesis from source to sink which is controlled by genetic factors of cultivars and environmental conditions. The production of strawberry runners is enhanced by removing the flowers allowing the runners to grow rapidly as they were formed, flowering ceases (Taylaran *et al*., 2011). These present results are in line with the reports of Uddin *et al.* (2018), Neetu and Sharma (2020).

Days taken for 50 percent flowering : The time taken to produce 50 percent flower by different cultivars was significantly varied as shown in Table 2. The cv. Camarosa (93.6 days) recorded earliest flowering which was statistically at par with cv. Winter dawn (97.8 days) and cv. Festival (103 days). The considerable variation in the flowering time in different cultivars may also be due to the variation in genetic factor and their chilling requirement as reported by Joolka and Badiyala (1983). The present findings are in similarity with the findings of (Oliveira and Scivittaro, 2011).

Days taken from flowering to harvest : The duration from flowering to fruit harvest varied from 29.4 days to 33.6 days. Minimum duration required from flowering to harvest was recorded in cv. Camarosa (29.4 days) whereas, maximum days was noted with cv. Winter dawn (33.60 days), which was also at par with cv. Festival (32.2 days). Similar results were also reported by Islam *et al*. (2012) and Aslam (2017). The earliness in flowering to harvest in the cultivars may be due to the number of days taken for flower emergence and the influence of climatic factors.

Fruit weight (g), Fruit length (cm) and Fruit diameter (cm) : Significant differences among cultivars as depicted in Table 2. The maximum fruit weight (9.54 g) was obtained in cv. Camarosa followed by cv. Festival (8.58 g), whereas minimum fruit weight was recorded with cv. Winter dawn (7.44 g). The data with respect to fruit length showed significant variation among cultivars as shown in Table 2. Maximum fruit length was recorded

Table 1 : Performance of strawberry cultivars for growth parameters.

Cultivars	Plant height (cm)	Plant spread		No. of leaves per plant	No. of flowers per plant
		(N-S (cm)	E-W (cm)		
Winter dawn	14.21	25.7	27.9	19.0	16.0
Festival	14.43	26.9	28.6	20.3	18.6
Camarosa	15.01	25.0	26.6	21.6	21.8
S.Em. ±	0.08	0.38	0.40	0.47	0.77
C.D. @ 5%	0.27	1.24	1.31	1.85	2.51

Table 2 : Performance of strawberry cultivars for yield and yield attributes.

Cultivars	No. of fruits/plant	No. of runners/ plant	Days taken for 50% flowering	Days taken from flowering to harvest	Fruit weight (g)	Fruit length (mm)	Fruit diameter (cm)	Yield/ plant (g)
Winter dawn	11.0	8.20	97.8	33.6	7.7	39.3	26.9	158.6
Festival	11.8	8.0	103.0	32.2	7.0	39.0	27.7	184.8
Camarosa	13.4	9.1	93.6	29.4	8.1	40.9	28.3	199.0
S. Em. ±	0.49	0.42	1.71	0.84	0.14	0.27	0.34	3.09
C.D @ 5%	1.60	1.44	5.60	2.74	0.46	0.90	1.13	10.09

Table 3 : Performance of strawberry cultivars for fruit quality attributes.

Cultivars	Total soluble solids (TSS °Brix)	Total sugar (%)	Ascorbic acid (mg/100g)
Winter dawn	8.8	4.6	41.3
Festival	9.0	4.9	46.5
Camarosa	9.4	5.4	47.2
S. Em. ±	0.11	0.15	0.58
C.D @ 5%	0.40	0.51	1.90

in cv. Camarosa (35.6 cm) followed by cv. Festival (33.9 cm) whereas, the least fruit length was obtained in cv. Winter dawn (30.0 cm). Statistical analysis with respect to fruit breath show significant differences among cultivars. The fruit diameter was to found to be maximum in cv. Camarosa (26.7 cm) followed by cv. Festival (25.8 cm) whereas, the least fruit breadth was recorded with cv. Winter dawn (25 cm). The variability in the fruit weight, fruit length and fruit diameter may be due to the cultivar characters and the present findings are in accordance with the findings of Verma and Sharma (2010), who reported that fruit morphological characters in strawberry depends on interaction between and blossoms position, number of developed achene and competition of plant vigour.

Fruit yield per plant (g) : The data depicted in Table 2 showed significant differences in fruit yield per plant among the cultivars. The maximum fruit yield per plant was recorded in cv. Camarosa (144.2 g) followed by cv. Festival (139.0 g) whereas the lowest fruit yield per plant was recorded in cv. Winter dawn (135.2 g). It may be due to the early emergence of flowers which enabled higher fruit set and fruit weight due to the formation of enhanced metabolites and photosynthesis at high rate. The present findings are in line with the reports of Hossan *et al.* (2013) and Ahsan *et al*. (2014). Yield attributing components like yield per plant, number of runners, leaves, fruits per plant, fruit setting percentage are related with the yield per unit area as reported by Mitra (1991)

Fruit quality parameters

Performance of strawberry cultivars for fruit quality attributes such as Total Soluble Solid (TSS), Total Sugar and Ascorbic acid : Significant differences were observed among the cultivars for TSS as shown in Table 3. Highest value of TSS was recorded in cv. Camarosa (9.4%), which was significantly at par with cv. Festival (9.0%) whereas, minimum value for TSS was obtained in cv. Winter dawn (8.8%). Maximum Total soluble solids could be due to the favourable temperature and humidity during the fruit growth period, especially during night which might have influenced the retention of TSS in the ripe fruits of strawberry (Sharma, 2002). Significant differences were observed between the treatments in terms of total sugar content as shown in Table 3. Maximum sugar content was recorded in cv. Camarosa (5.48%) followed by Festival (4.96%), which was also statistically at par with cv. Winter dawn (4.64%).

The differences in total sugar (%) in cultivars may be attributed to adaptability potential under sub temperate region of NICRA adopted village and may also be due to their genotypic differences. The results are also in confirmation with the findings obtained by Saima *et al*. (2014). The data pertaining to ascorbic acid in Table 3. depicted significant variation among the cultivars. Ascorbic acid ranged from 41.3 mg to 47.2 mg where maximum was recorded under cv. Winter dawn (47.29 mg) followed by Festival (46.57 mg) whereas, lowest was observed in cv. Camarosa (41.32 mg). The improvement in the ascorbic acid content of strawberry cultivars might be due to the increase level of metabolites that might have triggered the precursor of ascorbic acid biosynthesis in plants as mulches probably led to differences in soil moisture content, enhanced nutrient availability which in turn affected plant growth, development and strawberry fruit quality. The results are also in concord with the reports of Pramanick *et al*. (2013), Rostami *et al*. (2022), Chakraborty *et al*. (2023).

Conclusion

As per the results obtained cv. Winter dawn performed superior in term of vegetative growth, yield, yield attributes and biochemical parameters. Hence, the cultivar is suitable for cultivation under NICRA adopted village, Kalimpong district of North Bengal.

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