

Original Research Article

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## Standardization of Production Technology for Strawberry (*Fragaria × ananassa* Duch.) Cultivars in Terrace Gardening

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### ABSTRACT

A study was conducted to evaluate 04 strawberry cultivars (Sweet Charlie, Winter Down, Camarosa, Festival) at four planting times (10<sup>th</sup> October, 25<sup>th</sup> October, 5<sup>th</sup> November and 25<sup>th</sup> November) to be tested at 15 days intervals under sub tropic conditions of NCR Delhi region on terrace gardening. The cultivar selection was made based on plant growth, yield and important fruit quality parameters. These were harvested on each date. Parameters include plant height, number of leaves, crowns per plant, length of stolon, fruit number and weight per plant, fruit size and fruit yield per plant; fruit total soluble solids, acidity (%), ascorbic acid contents and juice content (%). The cultivar selection will be made based on plant growth, yield and important fruit quality parameters, harvested for each date. The Highest plant height was reported in Winter Down (19.4) and Sweet Charli (18.8) followed by Camarosa (16.8) and Festival (16.3). Similar trends in case of number of leaves per plant also reported in Winter Down (23.7) and Sweet Charli (24.5) followed by Camarosa (20.8) and Festival (18.2). The crown per plant was Winter Down (6.2) and Sweet Charli (5.2) followed by Camarosa (5.2) and Festival (4.8). The length of stolon registered in Sweet Charli (40.3) followed by Winter Down (36.9). The number of fruits harvested per plant was highest in Winter Down (16.5) and Sweet Charli (15.3) followed by Camarosa (13.4) and Festival (12.3). However the fruit size was maximum in Sweet Charli followed by Winter Down, Camarosa and Festival respectively. The highest fruit yield per plant (211.2 g) was recorded in Winter Down followed by Sweet Charli (205.2g), Camarosa (171.52g) and Festival (142.6g), while fruit weight was higher in Sweet Charli (13.2g) and Camarosa (12.8g). Fruit quality in terms of TSS in Winter Down (8.13<sup>o</sup>Brix) and Sweet Charli (9.0<sup>o</sup>Brix) followed by Camarosa (9.9<sup>o</sup>Brix) and Festival (8.9<sup>o</sup>Brix). (14.2<sup>o</sup>Brix), Titrable acidity (%) in Winter Down (0.88) and Sweet Charli (0.85) followed by Camarosa (0.69) and Festival (0.82), Ascorbic acid mg/100g pulp in Winter Down (68.5) and Sweet Charli (80.5) followed by Camarosa (72.5) and Festival (76.6) and juice content (%) in Winter Down (82.2) and Sweet Charli (85.2) followed by Camarosa (74.5) and Festival (73.2). Based on these findings selection of best two cultivar Winter Down and Sweet Charlie and date of planting at 10th October suitable for NCR Delhi region on terrace gardening were made.

### Keywords

Strawberry,  
Standardization,  
Yield, Quality,  
Terrace gardening

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### Introduction

Strawberry (*Fragaria × ananassa* Duch.) is an herbaceous perennial rosette and cultivated in plains as well as in the hills in humid or dry region (Sharma, 2002). Among the fruit crops, strawberry gives the quickest returns in the shortest possible time. Strawberry fruits are considered as complete fruit with 98% edible portion. The fruits are attractive with distinct and pleasant aroma and flavour, rich in

vitamins(C and B), proteins and minerals (P, K, Ca and Fe). Strawberries are one of the best natural sources of antioxidant and it is also anti carcinogenic and anti-diabetic (Singh *et al.*, 2007). Low calorific value, absence of cholesterol and higher level of minerals make it ideal for health conscious consumers. Crushed strawberry and strawberry syrup are used in soda fountain beverages, ice cream, chocolate, confectioneries and cosmetics. In recent years, strawberry plants can be also

easily seen in some houses of urban and peri-urban areas of big cities like New Delhi and National Territory Regions (NCR). The highly nutritive and attractive fruits, beautiful leaves, short plant stature with shallow roots, feasibility of growing in pots and shorter growing period could be the reason for its increasing acceptability among city dwellers. It is generally being grown for hobby but, it can also be taken as a venture in these areas especially on terraces, where space is at a premium. Moreover, strawberries will fare well for a year or two in pots or containers and this approach has several advantages over plants grown in the open where they suffer from soil-borne pests and diseases if grown on the same patch for a number of years (Singh *et al.*, 2007). There are enough informations available in literature regarding strawberry cultivation under open as well as protected conditions but is only for field grown crop for different agro-climatic conditions. However, there is lack of informations for pot culture and especially for terrace gardening in urban areas. For the successful strawberry production, the information of suitable cultivar, right planting time and the growing media would be essential. It is therefore, an urgent need to find a suitable cultivar by screening the potential cultivars to be used for pot culture and standardization of planting time and the suitable growing medium for better fruit production and quality of strawberries in such an expensive space of urban areas.

## **Materials and Methods**

The present study was conducted at Krishi Vigyan Kendra, Ujwa, New Delhi for NCR region Delhi during the year 2016-2018. NCT Delhi is a part of Indo-Gangetic plains that falls under semi-arid climatic zone with the annual average rainfall of 730 mm. The average height from sea level is 190-220 meter which is located between 28° 24' 17" to

28° 53' 00" North latitude and 76° 50' 24" to 77° 20' 37" East longitude. The planting material of strawberry different varieties were collected from the IARI regional station Himachal Pradesh and authorized Govt. nursery suitable (Sweet Charlie, Winter Down, Camarosa and Festival) for NCR Delhi region. The collected 10 potential collected cultivars will be evaluated in pot culture by providing uniform nutrient application and substrates along with the following uniform agro-techniques. The planted varieties were tested for suitable four planting dates (10<sup>th</sup> October, 25<sup>th</sup> October, 5<sup>th</sup> November and 25<sup>th</sup> November) respectively at 15 days intervals planting date (i.e. their suitability to agro climatic conditions of Delhi). The planting dates, height, number of leaves and first flower appearance data were recorded. The planting will be done by using appropriate size runner at normal planting time applicable for field condition. Each cultivar was replicated thrice with at least four plants in each replication for a treatment in completely randomized design. The cultivar selection was made based on plant growth, yield and important fruit quality parameters. This include plant height, number of leaves, crowns per plant, days for runner production, length of stolon, runner per plant, fruit number and weight per plant, fruit size and fruit yield per plant; fruit total soluble solids, acidity (%), ascorbic acid contents and juice content (%). The fruit quality determination was done following A.O.A.C (1980) method. Data were recorded for several growth and flowering characters using the standard methods. The ripe fruit of strawberry cultivars were harvested from mid-January to first week of March. These fruits were then analyzed for their physico-chemical properties from 10 randomly selected fruits from each picking. Fruit size was recorded by measuring the length and breadth using digital Vernier caliper while fruit weight was taken using top pan digital balance. Also the fruits were

counted for recording total number of fruit harvested and yield (g)/plant. The fruit from different samples were weighed and then juice was extracted from the pulp. The juice percent was calculated on the basis of the juice and was measured in a measuring cylinder and expressed in per cent as fresh weight basis. The juice obtained was weighed and then measured with measuring cylinder and the density of the juice was determined from the weight divided by volume of the juice and is expressed in gms/cc. The total soluble solids (TSS) were determined with Erma Hand Refractometer (0-32°Brix). The titratable acidity (%), ascorbic acid content and juice (%) were determined by method of AOAC (1980).

## **Results and Discussion**

There were wide variations among different strawberry cultivars and planting dates with respect to plant height, number of leaves, crowns per plant, length of stolon, fruit number and weight per plant, fruit size and fruit yield per plant (Table 1 to 4). Plant height was observed maximum in 'Winter Down' (19.4 cm) followed by 'Sweet Charlie' (18.8 cm) and 'Camarosa' (16.8 cm) whereas minimum in 'Festival' (16.3 cm). Second important group of cultivars having better growth in terms of plant height, plant spread, number of leaves and crowns per plant is Sweet Charlie. Growth parameter observed in present studies was in agreement with other workers (Sharma and Sharma, 2006 and Das *et al.*, 2007). In the climatic conditions prevalent in NCR region of Delhi is very much favorable for growth of strawberry crop. The effect of planting date was observed in different varieties. The highest mean plant height was observed in Winter Down variety followed by Sweet Charlie. The lowest mean plant height was observed in Festival variety. The highest mean number of leaves was observed of Winter Down varieties followed by Sweet Charlie. The lowest mean number of

leaves was observed in Festival variety. Among the planting date, highest plant height was reported on 10<sup>th</sup> Oct. similar pattern was observed in case of number of leaves. The effect of planting date was observed in different varieties. The highest mean Crowns/plant was observed of Sweet Charlie variety followed by Winter Down. The lowest mean Crowns/plant was observed in Festival variety. The highest mean Length of stolon (cm) was observed of Crowns/plant varieties followed by Sweet Charlie. The lowest mean number of leaves was observed in Festival. Among the planting date highest Crowns/plant was reported 10<sup>th</sup> Oct, similar pattern was observed in case of Length of stolon (cm). Planting time has direct effect on day and night temperature, day light intensity and photoperiod, which affect the floral induction, fruit size, quality and production.

Because 90 to 95% of a plant's dry weight is derived from photosynthesis and photosynthesis efficiency directly depends on day and night temperature, day light intensity and photoperiod. So, planting time of strawberry is important for dry matter production as well as the growth and yield a crop. Late planting of strawberry significantly reduced the economically viable yield, because later planted plants did not enjoy enough time for vegetative.

### **Effect of planting date**

The effect of planting date was observed in different varieties. The highest mean Fruit no./plant was observed of Winter Down variety followed by Sweet Charlie. The highest mean Fruit size (mm) was observed of Sweet Charlie varieties followed by Winter Down. The lowest mean number of leaves was observed in Festival. Among the Planting date 10<sup>th</sup> Oct., it was found best for this variety. Similar pattern was observed in case of Fruit size (mm).

**Table.1** Effect of planting date and variety on strawberry plant height

| Variety (V)          | Plant Height (cm)     |                       |                      |                       |             | No. of leaves         |                       |                      |                       |             |
|----------------------|-----------------------|-----------------------|----------------------|-----------------------|-------------|-----------------------|-----------------------|----------------------|-----------------------|-------------|
|                      | Planting date (D)     |                       |                      |                       |             | Planting date (D)     |                       |                      |                       |             |
|                      | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean        | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean        |
| <b>Sweet Charlie</b> | 18.8                  | 17.6                  | 16.9                 | 16.2                  | 17.4        | 24.5                  | 22.7                  | 21.3                 | 20.7                  | 22.3        |
| <b>Camarosa</b>      | 16.8                  | 16.2                  | 15.9                 | 14.6                  | 15.9        | 20.8                  | 19.4                  | 18.7                 | 17.8                  | 19.2        |
| <b>Festival</b>      | 16.3                  | 15.7                  | 15.1                 | 14.7                  | 15.5        | 18.2                  | 17.4                  | 17.1                 | 15.2                  | 17.0        |
| <b>Winter Down</b>   | <b>19.4</b>           | 17.8                  | 17.2                 | 16.8                  | <b>17.8</b> | 23.7                  | 20.8                  | 19.2                 | 18.7                  | <b>20.6</b> |
| <b>Mean</b>          | <b>17.8</b>           | 16.8                  | 16.3                 | 15.6                  | 16.6        | 21.8                  | 20.1                  | 19.1                 | 18.1                  | 19.8        |
| Variety              | Crowns/plant          |                       |                      |                       |             | Length of stolen (cm) |                       |                      |                       |             |
|                      | Planting date (D)     |                       |                      |                       |             | Planting date (D)     |                       |                      |                       |             |
|                      | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean        | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean        |
| <b>Sweet Charlie</b> | 5.2                   | 4.8                   | 4.5                  | 4.2                   | 4.68        | <b>44.6</b>           | 41.8                  | 38.4                 | 36.2                  | <b>40.3</b> |
| <b>Camarosa</b>      | 5.2                   | 4.8                   | 4.5                  | 4.2                   | 4.68        | 37.6                  | 36.8                  | 34.5                 | 31.8                  | 35.2        |
| <b>Festival</b>      | 4.8                   | 4.3                   | 4                    | 3.7                   | 4.20        | 36.7                  | 36.2                  | 34.7                 | 32.6                  | 35.1        |
| <b>Winter Down</b>   | 6.2                   | 5.6                   | 4.7                  | 4.1                   | <b>5.15</b> | 39.6                  | 38.2                  | 36.4                 | 33.2                  | 36.9        |
| <b>Mean</b>          | <b>5.35</b>           | 4.88                  | 4.43                 | 4.05                  | 4.68        | <b>39.6</b>           | 38.3                  | 36.0                 | 33.5                  | 36.8        |

**Table.2** Effect of planting date and variety on no. of crowns/ plant and stolen length of strawberry

| Variety              | Fruit no./plant       |                       |                      |                       |       | Fruit size (mm)       |      |                       |      |                      |      |                       |      |      |      |
|----------------------|-----------------------|-----------------------|----------------------|-----------------------|-------|-----------------------|------|-----------------------|------|----------------------|------|-----------------------|------|------|------|
|                      | Planting date (D)     |                       |                      |                       |       | Planting date (D)     |      |                       |      |                      |      |                       |      |      |      |
|                      | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean  | 10 <sup>th</sup> Oct. |      | 25 <sup>th</sup> Oct. |      | 5 <sup>th</sup> Nov. |      | 25 <sup>th</sup> Nov. |      | Mean |      |
|                      |                       |                       |                      |                       |       | L                     | B    | L                     | B    | L                    | B    | L                     | B    | L    | B    |
| <b>Sweet Charlie</b> | 15.3                  | 13.8                  | 12.2                 | 10.7                  | 13.00 | 42.9                  | 34.7 | 39.9                  | 30.6 | 36.4                 | 27.4 | 30.2                  | 24.1 | 37.3 | 29.2 |
| <b>Camarosa</b>      | 13.4                  | 12.3                  | 11.1                 | 10.6                  | 11.85 | 42.5                  | 33.2 | 39.9                  | 39.6 | 31.4                 | 22.2 | 26.4                  | 19.7 | 35.1 | 26.2 |
| <b>Festival</b>      | 12.3                  | 11.8                  | 11.2                 | 10.8                  | 11.52 | 39.5                  | 31.6 | 36.9                  | 28.6 | 32.6                 | 25.2 | 29.9                  | 23.6 | 34.7 | 27.3 |
| <b>Winter Down</b>   | 16.5                  | 15.8                  | 12.4                 | 11.7                  | 14.10 | 43.2                  | 32.8 | 41.4                  | 29.8 | 36.4                 | 26.4 | 31.1                  | 23.6 | 38.0 | 28.2 |
| <b>Mean</b>          | 14.4                  | 13.4                  | 11.7                 | 10.9                  | 18.7  | 42.0                  | 33.1 | 39.5                  | 32.2 | 34.2                 | 25.3 | 29.4                  | 22.8 | 36.3 | 27.7 |

**Table.3** Effect of planting date and variety on strawberry fruit no. and fruit size (length, L; breadth B)

| Variety              | Average fruit weight (g) |                       |                      |                       |       | Fruit yield/plant (g) |                       |                      |                       |       |
|----------------------|--------------------------|-----------------------|----------------------|-----------------------|-------|-----------------------|-----------------------|----------------------|-----------------------|-------|
|                      | Planting date (D)        |                       |                      |                       |       | Planting date (D)     |                       |                      |                       |       |
|                      | 10 <sup>th</sup> Oct.    | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean  | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean  |
| <b>Sweet Charlie</b> | 13.4                     | 12.7                  | 11.6                 | 10.5                  | 12.05 | 205.02                | 175.3                 | 141.5                | 112.3                 | 158.5 |
| <b>Camarosa</b>      | 12.8                     | 11.7                  | 10.9                 | 10.3                  | 11.43 | 171.52                | 143.9                 | 120.9                | 109.2                 | 136.4 |
| <b>Festival</b>      | 11.6                     | 10.8                  | 10.4                 | 9.7                   | 10.63 | 142.6                 | 127.4                 | 116.5                | 104.8                 | 121.3 |
| <b>Winter Down</b>   | 12.8                     | 15.8                  | 11.6                 | 10.3                  | 12.63 | 211.2                 | 169.1                 | 143.8                | 120.5                 | 161.2 |
| <b>Mean</b>          | 12.65                    | 12.75                 | 11.13                | 10.20                 | 11.68 | 182.59                | 162.7                 | 130.7                | 111.7                 | 144.3 |

**Table.4** Effect of planting date and variety on strawberry fruit weight and fruit yield (kg/plant)

| Variety              | TSS                   |                       |                      |                       |              | Titrable acidity (%)  |                       |                      |                       |             |
|----------------------|-----------------------|-----------------------|----------------------|-----------------------|--------------|-----------------------|-----------------------|----------------------|-----------------------|-------------|
|                      | Planting date (D)     |                       |                      |                       |              | Planting date (D)     |                       |                      |                       |             |
|                      | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean         | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean        |
| <b>Sweet Charlie</b> | <b>9.0</b>            | 9.6                   | 9.8                  | 9.5                   | 9.48         | 0.85                  | 0.82                  | 0.75                 | 0.77                  | 0.80        |
| <b>Camarosa</b>      | <b>9.9</b>            | 10.3                  | 10.5                 | 11.8                  | <b>10.63</b> | 0.69                  | 0.66                  | 0.65                 | 0.61                  | <u>0.65</u> |
| <b>Festival</b>      | <b>8.9</b>            | 9.3                   | 9.1                  | 9.6                   | 9.23         | 0.82                  | 0.78                  | 0.77                 | 0.75                  | 0.78        |
| <b>Winter Down</b>   | <b>8.13</b>           | 8.35                  | 8.33                 | 8.88                  | 8.42         | 0.88                  | 0.87                  | 0.90                 | 0.92                  | <b>0.89</b> |
| <b>Mean</b>          | <b>8.98</b>           | 9.39                  | 9.43                 | 9.95                  | 9.44         | <b>0.81</b>           | 0.78                  | 0.77                 | 0.76                  | 0.78        |

**Table.5** Effect of planting date and variety on strawberry fruit TSS and Acidity

| Variety              | Ascorbic acid (mg/100g pulp) |                       |                      |                       |              | Juice content (%)     |                       |                      |                       |              |
|----------------------|------------------------------|-----------------------|----------------------|-----------------------|--------------|-----------------------|-----------------------|----------------------|-----------------------|--------------|
|                      | Planting date (D)            |                       |                      |                       |              | Planting date (D)     |                       |                      |                       |              |
|                      | 10 <sup>th</sup> Oct.        | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean         | 10 <sup>th</sup> Oct. | 25 <sup>th</sup> Oct. | 5 <sup>th</sup> Nov. | 25 <sup>th</sup> Nov. | Mean         |
| <b>Sweet Charlie</b> | 80.5                         | 82.2                  | 85.5                 | <b>88.6</b>           | <b>84.20</b> | <b>85.2</b>           | 83.5                  | 80.6                 | 78.6                  | <b>81.98</b> |
| <b>Camarosa</b>      | 72.5                         | 72.3                  | 74.5                 | 76.4                  | 73.93        | 74.5                  | 72.6                  | 71.5                 | 66.3                  | 71.23        |
| <b>Festival</b>      | 76.6                         | 78.2                  | 80.1                 | 82.2                  | 79.28        | 73.2                  | 72.1                  | 70.8                 | 68.5                  | 71.15        |
| <b>Winter Down</b>   | 68.5                         | 71.2                  | 73.5                 | 75.0                  | 72.05        | 82.2                  | 82.5                  | 78.8                 | 75.6                  | 79.78        |
| <b>Mean</b>          | 74.53                        | 75.98                 | 78.40                | <b>80.55</b>          | 77.36        | <b>78.78</b>          | 77.68                 | 75.43                | 72.25                 | 76.03        |



Planting time has direct effect on day and night temperature, day light intensity and photoperiod, which affect the floral induction, fruit size, quality and production (Table 5). A Highest Average fruit weight was observed in Winter down followed by Sweet charline similar pattern was noticed in fruits yield per plant. The date of sowing 25<sup>th</sup> Oct. was found best for fruits weight and 10<sup>th</sup> Oct for fruits yield. Because 90 to 95% of a plant's dry weight is derived from photosynthesis and photosynthesis efficiency directly depends on day and night temperature, day light intensity and photoperiod. So, planting time of strawberry is important for dry matter production as well as the growth and yield a crop. Late planting of strawberry significantly reduced the economically viable yield, because later planted plants did not enjoy enough time for vegetative. A Highest TSS was observed in Camarosa followed by Sweet charline. However, Titrable acidity was found in winter down. Date of planting 10<sup>th</sup> Oct. was found best for TSS as well as Titratable acidity. The mean titrable acidity of 0.78 for all the varieties and highest of 0.89 for winter down. Highest Ascorbic acid (mg/100g pulp) was found in 25<sup>th</sup> Nov in Sweet Charlie and Juice content (%) in 10<sup>th</sup> Oct. in Sweet Charlie variety. The mean ascorbic acid of 77.36 for all the varieties at different time with highest mean of 84.20 for sweet Charlie. The juice content in strawberry is highest at 10<sup>th</sup> of October and mean of 81.98.

The formations for pot culture and especially terrace gardening in urban areas for strawberry farming the information of suitable cultivar, right planting time and the growing media is essential. The potential cultivars to be used for pot culture and standardization of planting time and the suitable growing medium for better fruit production and quality of strawberries is conducted in present study. The cultivar selection made based on plant growth, yield and important fruit quality

parameters, harvested for each date. The Highest plant height was reported in Winter Down (19.4) and Sweet Charli (18.8). Number of leaves per plant reported in Winter Down (23.7) and Sweet Charli (24.5). The crown per plant was Winter Down (6.2) and Sweet Charli (5.2) followed by Camarosa (5.2) and Festival (4.8). The length of stolen registered in Sweet Charli (40.3) followed by Winter Down (36.9). The number of fruits harvested per plant was highest in Winter Down (16.5) and Sweet Charli (15.3). However the fruit size was maximum in Sweet Charli followed by Winter Down, Camarosa and Festival respectively. The highest fruit yield per plant (211.2 g) was recorded in Winter Down followed by Sweet Charli (205.2g), Camarosa (171.52g) and Festival (142.6g), while fruit weight was higher in Sweet Charli (13.2g) and Camarosa (12.8g). The above study on different parameters of strawberry is a kind of new technique of horticulture crops under the urban scenario.

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