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

Rakesh Kumar* and B.S. Hansra

AICPHT & CCM, Amity University, Noida (U.P.), India

*Corresponding author

A B S T R A C T

An experiment was conducted to evaluate 04 strawberry cultivars (Sweet Charlie, Winter Down, Camarosa, Festival) at four planting times (10th October, 25th October, 5th November and 25th 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 stolen, 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 Charlie (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 Charlie (24.5) followed by Camarosa (20.8) and Festival (18.2). The crown per plant was Winter Down (6.2) and Sweet Charlie (5.2) followed by Camarosa (5.2) and Festival (4.8). The length of stolen registered in Sweet Charlie (40.3) followed by Winter Down (36.9). The number of fruits harvested per plant was highest in Winter Down (16.5) and Sweet Charlie (15.3) followed by Camarosa (13.4) and Festival (12.3). However the fruit size was maximum in Sweet Charlie 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 Charlie (205.2g), Camarosa (171.52g) and Festival (142.6g), while fruit weight was higher in Sweet Charlie (13.2g) and Camarosa (12.8g). Fruit quality in terms of TSS in Winter Down (8.13°Brix) and Sweet Charlie (9.0°Brix) followed by Camarosa (9.9°Brix) and Festival (8.9°Brix). (14.2°Brix), Titrable acidity (%) in Winter Down (0.88) and Sweet Charlie (0.85) followed by Camarosa (0.69) and Festival (0.82), Ascorbic acid mg/100g pulp in Winter Down (68.5) and Sweet Charlie (80.5) followed by Camarosa (72.5) and Festival (76.6) and juice content (%) in Winter Down (82.2) and Sweet Charlie (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.

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 file grown crop for 
different agro-climatic conditions. However, 
there is lack of in formations 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 
medium 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\textsuperscript{th} 
October, 25\textsuperscript{th} October, 5\textsuperscript{th} November and 25\textsuperscript{th} 
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 tritratable 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 stolen, 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 in Winter Down variety 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 10th 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 stolen (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 10th Oct, similar pattern was observed in case of Length of stolen (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 10th 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) |              |
|             | 10th Oct.         | 25th Oct.    |
|             | 5th Nov.          | 25th Nov.    |
|             | Mean              |              |
| Sweet Charlie | 18.8             | 17.6         |
|              | 16.9              | 16.2         |
|              | 17.4              |              |
| Mean         | 17.8              | 16.8         |
|              | 16.3              | 15.6         |
|              | 16.6              |              |
| Camarosa     | 16.8              | 16.2         |
|              | 15.9              | 14.6         |
|              | 15.9              |              |
| Mean         | 17.8              | 16.8         |
| Festival     | 16.3              | 15.7         |
|              | 15.1              | 14.7         |
|              | 15.5              |              |
| Mean         | 17.8              | 16.8         |
| Winter Down  | 19.4              | 17.8         |
|              | 17.2              | 16.8         |
|              | 17.8              |              |
| Mean         | 17.8              | 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) |
|             | 10th Oct.         | 25th Oct.    |
|             | 5th Nov.          | 25th Nov.    |
|             | Mean              |              |
| Sweet Charlie | 5.2              | 4.8          |
|              | 4.5              | 4.2          |
|              | 4.68             |              |
| Mean         | 5.35             | 4.88         |
|              | 4.43             | 4.05         |
|              | 4.68             |              |
| Camarosa     | 5.2              | 4.8          |
|              | 4.5              | 4.2          |
|              | 4.68             |              |
| Mean         | 5.35             | 4.88         |
|              | 4.43             | 4.05         |
|              | 4.68             |              |
| Festival     | 4.8              | 4.3          |
|              | 4              | 3.7          |
|              | 4.20             |              |
| Mean         | 5.15             | 4.88         |
|              | 4.43             | 4.05         |
|              | 4.68             |              |
| Winter Down  | 6.2              | 5.6          |
|              | 4.7              | 4.1          |
|              | 5.15             |              |
| Mean         | 5.15             | 4.88         |
|              | 4.43             | 4.05         |
|              | 4.68             |              |

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) |                |
|             | 10th Oct.        | 25th Oct.       |
|             | 5th Nov.         | 25th Nov.       |
|             | Mean             |                |
|             | L     B     L     B | L     B     L     B |
| Sweet Charlie | 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 |
| Camarosa     | 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 |
| Festival     | 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 |
| Winter Down  | 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 |
| Mean         | 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)        |                       |
|               | 10th Oct. | 25th Oct. | 5th Nov. | 25th Nov. | Mean | 10th Oct. | 25th Oct. | 5th Nov. | 25th Nov. | Mean |
| Sweet Charlie | 13.4      | 12.7      | 11.6     | 10.5      | 12.05 | 205.02 | 175.3    | 141.5    | 112.3     | 158.5 |
| Camarosa      | 12.8      | 11.7      | 10.9     | 10.3      | 11.43 | 171.52 | 143.9    | 120.9    | 109.2     | 136.4 |
| Festival      | 11.6      | 10.8      | 10.4     | 9.7       | 10.63 | 142.6  | 127.4    | 116.5    | 104.8     | 121.3 |
| Winter Down   | 12.8      | 15.8      | 11.6     | 10.3      | 12.63 | 211.2  | 169.1    | 143.8    | 120.5     | 161.2 |
| Mean          | 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) |                       |
|               | 10th Oct. | 25th Oct. | 5th Nov. | 25th Nov. | Mean | 10th Oct. | 25th Oct. | 5th Nov. | 25th Nov. | Mean |
| Sweet Charlie | 9.0        | 9.6       | 9.8      | 9.5       | 9.48 | 0.85      | 0.82      | 0.75      | 0.77      | 0.80 |
| Camarosa      | 9.9        | 10.3      | 10.5     | 11.8      | 10.63 | 0.69      | 0.66      | 0.65      | 0.61      | 0.65 |
| Festival      | 8.9        | 9.3       | 9.1      | 9.6       | 9.23 | 0.82      | 0.78      | 0.77      | 0.75      | 0.78 |
| Winter Down   | 8.13       | 8.35      | 8.33     | 8.88      | 8.42 | 0.88      | 0.87      | 0.90      | 0.92      | 0.89 |
| Mean          | 8.98       | 9.39      | 9.43     | 9.95      | 9.44 | **0.81**  | 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)           |                   |
|               | 10th Oct. | 25th Oct. | 5th Nov. | 25th Nov. | Mean | 10th Oct. | 25th Oct. | 5th Nov. | 25th Nov. | Mean |
| Sweet Charlie | 80.5      | 82.2      | 85.5     | **88.6**  | 84.20 | **85.2**  | 83.5      | 80.6      | 78.6      | **81.98** |
| Camarosa      | 72.5      | 72.3      | 74.5     | 76.4      | 73.93 | 74.5      | 72.6      | 71.5      | 66.3      | 71.23 |
| Festival      | 76.6      | 78.2      | 80.1     | 82.2      | 79.28 | 73.2      | 72.1      | 70.8      | 68.5      | 71.15 |
| Winter Down   | 68.5      | 71.2      | 73.5     | 75.0      | 72.05 | 82.2      | 82.5      | 78.8      | 75.6      | 79.78 |
| Mean          | 74.53     | 75.98     | 78.40    | **80.55** | 77.36 | **78.78** | 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 25th Oct. was found best for fruits weight and 10th 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 10th Oct. was found best for TSS as well as Titratable acidity. The mean titratable 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 25th Nov in Sweet Charlie and Juice content (%) in 10th 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 10th 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.

References

A.O.A.C., 1980. Official methods of analysis. Association of official analytical chemists. Washington, D.C. USA.
Beniwal L S, Daulta B S and Bisla S S. 1989. Evaluation of different strawberry (Fragaria ananassa L.) cultivars under Hissar condition-Growth, flowering and fruiting. Haryana Journal of Horticultural Science 18 (1-2): 34-39.
Chandel J S and Badiyala S D. 1996. Performance of some strawberry cultivars in foothills of Himachal Pradesh. Annals of Agricultural Research 17 (4): 375-378.
Das B, Vishal Nath, Jana B R, Dey P, Pramanick K K and Kishore D K. 2007. Performance of strawberry cultivars grown on different mulching materials under sub humid subtropical plateau
conditions eastern India. *Indian Journal of Horticulture* 64 (2): 13-143.

Dwivedi S K, Abdule Kareem and Raut B. 2004. Introduction and evaluation of strawberry cultivars for cold arid conditions of Ladakh. *Progressive Horticulture* 36 (2): 207-210.

Gomez A A and Gomez K A. 1984. Statistical procedures for agricultural research. John Wiley and Sons, Inc., New York, pp. 680.

Hassan G I., Godara A K, Kumar Jitender and Huchche A D. 2001. Evaluation of different strawberry (*Fragaria x ananassa* Duch.) cultivars under Haryana condition. *Haryana Journal of Horticultural Science* 30 (1-2): 41-43.

Rangana S. 1994. Handbook of analysis and quality control for fruits and vegetable products. 2nd edition, Tata McGraw hill publication company Ltd. New Delhi, India.

Sharma G and Sharma O C. 2006. Correlation and path analysis in strawberry (*Fragaria x ananassa* Duch.). *The Horticultural Journal* 19 (1): 1-4.

Sharma R L, Badiyala S D and Singh L. 1981. Vaietal differences in fruit quality of strawberry. *Haryana Journal of Horticultural Science* 10 (3-4): 193-195.

Sharma R M and Yamdagni R. 2000. Modern strawberry cultivation. Kalyani Publishers, New Delhi. pp 172

Sharma R R and Sharma V P. 2003. Mulch type influences plant growth, albinism disorder and fruit quality in strawberry (*Fragaria x ananassa* Duch.). *Fruits (Paris)*. 58: 221-227.

Sharma R R and Singh S K. 1999. Strawberry cultivation-a high remunerative farming enterprise. *Agro India* 3 (2): 29-31

Sharma R R. 2002. Strawberry. International Book Distributing Co. Lucknow.

Shaw D. 1990. Response to selection and associated changes in genetic variance for soluble solids and titrable acids content in strawberry. *Journal of American Society of Horticulture Science* 15: 839-843.

Shukla S N, Srivastava R P, Singh D D and Singh R P. 1980. Performance of strawberry varieties grown in the hills of U.P. *Indian Journal of Horticulture* 37(2): 136-145.

Singh Akath, L. C. De and K.M. Bujbarbaruah. 2007. Improved package of practices of strawberry cultivation. *Technical bulletin number*. 28. ICAR Research complex for NEH region Umiam Meghalaya. Pp. 30

Verma S K, Singh R K and Arya R R. 2002. Variability and correlation studies in strawberry germplasm for quantiative traits. *Indian Journal of Horticulture* 59 (1): 39-43.

Wani M S, Rather B A, Sharma M K and Singh S R. 2007. Effect of different planting times and mulches on flowering, yield and quality of strawberry. *The Horticultural Journal*. 20(1): 5-7.

---

**How to cite this article:**

Rakesh Kumar and Hansra, B.S. 2019. Standardization of Production Technology for Strawberry (*Fragaria × ananassa* Duch.) Cultivars in Terrance Gardening. *Int.J.Curr.Microbiol.App.Sci.* 8(09): 1-7. doi: [https://doi.org/10.20546/ijcmas.2019.809.001](https://doi.org/10.20546/ijcmas.2019.809.001)