RESEARCH ARTICLE

# PERFORMANCE OF STRAWBERRY CULTIVARS FOR GROWTH, YIELD AND QUALITY UNDER NATURALLY VENTILATED POLYHOUSE CONDITIONS

**Appani Laxman Kumar[1]*, K. Vanajalatha[2], P. Prasanth[3], Veena Joshi1[4], D. Saida Naik[5] and D. Srinivasa Chary[6]**

*[1*] SKLTSHU, Mulugu Siddipet, Telangana, India*
*[2]SKLTS Horticultural University, Mulugu, Telangana, India*
*[3]Floricultural Research Station ARI, Rajendranagar, Hyderabad, Telangana, India*
*[4]SKLTS Horticultural University, Mulugu, Telangana, India*
*[5]Dept. of Crop Physiology, College of Agriculture, PJTSAU, Hyderabad, Telangana, India*
*[6]Dept. of Mathematics and Statistics, College of Agriculture, PJTSAU, Hyderabad, Telangana, India*

*Received-23.11.2021, Revised-14.12.2021, Accepted-24.12.2021*

**Abstract:** Strawberry has considerable genetic diversity. Evaluation of cultivars has gained paramount importance and essential for recommendation of cultivars to particular location. Six strawberry cultivars were studied for growth, flowering, yield and quality grown at temperature below 28ºC under naturally ventilated polyhouse. The pooled data revealed maximum plant height (22.58 cm), plant spread (31.50 cm East-West), (33.67 cm North-South), minimum number of days to fifty % flowering (103.99 days), number of days flowering to fruit set (12.35 days), number of days to maturity (27.88 days), maximum number of primary fruits (3.32), secondary (4.27), tertiary fruits (5.44) , fruit yield per plot (2.00 kg) and yield per hectare (11.34 t $ha^{-1}$) were recorded in Winter Dawn. Among the evaluated cultivars, Sweet Charlie had recorded maximum total sugars (6.17%) while Winter Dawn had registered minimum albinism disorder (1.42%) and maximum benefit cost ratio (2.29) as per the pooled data.

**Keywords:** Strawberry, Cultivars, Diversity, Polyhouse, Performance

## INTRODUCTION

Strawberry (*Fragaria ananassa* Duch) is an important fruit crop of India. Its commercial production is possible in temperate and sub-tropical areas of the country. Strawberry fruit contains a higher %age of Ascorbic acid, phenolics and flavonoids (Hakkinen and Torronen, 2000).

In India Strawberry is cultivated in Himachal Pradesh, Uttar Pradesh, Maharashtra, West Bengal, Delhi, Haryana, Punjab and Rajasthan. As per the third advance estimates in Indiastrawberry cultivated in area 3000 hectares with annual production of 20,000 metric tons (NHB 2021-22).

Strawberry has broad genetic variability. Selecting and testing of elite cultivars in different agro-climatic conditions is imperative for obtaining desirable yields and quality. There was no scientific research information cultivation of strawberry under Telangana conditions. Therefore, need to introduce improved strawberry cultivars to the targeted location is crucial for strawberry production and productivity.

## MATERIALS AND METHODS

The experiment was conducted from September to February during the year 2018-19 and 2019-20 at college farm SKLTSHU, Hyderabad which is located at the latitude of 170.19' N and 790. 23'E longitude, at an altitude of 542.6 m above mean sea level. The soil analysis was conducted and recommended organic manures and fertilizers (50 tons of Farm Yard Manure and 80, 40, and 40 kg ha of N(Urea), $P_2O_5$ (SSP) and $K_2O$ (MOP) are incorporated in to soil. Six cultivars (Winter Dawn, Sweet Charlie, Barak, Hadar, Yasmin and Shani)of strawberry collected from Kumar Florist, Pune. These cultivars are planted at spacing of 50 x 30 cm on 1.5 x 1.0 raised beds in naturally ventilated polyhouse, temperature below 28ºC and Relative Humidity of 75 to 80 % was maintained using foggers and opening side walls. The recommended cultivation practices are followed. The experiment was laid out in Randomized Block Design (RBD) with six treatments and four replications.

The data was recorded for following parameters such as plant height, plant spread, days to 50 % flowering, days from flowering to fruit set, number of primary, secondary, tertiary fruits, days to maturity, fruit yield per plot, fruit yield per hectare, incidence of albinism disorder and total sugars % during both the years 2018-19 and 2019-20.Analysis of variance technique procedure given by researchers was used for statistical analysis. The data was statistically analysed using OPSTAT, a Windows-based computer programme.

**Albinism disorder (%)**

Albinism disorder was observed in strawberry fruits due to lack of colour development during fruit ripening. Albinism incidence was recorded in five

*Corresponding Author

randomly selected plants of each treatment and each replication. The following formula was used for calculating %of albino fruits (Sharma *et al*., 2007).

$$\text{Albinism (\%)} = \frac{\text{Number of albino fruits}}{\text{Total number of fruits}} \times 100$$

**Benefit costratio**

Cost of production for all the treatments was worked out on the basis of prevailing input and market price of the produce. The net realization was calculated by deducting the cost of production per hectare from the gross realization and per rupee invested was calculated treatment wise to assess the economic impact of the treatment by dividing the net realization per hectare by the cost of production per hectare. Benefit cost ratio was worked out as follows

$$\text{Benefit-Cost ratio} = \frac{\text{Gross return (Rs.) ha}^{-1}}{\text{Cost of cultivation (Rs.) ha}^{-1}}$$

## RESULTS AND DISCUSSION

**Plant height (cm) :** It was evident from the investigation that highest plant height (21.88 cm) was registered in cultivar Winter Dawn and it was at par with cultivars Sweet Charlie (21.59 cm), Barak (20.75 cm) and Hadar (19.38 cm) while the lowest plant height (17.59 cm) was recorded in cultivar Yasmin during the year 2018-19.

During the year 2019-20 as per the data presented in the Table 1 maximum plant height was registered in cultivar Winter Dawn (23.27 cm) and it was at par with cultivars Sweet Charlie (21.65 cm), Barak (20.91 cm) and Hadar (20.83 cm) whereas minimum plant height (18.41 cm) was observed in cultivar Shani.

The pooled analysis revealed that highest plant height (22.58 cm) was recorded in cultivar Winter Dawn and statistically similar with cultivar Sweet Charlie (21.62 cm) whereas lowest plant height (18.51 cm) was noticed in cultivar Shani at 120 days after planting.

A significant variation was observed among different strawberry cultivars in respect to plant height. These significant variations in characters with reference to plant height can be attributed to the genetic variation of the cultivars (Li *et al*., 1993). Similar results are also supported by Gowda *et al*. (2017) in strawberry.

**Plant spread East- West and North-South (cm)**

The plant spread ranged from 24.68 to 31.08 cm during 2018-2019 and 25.30 to 31.92 cm in 2019-20 whereas pooled values ranged from 25.30 to 31.50 cm in East-West (Table: 1).

During the year 2018-19, maximum plant spread (31.08 cm) was observed in cultivar Winter Dawn and it was at par with cultivar Sweet Charlie (29.19 cm) while minimum plant spread (24.68 cm) was noticed in cultivar Yasmin.

In the year 2019-20, cultivar Winter Dawn had highest plant spread (31.92 cm) and it was at par with cultivar Sweet Charlie (29.05 cm) while lowest plant spread (25.30 cm) in East- West direction was recorded in cultivar Shani.

The pooled analysis indicated that cultivar Winter Dawn had maximum spread (31.50 cm) in East-West direction followed by cultivar Sweet Charlie (29.12 cm) and minimum plant spread (25.30 cm) was observed in cultivar Shani at 120 days after planting.

The maximum plant spread (33.03 cm) in North-South direction was found in cultivar Winter Dawn and it was statistically on par with cultivar Sweet Charlie (32.56 cm), Barak (29.49 cm) and Hadar (29.11 cm) while minimum plant spread (26.22 cm) was noticed in cultivar Yasmin during 2018-19.

During the year 2019-20, highest plant spread (34.31 cm) was observed in cultivar Winter Dawn and it was statistically similar with cultivars Sweet Charlie (32.84 cm), Barak (32.13 cm) and Hadar (31.41 cm) whereas, lowest plant spread (28.33 cm) was recorded in cultivar Shani.

It is evident from the pooled data highest plant spread (33.67 cm) was observed in cultivar Winter Dawn and it was statistically on par with cultivar Sweet Charlie (32.70 cm) while lowest plant spread (27.70 cm) in north south direction was observed in cultivar Yasmin at 120 days after planting.

These significant variations in plant spread may be due to genetic nature of cultivars and due to increased length and weeping growth of leaf petioles which lean outwards resulting in higher plant spread. These findings are also supported by Kumar *et al*. (2011) in strawberry.

**Days to 50% flowering:** It was observed from the data presented in the Table 2 showed non- significant difference among cultivars with respect to days to 50 % flowering during 2018-19, 2019-20 and pooled data.

During the year 2018-19 and 2019-20, the days to 50 % flowering was minimum in cultivar Winter Dawn (102.17 and 105.82) while it was registered maximum in cultivars Yasmin (106.70) and Shani (108.89).

Pooled analysis showed that the days to 50 % flowering was maximum (107.70) in cultivar Yasmin and it was followed by cultivar Shani (106.79). However lowest number of days to 50 % flowering was noticed in cultivar Winter Dawn (103.99). The variation in number of days to fifty % flowering might be due to genetic nature of cultivars. The results obtained in the present study are in line with reports of Gowda *et al*. (2017) in strawberry, Kumar *et al*. (2018) in cucumber, Anuradha *et al*. (2020) in tomato.

**Flowering to fruit set (days):** The data pertaining to number of days from flowering to fruit set was depicted in the Table 2 showed significant difference

among the cultivars during 2018-19, 2019-20 and Pooled data.

The days from flowering to fruit set was recorded minimum (12.32) in cultivar Winter Dawn and maximum (15.78) in cultivar Yasmin and cultivar Yasmin was statistically similar with cultivar Shani (14.26) during 2018-19. During 2019-20, maximum number of days from flowering to fruit set was observed in cultivar Shani (15.12) and it was on par with cultivars Yasmin (14.56) and Hadar (14.15) whereas minimum number of days (12.38) from flowering to fruit set was observed in cultivar Winter Dawn.

The pooled data indicates maximum number of days (15.17) from flowering to fruit set was observed in cultivar Yasmin and it was on par with cultivars Shani (14.69) and Hadar (13.86). However, minimum number of days (12.35) from flowering to fruit set was observed in cultivar Winter Dawn (12.35).The minimum number of days from flowering to fruit set was due to early fruit growth depends greatly on root starch reserve for up to one month after planting (Mann, 1930).

**Number of primary fruits per plant:** The perusal of data presented in the Table 2 revealed that strawberry cultivars differed significantly for number of primary fruits per plant during 2018-19, 2019-20 and Pooled data.

During year 2018-19, 2019-20 and pooled data number of primary fruits per plant was highest in cultivar Winter Dawn (3.28, 3.35 3.32) and it was statistically similar with cultivars Sweet Charlie (3.23, 3.27, 3.25), Barak (3.13, 3.22, 3.17) and Hadar (3.07, 3.19, 3.13). However, lowest number of primary fruits was observed in cultivars Yasmin (2.59, 2.79) and Shani (2.90) during 2018-19, pooled data and 2019-20 respectively. The size of the fruit is controlled by the dimension of the receptacle and number of achenes. The stimulating effects of achenes are quite different in various genotypes (Hortynski *et al*., 1991).

**Number of secondary fruits per plant:** Significant differences were observed for the character number of secondary fruits per plant during 2018-19, 2019-20 and pooled data.

From the data presented in the Table 3 it was evident that maximum number of secondary fruits (4.25, 4.30 and 4.27) was harvested from cultivar Winter Dawn during 2018-19, 2019-20 and pooled data. However, minimum number of secondary fruits per plant was found in cultivars Yasmin (3.41, 3.52) and Shani (3.44) during the year 2018-19, pooled data and 2019-20 respectively.

During 2018-19, highest number of secondary fruits per plant (4.25) was registered in cultivar Winter Dawn and it was statistically similar with cultivars Sweet Charlie (4.15), Barak (4.01) and Hadar (3.86). During 2019-20 and pooled data, maximum number of secondary fruits (4.30 and 4.27) was obtained from cultivar Winter Dawn and it was statistically similar with cultivars Sweet Charlie (4.21 and 4.18) and Barak (4.13 and 4.07) during respectively. It was noticed from the data that lowest number of secondary fruits (3.41, 3.44 and 3.52) harvested from cultivars Yasmin and Shani during 2018-19, 2019-20 and pooled data. The secondary fruits are smaller in size than primary fruits. The differences in fruit size among cultivars were due to the combined effects of developed achene number, developed achene size, differential activity of achenes in producing growth hormones and differential response of receptacular tissue to growth hormones (Moore *et al*., 1970). These results are supported by Hortynski *et al*. (1991) in strawberry.

**Number of tertiary fruits per plant:** It was evident from the investigation and data present in the Table 3 that substantial variation existed among the cultivars for number of tertiary fruits per plant and varied significantly during 2018-19, 2019-20 and pooled data.

During year 2018-19 and 2019-20, highest number of tertiary fruits per plant (5.40 and 5.49) was noticed in cultivar Winter Dawn and it was on par with cultivars Sweet Charlie (5.20 and 5.34), Barak (5.13 and 5.18) and Hadar (5.02 and 5.10) whereas minimum number of tertiary fruits (4.38 and 4.83) per plant was registered in cultivars Yasmin and Shani.

The pooled data ranged from 4.65 to 5.44 and maximum number of tertiary fruits per plant (5.44) was registered in cultivar Winter Dawn and it was statistically similar with cultivars Sweet Charlie (5.27) and Barak (5.15) whereas minimum number of tertiary fruits (4.65) was noticed in cultivar Yasmin.

The tertiary fruits are smaller in size and higher in number than primary and secondary fruits. The size of the fruit is controlled by dimension of receptacle and number of achenes. The stimulating effects of achenes are quite different in various genotypes (Hortynski *et al*., 1991). These results are supported by the findings of Moore *et al*. (1970) in strawberry.

**Days to maturity (duration):** The observations from the data presented in the Table 3 related to number of days taken by various cultivars to attain maturity revealed significant differences during 2018-19, 2019-20 and Pooled data.

Cultivar Winter Dawn took least number of days for fruit maturation (28.30 days) and it was followed by cultivars Sweet Charlie (29.29) and Barak (29.85) whereas highest number of days taken to maturation (31.83) was observed in cultivar Yasmin during the year 2018-19.

During the year 2019-20, maximum number of days taken to maturity was noticed in cultivar Shani (31.50) and it was statistically on par with cultivar Yasmin

(29.73) while the minimum number of days to maturity (27.46) was recorded in cultivar Winter Dawn.

Pooled analysis showed that cultivar Shani was late (31.33 days) to mature which on an average took 31.33 days and at par with cultivars Yasmin (30.78) and Hadar (29.97) whereas cultivar Winter Dawn was found earliest to mature (27.88). The early emergence of first flower, minimum number days to fifty % flowering, flowering duration and flowering to fruit set subsequently reduced the number days to maturity in Winter Dawn compared to other cultivars. The variation in days to maturity of different cultivars may be due to genetic makeup of cultivars. These findings are supported by Anuradha *et al*. (2020) in tomato, Gowda *et al*. (2017) in strawberry.

**Fruit yield per plot (kg):** The data pertaining to parameter fruit yield per plot presented in the Table 4 showed significant difference during 2018-19, 2019-20 and pooled data.

The highest yield of 1.97 and 2.00 kg per plot was recorded in cultivar Winter Dawn during the year 2018-19 and pooled data.

The significantly maximum yield per plot (1.97 and 2.00 kg) was noticed in cultivar Winter Dawn and it was on par with cultivars Sweet Charlie (1.91 and 1.94 kg) and Barak (1.82 and 1.85 kg) whereas minimum yield per plot (1.34 and 1.49 kg per plot) was recorded in cultivar Yasmin during the year 2018-19 and pooled data.

During the year 2019-20, significantly highest yield (2.03 kg per plot) was obtained by cultivar Winter Dawn and it was statistically similar with cultivar Sweet Charlie (1.96 kg per plot) and lowest yield per plot of 1.52 kg was recorded in cultivar Shani.

Yield was a complex character and indirectly affected by its contributing characters like flowers per plant, fruit set (%). It was noticed that yield potential under various conditions are influenced by genetic nature of plant (Gowda *et al*., 2017).

**Yield (tha$^{-1}$):** The observations recorded on fruit yield per hectare (tons) are shown in Table 4 represented significant difference among cultivars during 2018-19, 2019-20 and pooled data.

Significantly highest yield (11.15 and 11.34 tha$^{-1}$) was recorded in cultivar Winter Dawn and it was on par with cultivars Sweet Charlie (10.83 and 10.98 tha$^{-1}$) and Barak (10.30 and 10.50 tons per hectare) whereas lowest yield (7.57 and 8.47 tha$^{-1}$) was noticed in cultivar Yasmin during 2018-19 and pooled data respectively.

During the year 2019-20 maximum yield per hectare (11.53tha$^{-1}$) was noticed in cultivar Winter Dawn and minimum yield (8.67 tha$^{-1}$) was recorded in cultivar Shani.

The fruits yield per hectare was significantly differed in different strawberry cultivars and varied from 8.47 to 11.34 tha$^{-1}$. Components like yield per plant, number of crowns, number of leaves per plant, plant size, number of inflorescences, number of fruits per plant, fruit set and total number of achenes per berry are related with the yield per unit area.

**Albinism disorder (%):** The perusal of data presented in the Table 4 revealed that strawberry cultivars differed significantly in respect of albinism during 2018-19, 2019-20 and pooled data.

During 2018-19, highest albinism % (4.04 %) was noticed in cultivar Barak while lowest albinism % (1.35%) was recorded in cultivar Winter Dawn. In the year 2019-20, Barak cultivar recorded maximum albinism (3.91 %) followed by cultivar Hadar (2.84 %). However lowest albinism (1.25 %) was observed in cultivar Shani.

According to pooled data, maximum albinism (3.98 %) was registered in cultivar Barak and minimum albinism (1.42%) was noticed in cultivars Winter Dawn and Shani.

The strawberry cultivars showed variation in albinism % from 1.42 to 3.98 %. The maximum albinism (3.98 %) was noted in cultivar Barak and minimum (1.42 %) was registered in cultivar Winter Dawn and Shani as per pooled data. The wider variability with respect to albinism among the different cultivars may be due to genetic variability (Wani *et al*., 2007) in strawberry.

**Total sugars (%):** It was observed from the data presented in the Table 4 showed significant difference among cultivars pertaining to total sugars during 2018-19, 2019-20. In contrast, non-significant difference was noticed for pooled data.

During 2018-19, cultivar Sweet Charlie recorded maximum total sugars (6.24 %) and it was at par with cultivar Winter Dawn (6.01 %) whereas a minimum total sugar (5.74 %) was noticed in cultivar Yasmin. In second year of study (2019-20), similarly cultivar Sweet Charlie recorded highest total sugars (6.10 %) and it was statistically similar to cultivars Winter Dawn (6.07 %), Barak (6.05 %), and Hadar (6.00 %) whereas, minimum total sugar (5.52 %) was observed in the fruits of cultivar Shani.

The highest total sugar content (6.17 %) was noticed in cultivar Sweet Charlie followed by cultivars Winter Dawn (6.04 %) and Barak (5.99 %). However, lowest total sugars were observed in cultivars Shani (5.52 %).

The character total sugars showed marked variation, highest total sugar % (6.17 %) was noticed in cultivar Sweet Charlie as per the pooled data. The reasons for deviation in total sugars may be ascribed due to cultivars genetic makeup. These findings are in close conformity with work of Gowda *et al*. (2017) in strawberry, Chandel and Badiyala (1996) in strawberry.

**Economics of strawberry cultivars cultivated under naturally ventilated polyhouse:** The benefit cost ratio

in different cultivars of strawberry presented in Table 5. The benefit cost ratio was calculated on basis on yield per plant and average of two years data. The cultivar Winter Dawn accounted for maximum net income (Rs. 65383.72), Gross income (Rs. 116167.70) and maximum benefit cost ratio (2.29) whereas the minimum benefit cost ratio (Rs. 1.73) was recorded in cultivar Yasmin for 560 square meters area of naturally ventilated poly house. Pozderec *et al*. (2010) was also of the similar view that protected cultivation presents a lot of opportunity in terms of better economic gain in shorter span of cropping period.

**Table 1.** Performance of different strawberry cultivars on plant height (cm) and spread in East-West and North-South (cm) under naturally ventilated polyhouse

| Treatments | Plant Height (cm) | | | Plant Spread East -West(cm) | | | Plant Spread North –South(cm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| Winter Dawn | 21.88 | 23.27 | 22.58 | 31.08 | 31.92 | 31.50 | 33.03 | 34.31 | 33.67 |
| Sweet Charlie | 21.59 | 21.65 | 21.62 | 29.19 | 29.05 | 29.12 | 32.56 | 32.84 | 32.70 |
| Barak | 20.75 | 20.91 | 20.83 | 26.08 | 27.86 | 26.97 | 29.49 | 32.13 | 30.81 |
| Hadar | 19.38 | 20.83 | 20.11 | 26.54 | 27.05 | 26.79 | 29.11 | 31.41 | 30.26 |
| Yasmin | 17.59 | 19.76 | 18.68 | 24.68 | 26.83 | 25.75 | 26.22 | 29.18 | 27.70 |
| Shani | 18.60 | 18.41 | 18.51 | 25.31 | 25.30 | 25.30 | 28.49 | 28.33 | 28.41 |
| SEm± | 1.00 | 0.96 | 0.48 | 1.31 | 1.19 | 0.47 | 1.41 | 1.19 | 0.65 |
| CD (5%) | 3.00 | 2.90 | 1.74 | 3.94 | 3.59 | 1.70 | 4.25 | 3.59 | 2.35 |

CD: Critical Difference, SEm±: Standard Error Mean, NS: Non significant

**Table 2.** Performance of different strawberry cultivars ondays to 50 % flowering, days from flowering to fruit setand number of primary fruits per plant under naturally ventilated polyhouse

| Treatments | Days to 50% flowering | | | Flowering to fruit set (days) | | | Number of primary fruits per plant | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| Winter Dawn | 102.17 | 105.82 | 103.99 | 12.32 | 12.38 | 12.35 | 3.28 | 3.35 | 3.32 |
| Sweet Charlie | 103.80 | 106.66 | 105.23 | 13.25 | 13.56 | 13.41 | 3.23 | 3.27 | 3.25 |
| Barak | 104.22 | 106.39 | 105.31 | 13.39 | 13.84 | 13.62 | 3.13 | 3.22 | 3.17 |
| Hadar | 104.18 | 106.72 | 105.45 | 13.57 | 14.15 | 13.86 | 3.07 | 3.19 | 3.13 |
| Yasmin | 106.70 | 108.70 | 107.70 | 15.78 | 14.56 | 15.17 | 2.59 | 3.00 | 2.79 |
| Shani | 104.69 | 108.89 | 106.79 | 14.26 | 15.12 | 14.69 | 2.87 | 2.90 | 2.89 |
| SEm± | 0.97 | 1.00 | 0.98 | 0.60 | 0.41 | 0.37 | 0.10 | 0.09 | 0.07 |
| CD (5%) | NS | NS | NS | 1.82 | 1.24 | 1.33 | 0.31 | 0.29 | 0.26 |

CD: Critical Difference, SEm±: Standard Error Mean, NS: Non significant

**Table 3.** Performance of different strawberry cultivars on number of secondary, tertiary fruits per plant, days to maturity (duration)

| Treatments | Number of secondary fruits per plant | | | Number of tertiary fruits per plant | | | Days to maturity (duration) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| Winter Dawn | 4.25 | 4.30 | 4.27 | 5.40 | 5.49 | 5.44 | 28.30 | 27.46 | 27.88 |
| Sweet Charlie | 4.15 | 4.21 | 4.18 | 5.20 | 5.34 | 5.27 | 29.29 | 28.13 | 28.71 |
| Barak | 4.01 | 4.13 | 4.07 | 5.13 | 5.18 | 5.15 | 29.85 | 28.89 | 29.37 |
| Hadar | 3.86 | 3.69 | 3.77 | 5.02 | 5.10 | 5.06 | 30.89 | 29.05 | 29.97 |
| Yasmin | 3.41 | 3.63 | 3.52 | 4.38 | 4.92 | 4.65 | 31.83 | 29.73 | 30.78 |
| Shani | 3.74 | 3.44 | 3.59 | 4.75 | 4.83 | 4.79 | 31.15 | 31.50 | 31.33 |
| SEm± | 0.14 | 0.18 | 0.10 | 0.19 | 0.14 | 0.09 | 0.31 | 0.73 | 0.43 |
| CD (5%) | 0.41 | 0.55 | 0.35 | 0.57 | 0.41 | 0.34 | 0.93 | 2.21 | 1.57 |

CD: Critical Difference, SEm±: Standard Error Mean

**Table 4.** Performance of different strawberry cultivars on yield per plot (kg) and yield (tha-1), Albinism disorder (%) and Total sugars (%) under naturally ventilated polyhouse

| Treatments | Yield per plot (kg) | | | Yield (tha$^{-1}$) | | | Albinism disorder (%) | | | Total sugars (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| Winter Dawn | 1.97 | 2.03 | 2.00 | 11.15 | 11.53 | 11.34 | 1.35 | 1.50 | 1.42 | 6.01 | 6.07 | 6.04 |
| Sweet Charlie | 1.91 | 1.96 | 1.94 | 10.83 | 11.13 | 10.98 | 3.05 | 2.62 | 2.84 | 6.24 | 6.10 | 6.17 |
| Barak | 1.82 | 1.89 | 1.85 | 10.30 | 10.70 | 10.50 | 4.04 | 3.91 | 3.98 | 5.93 | 6.05 | 5.99 |
| Hadar | 1.66 | 1.73 | 1.70 | 9.40 | 9.83 | 9.61 | 3.06 | 2.84 | 2.95 | 5.82 | 6.00 | 5.91 |
| Yasmin | 1.34 | 1.65 | 1.49 | 7.57 | 9.37 | 8.47 | 1.67 | 1.54 | 1.61 | 5.74 | 5.95 | 5.85 |
| Shani | 1.51 | 1.53 | 1.52 | 8.58 | 8.67 | 8.62 | 1.58 | 1.25 | 1.42 | 5.79 | 5.25 | 5.52 |
| SEm± | 0.05 | 0.04 | 0.05 | 0.28 | 0.24 | 0.31 | 0.05 | 0.08 | 0.10 | 0.09 | 0.17 | 0.14 |
| CD (5%) | 0.15 | 0.13 | 0.19 | 0.85 | 0.72 | 1.14 | 0.15 | 0.25 | 0.36 | 0.27 | 0.53 | NS |

CD: Critical Difference, SEm±: Standard Error Mean, NS : Non Significant

**Table 5.** Economics of strawberry cultivars cultivated under naturally ventilated polyhouse (560 sq m2)

| Cultivars | Total cost of cultivation (Rs.) | Fruit yield (kgs/plot) | Gross income (Rs.) | Net Income (Rs.) | Benefit: Cost ratio |
|---|---|---|---|---|---|
| Winter Dawn | 50,784 | 553.18 | 116167.7 | 65383.72 | 2.29 |
| Sweet Charlie | 50,784 | 536.10 | 112581.7 | 61797.71 | 2.22 |
| Barak | 50,784 | 513.62 | 107860 | 57076.03 | 2.12 |
| Hadar | 50,784 | 471.77 | 99071.23 | 48287.23 | 1.95 |
| Yasmin | 50,784 | 418.11 | 87804.11 | 37020.11 | 1.73 |
| Shani | 50,784 | 425.41 | 89336.97 | 38552.97 | 1.76 |

**ACKNOWLEDGEMENT**

The author would like to express their thanks to Sri Konda Laxman Telangana State Horticultural University for financial support and members of advisory committee for their support during research work.

**REFERENCES**

**Anuradha, S., S. Paramveer, B. Ajay and K. Randhi** (2020). Evaluation of tomato (*Solanum Lycopersicum* L.) genotypes for morphological, qualitative and biochemical traits for protected cultivation. *Current Journal of Applied Science and Technology*, 39(2): 105-111.

Google Scholar

**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.

Google Scholar

**Gowda, M.B.M., Madaiah, D., Dinesh, K.M., Sivkumar, B.S. and Ganapathi, M.** (2017). Performance of strawberry (*Fragaria* x *ananassa* Duch.) genotypes for growth and yield characters in hill zone of Karnataka. *Journal of Plant Development Sciences*, 9 (10): 963-965.

Google Scholar

**Hakkinen, S. H. and Torronen, A. R.** (2000). Content of flavonols and selected phenolic acids in strawberries and *Vaccinium* species: Influence of cultivar, cultivation site and technique. *Food Res. Int*., 33: 517-524.

Google Scholar

**Hortynski, J.A., Zebrowska, J. and Gawronski, J.** (1991). Factor influencing fruit size in strawberry (*Fragaria ananassa* Duch.). *Euphytica*, 56:67-74.

Google Scholar

**Kumar, A., Avasthe, R.K., Pandey, B.K., Ramesh, D.R. and Rahman, H.** (2011). Varietal screening of strawberry (*Fragaria* x *ananassa* Duch.) under organic production system for fruit quality and yield in mid-hills of Sikkim Himalayas. *Indian Journal of Plant Genetic Resource*, 24(2): 243–245.

Google Scholar

**Kumar, A., Kumar, S. and Pal, A.K.** (2008). Genetic variability and characters association for fruit yield and yield traits in cucumber. *Indian Journal of Horticulture*, 65(4):423-428.

Google Scholar

**Li, G.Y., Sui, W. and Ding, X.D.** (1993). Comprehensive evaluation of economic characters of some principal cultivars of strawberry. *Journal of North-East Agriculture College*, 24: 224-30.

Google Scholar

**Mann, C.E.T.** (1930). Studies in the root and shoot growth of the strawberry. The origin, development, and function of the roots of the cultivated strawberry (*Fragaria virginiana* x *chiloensis*). *Annals of Botany*, 44: 56-84.

Google Scholar

**Moore, J.N., Brown, G.R. and Brown, E.D.** (1970). Comparison of factors influencing fruit size in large fruited and small fruited clones of strawberry. *Journal American Society Horticultural Sciences*, 95(6): 827-831.

Google Scholar

**Pozderec, S., Pazek, K. and Bavec, M.** (2010). Economics of peppers and salad cucumbers production on an open land and in a protected space. *Agriculturae Conspectus Scientificus*, 75(3): 127-132.

Google Scholar

**Sharma, R.R., Singh, R., Singh, D. and Gupta, R.K.** (2007). Influence of row covers and mulching interaction on leaf physiology, fruit yield and albinism incidence in Sweet Charlie strawberry (*Fragaria* × *ananassa* Duch.). *Fruits*, 63: 103–110.

Google Scholar

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

Google Scholar