The Effect of the Growing Media and Planting Distances on the Growth and Yield of Strawberry (*Fragaria ananassa* Duch.) Grown in Plastic Tubes

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**Abstract.** This study is conducted in the unheated greenhouse of the Department of Horticulture and Landscape - College of Agriculture - Tikrit University during the two seasons 2020-2021. It aims to know the effect of growth medium and planting distances on growth and yield of three varieties of strawberry with a diameter of 6 inches. The study includes three factors, the first factor is media at three levels which are the loamy soil only, the loamy soil + peat moss and peat moss only. The second factor is planting distances which include three distances, 15, 20 and 25 cm between one plant and another. The third factor is the varieties which include three varieties, namely Camarosa, Sweet Charlie and Ruby gem. The experiment is implemented by designing randomized complete sectors according to the split-split plot design with three replicates, each replicate containing three tubes with a diameter of 6 inches, length of each tube 6 meters and each tube containing three experimental units. Thus, each replicate contains 9 experimental units with a length of 2 meters, the growth medium was set in the main plots and the planting distances in the sub-plots, while the cultivars took the sub-sub-plots. The most important results can be summarized as follows: Peat moss is significantly superior in the characteristics of average number of leaves, leaf area, average number of flowers, total soluble solids, and total acidity, amounting to 21.95 leaf plant$^{-1}$, 753.6 cm$^{2}$, 20.22 flower plant$^{-1}$, 9.119 and 1.335%, respectively. Ruby gem variety significantly outperformed in the characteristics of average number of leaves, leaf area, average number of flowers, and total soluble solids percentage, amounting to 19.65 leaf plant$^{-1}$, 594.6 cm$^{2}$, 20.22 flower plant$^{-1}$ and 8.537%, respectively; while the varieties have not differed significantly among themselves in the total acidity ratio. The distance D$_3$ is significantly superior in the average number of leaves and leaf area, amounting to 18.73 leaf plant$^{-1}$, 577.2 cm$^{2}$. On the other hand, the distance D$_2$ is superior in the two characteristics, namely the average number of flowers and the percentage of total soluble solids amounting to 19.70 flower plant$^{-1}$ and 8.156%, while no significant differences are observed in the characteristic of the total acidity percentage.

1. **Introduction**

Strawberry is a perennial herbaceous plant that is considered as one of the fruits that yields small fruits and is widespread in the world. Its name is derived from *Fragaria ananassa* Duch. from the Latin word fragrans. It is named in English Strawberry, in French *Fraise*, and in Italian *Fragola*, from which the name was derived in Egypt as Farawla (strawberry). In Syria it is called strawberry or Feraiz. In Turkey, it is called Chillaik, from which the name is taken in Iraq as Chillaik [1, 2]. Its cultivation is currently spread in more than 63 countries,
and the global production of strawberry in 2012 is about 4,516,810 tons, and the cultivated areas in the world are about 241,109 hectares. The United States of America ranks first in the list of strawberry-producing countries, with a production reaching (1,366,850) tons, which is more than a quarter of the world’s production. Egypt comes in fifth place after Mexico, Turkey and Spain for the same year with (24,227) tons [3]. Plastic pipe cultivation, which is a form and method of vertical cultivation, allows the increase in the number of plants per square meter by several times according to the diameter of the pipe used, and this in turn is positively reflected on the increase in the productivity of the square meter. Using the vertical farming system, the density of cultivation can increase by three to four times [4]. The physical properties of soil are improved by adding some media such as sand, peat moss, sawdust and animal waste, as the mere use of soil and water without any improvement in its physical properties gives bad results [5]. [6] found in their study on the effect of plant density and growth media on the growth and production of licorice that the growth medium consisting of peat moss at all distances gave a significant increase in the number of fruits, fruit size, fruit weight and total acidity compared to other media (sand, silt, coconut and municipal manure). Planting distances greatly affect the production and quality of the strawberry fruits that are grown from the cuttings. Optimum spacing between plants ensures proper growth and plant development resulting in maximum crop yield and best land use [7]. [8] carried out a study at Guru Kashi University in India on the effect of covering and spacing between plants on vegetative growth, yield and quality of three varieties of strawberry, namely Chandler, Camarosa and Winter Dawn. They used three planting distances: 30 x 15 cm, 30 x 20 cm, 30 x 30 cm. They indicated the superiority of the distance 30 x 30 cm significantly in the number of leaves, amounting to 18.37 leaves plant⁻¹. [9] conducted his study in the unheated greenhouses of the Department of Horticulture and Landscape planning - College of Agriculture - Tikrit University to evaluate different programs of the organic farming system in the productivity of strawberry plants grown under the greenhouse. He found that Ruby gem and Festival varieties are superior to Albion variety in the average number of leaves, respectively: 32.53 and 31.53 leaf plant⁻¹, while the Festival variety is superior to the other two varieties in the leaves content of chlorophyll reaching 1.812% and 6.654 mg g⁻¹.

2. Materials and Methods

This experiment is conducted in the unheated plastic house in the field of the Department of Horticulture and Landscape Planning of the College of Agriculture - Tikrit University during the agricultural season 2019-2020. The soil is analyzed after taking random samples from the field soil before planting at a depth of (0-30) cm. The analysis is carried out in the High Studies laboratories - Department of Horticulture and Landscape Planning - College of Agriculture - Tikrit University, after mixing the sample well. The table shows some of the chemical and physical properties of the field soil before planting.

| Analysis type | K (mg L⁻¹) | P (%) | N (%) | Lime (%) | Organic materials(%) | EC | pH | Soil Texture | Clay (%) | Silt (%) | Sand (%) |
|---------------|------------|-------|-------|----------|--------------------|----|----|-------------|----------|----------|----------|
| Celtic Lumian | 32         | 11.4  | 12.5  | 23.5     | 1.4                | 2.3| 7.8| Celtic       | 30       | 52.5     | 20       |

The experiment was divided into three replicates. Each replicator contains three tubes, the tube length is 6 meters and the diameter is 6 inches, and each tube contains three experimental units. Thus, the number of experimental units in one replicate is 9 experimental, each experimental unit contains a number of plants that vary according to the distance between one plant and another. When the distance between one plant and another is 15 cm, the number of plants is 13 plants, when the distance between one plant and another is 20 cm, the number of
plants is 10, and at the distance of 25 cm between one plant and another, the number of plants is 8 plants. The experiment was implemented by designing the RCBD randomized complete block design according to the split-split-plot design system. The cultivation method was placed in the main plots and the planting distances in the sub-plots, while the cultivars took the sub-sub-plots. The experiment included a study of three factors:

The first factor: the media, which include three media that are the loamy soil only, the loamy soil + with peat moss, and peat moss only symbolized by the symbols (M₀, M₁, M₂), respectively.

The second factor: the planting distances, which include three distances, 15, 20 and 25 cm between one plant and another and symbolized by the symbols (D₁, D₂, and D₃), respectively.

The third factor: include three varieties:
1. Camarosa V₁; It is one of the short-day varieties that produces large to very large fruits and its size remains constant throughout the production period. The inner color of the fruits is bright red, and it is one of the newly introduced varieties from California, and it has become very popular because of its more cohesive pulp that bears long distance shipping (Poling, 1993).
2. Sweet Charlie V₂; A short-day cultivar that bears early fruit and produces fruits with a distinctive sweet flavor that are resistant to anthracnose (Colletotrichum acutatum) Plants of this variety generally begin producing ripe fruit about two weeks before the production of UCLA cultivar 'Camarosa', which is currently the standard cultivar in main season in West Central Florida. Named "Sweet Charlie" in honor of the late Charles M (Charlie Howard), a plant pathologist at the University of Florida Research and Education Center from 1967 to 1991.
3. Ruby gem V₃; This cultivar arose in 1998 from cross-breeding between Earlbrit (Chandler et al., 2000) and Carlsbad (Voth et al., 1994). It is a short day cultivar. It is an early cultivar suitable for regions with warm winters and is highly productive. The color of the fruit is dark red, shiny, and the sugar content in it. Balanced with acidity, the fruit is a solid succulent, and the plants are resistant to fusarium wilt (Habib and Al Faraon, 2013).

Studied Characteristics:
1- Average number of leaves (leaf plant⁻¹)
2- Average leaf area (cm²)
   Leaf area = average area of one leaf x number of total leaves of the plant
3- Average number of total flowers (flower plant⁻¹)
   Average number of flowers of a plant⁻¹ = (the total number of flowers for the five plants / 5
4- Total Soluble Solid%.
   Using a Hand refracto meter
5 - Total Acidity %:
   \[ T = \frac{T \times N \times Eq \times 100}{VS \times 100} \]
   \[ T = \] volume of the base used by blunting
   \[ N = \] caliber of the base used by erosion (0,1 caliber)
   \[ Eq = \] equivalent weight of citric acid (64)
   \[ VS = \] volume of juice used by blunting (2 cm³).

3. Results and Discussion

3.1. Average Number of Leaves (Leaf Plant⁻¹)
The data in Table (2) indicate the significant superiority of the peat moss treatment over the rest of the media by recording an average number of leaves 21.95 leaf plant⁻¹, while the loamy soil treatment recorded an average number of leaves 13.99 leaf plant⁻¹. The Ruby gem variety significantly outperformed the rest of the varieties by recording an average of 19.65 leaf plant⁻¹. As for the planting distances, the distance D₃ is significantly superior by giving the highest number of leaves amounting to 18.73 leaf plant⁻¹ compared to the lowest number of leaves 16.72 leaf plant⁻¹ at the distance D₁. The M₂V₃ treatment is significantly superior to the rest of the treatments by giving the largest number of leaves reaching 23.62 leaf plant⁻¹, while the
lowest number of leaves is recorded in the M₀V₁ treatment. The M₁D₁ treatment is significantly superior in giving the highest number of leaves, reaching 23.38 leaf plant⁻¹, while the M₀D₁ treatment has recorded the lowest average number of leaves with 13.42 leaf plant⁻¹. Treatment V₁D₁ significantly outperformed the rest of the treatments by giving the highest average number of leaves reaching 21.48 leaf plant⁻¹, while the lowest number of leaves is 14.31 leaf plant⁻¹ with the treatment V₁D₁. The triple interaction treatments of M₂V₃D₁ and M₂V₃D₃ are significantly superior in the average number of leaves, giving 25.43 leaf⁻¹ and 25.07 leaf⁻¹, while the lowest number of leaves is recorded with the triple interaction treatment M₀V₁D₃ amounting to 10.13 leaf plant⁻¹.

Table 2. Effect of Growing media, planting spaces, Varieties and the interaction in Average number of leaves (leaf plant⁻¹)

| Growing media | Varieties | Planting spaces | Growing × Varieties |
|---------------|-----------|-----------------|---------------------|
|               |           | D₁              | D₂              | D₃              |
| Loam Soil     | V₁        | 11.90           | 10.97           | 10.13           | 11.00           |
|               | Kl        | lm              | m               | f               |
|               | V₂        | 13.70           | 14.73           | 14.87           | 14.43           |
|               | J         | ghi             | ghi             | e               |
|               | V₃        | 15.83           | 14.57           | 19.23           | 16.54           |
|               | Gh        | hij             | def             | d               |
|               | V₁        | 19.07           | 23.40           | 20.90           | 21.12           |
|               | Def       | b               | c               | b               |
| Peat moss     | V₁        | 19.50           | 19.67           | 24.17           | 21.11           |
|               | Cdef      | cde             | ab              | b               |
|               | V₃        | 25.43           | 20.37           | 25.07           | 23.62           |
|               | A         | cd              | a               | a               |
|               | V₁        | 11.97           | 13.17           | 16.13           | 13.76           |
|               | Kl        | jk              | gh              | e               |
|                |           |                 |                 |                 |
| Loam Soil × Peat moss (1:1) | V₁ | 14.87           | 16.27           | 17.97           | 16.37           |
|               | V₂        | 18.23           | 18.00           | 20.13           | 18.79           |
|               | Ghi       | g               | f               | d               |
|               | Ef        | f               | cd              | c               |
| The general Effect of planting spaces | | | | |
| | 16.72 | 16.79 | 18.73 |
| | B | b | a |

Growing × spaces

| Growing × spaces | Growing media |
|------------------|---------------|
| Loam Soil        | 13.81         | 13.42         | 14.74         | 13.99 |
| Peat moss        | 21.33         | 21.14         | 23.38         | 21.95 |
| Loam Soil × Peat moss (1:1) | 15.02 | 15.81 | 18.08 | 16.30 |

Varieties × spaces

| Varieties | The general effect of varieties |
|-----------|-------------------------------|
| V₁        | 14.31                         | 15.84                         | 15.72                         | 15.29 |
|           | F                             | e                             | e                             | c     |
| V₂        | 16.02                         | 16.89                         | 19.00                         | 17.30 |
|           | E                             | d                             | c                             | b     |
| V₃        | 19.83                         | 17.64                         | 21.48                         | 19.65 |
|           | B                             | d                             | a                             | a     |

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3.2. Average Leaf Area (cm²)

It is noted from Table (3) that peat moss has a significant effect on the average leaf area by giving 753.6 cm² compared to the lowest rate of 320.4 cm² in the loamy soil. As for the varieties, Ruby gem outperforms the rest of the varieties in this characteristic, recording 594.6 cm² while the Camarosa variety records the lowest average for the leaf area with 419.8 cm². As for the general effect of distances, the D₃ distance outperforms the rest of the distances recorded at 577.2 cm² compared to the lowest rate recorded at the distance D₁ which is 475.2 cm². We also note from the same table that the M₂V₃ interaction treatment gives the largest leaf area of 851.7 cm² compared to the lowest value of 245.7 cm² recorded when treating the interaction between the loamy soil and Camarosa variety. The M₂D₃ treatment has outperformed the rest of the treatments by giving the largest leaf area amounting to 841.9 cm².

Table 3. Effect of Growing media, planting spaces, Varieties and the interaction in Average leaf area (cm²)

| Growing media       | Varieties | Planting spaces | Growing × Varieties |
|---------------------|-----------|-----------------|---------------------|
|                     | D₁        | D₂              | D₃                  |
| Loam Soil           | V₁        | 225.6           | 285.5              | 226.1              |
|                     | V₂        | 291.2           | 326.9              | 373.3              |
|                     | V₃        | 321.03          | 323.1              | 511.1              |
|                     | V₄        | 585.6           | 737.2              | 702.3              |
| Peat moss           | V₁        | 621.6           | 689.9              | 874.1              |
|                     | V₂        | 899.3           | 722.6              | 949.5              |
|                     | V₃        | 269.8           | 332.03             | 414.3              |
|                     | V₄        | 405.6           | 442.5              | 554.2              |
|                     | V₅        | 495.2           | 539.9              | 589.9              |
| Loam Soil × Peat moss (1:1) | V₁     | 279.3           | 311.9              | 370.2              |
|                     | V₂        | 702.1           | 716.6              | 841.9              |
|                     | V₃        | 390.2           | 716.6              | 841.9              |

The general Effect of planting spaces

| 475.2              | 488.9              | 577.2              |

The general effect of growing media

| Growing × spaces |
|------------------|
| 279.3            |
| 702.1            |
| 390.2            |

The general effect of varieties

| Varieties × spaces |
|--------------------|
| 320.4              |
| 753.6              |
| 449.3              |
compared to the lowest leaf area amounting to 279.3 cm² recorded by treatment M_0D_1. Treatment V_3D_3 has outperformed the rest of the treatments in this characteristic amounting to 683.5 cm², while the lowest value for this characteristic is with treatment V_1D_1 which amounts to 360.3 cm². We also note from the same table regarding the interaction between the three study factors, that the M_2V_3D_3 treatment is significantly superior to the rest of the treatments in the average leaf area amounting to 949.5 cm² compared to the lowest leaf area of 225.6 cm² with treatment M_0V_1D_1.

3.3. Average Number of Flowers (flower plant⁻¹)

The results of Table (3) indicate that the medium consisting of peat moss and the medium consisting of soil and peat moss at a ratio of 1:1 have a significant effect on this characteristic by recording an average of 20.22 and 19.34 flower plant⁻¹ compared to the medium consisting of soil only, which gives 17.22 flower plant⁻¹. As for the general effect of the varieties, the Ruby gem variety significantly outperforms the rest of the varieties by giving the highest average number of flowers 20.22 flower plant⁻¹, compared to the lowest number of flowers 17.29 plant⁻¹ with Camarosa. Regarding the general effect of planting distances, the distance D_2 is significantly superior in giving the highest average number of flowers, which amounts to 19.70 flower plant⁻¹, while the lowest rate of the number of flowers is recorded at distance D_1 which is 18.23 flower plant⁻¹.

As for the dual interaction treatments between media and varieties, the M_1V_3 treatment is significantly superior in giving the largest number of flowers reaching 21.76 flower plant⁻¹, compared to the rest of the treatments as it is the lowest number of flowers with the treatment M_0V_1 amounting to 14.83 flower plant⁻¹. The treatments M_2D_1, M_2D_2 and M_1D_3 are significantly superior, which amount to 20.40, 20.45 and 20.22 flower plant⁻¹, respectively, compared to the lowest number of flowers with the treatment M_0D_1 amounting to 16.33 flower plant⁻¹. Treatment V_3D_2 is superior in giving the highest number of flowers, which is significantly 22.08 flower plant⁻¹, compared to the lowest number of flowers 15.64 plant⁻¹ with treatment V_1D_1. As for the triple interaction, the treatment M_1V_3D_2 has given asignificant superiority in the number of flowers reaching 25.07 flower plant⁻¹ flowers compared to the lowest number of flowers 13.53 plant⁻¹ flowers with M_0V_1D_3 treatment.

3.4. Total Soluble Solids (%) 

It is clear from Table (4) that there are significant differences in the Total soluble solids, as Peat moss is significantly superior to the rest of the media in this characteristic, recording 9.911% compared to the lowest value of 7.044% with the loamy soil treatment. Also, Ruby gem variety has significantly outperformed the rest of the varieties in this characteristic by giving it a percentage of 8.537%, while the lowest value for this characteristic is recorded in Camarosa variety amounting to 7.293%. With regard to the distance between plants, we notice from the same table that the distance D_2 is significantly superior to the rest of the distances in the percentage of total soluble solids, amounting to 8.156%, compared to the lowest percentage of 7.811%. The dual interaction treatment between Peat moss and Ruby gem is significantly superior to the rest of the treatments by giving it a percentage of 9.978%, while the M_0V_1 treatment has given the lowest percentage of solids amounting to 6.678%. As for the interaction between the planting medium and the distances, the interaction treatment between the peat moss medium and the distance D_2 is significantly superior by giving it a
percentage of 9.444%, while the lowest percentage of soluble solids is recorded when the interaction between the mixed soil and the distance D1 amounts to 6.900%. The dual interaction treatment between Sweet Charlie and the distances D2 and D3 has significantly outperformed the rest of the interaction treatments in this characteristic by giving a percentage of 8.967 and 8.044%, respectively, compared to the interaction treatment between Camarosa and all planting distances, which have given the lowest values of 7.222, 7.300 and 7.356%, respectively. From the same table, with regard to the triple interaction treatments among the factors of the study, we note that treatment M2V3D2 is significantly superior to the rest of the treatments in this characteristic by giving a percentage of 10.56% compared to the lowest percentage of treatment M0V1D1 which amounts to 6.033%.

Table 4. Effect of Growing media, planting spaces, Varieties and the interaction in Average number of flowers (flower plant⁻¹)

| Growing media | Varieties | Planting spaces | Growing × Varieties |
|---------------|-----------|-----------------|---------------------|
|               |           | D1   | D2   | D3   |                |
| Loam Soil     | V1        | 14.30| 16.67| 13.53| 14.83          |
|               |           | kl   | hij  | l    | f              |
|               | V2        | 19.28| 17.93| 17.33| 18.18          |
|               |           | def  | fghi | fghij| d              |
|               | V3        | 15.40| 21.90| 18.67| 18.66          |
|               |           | jk   | bc   | efg  | d              |
|               | V1        | 16.43| 22.00| 21.30| 19.91          |
|               |           | hij  | bc   | bc   | b              |
| Peat moss     | V2        | 22.40| 20.00| 19.00| 20.49          |
|               |           | b    | cde  | def  | b              |
|               | V3        | 22.37| 19.27| 19.10| 20.24          |
|               |           | b    | def  | def  | b              |
| Loam Soil ×  | V1        | 16.18| 16.93| 18.25| 17.12          |
| Peat moss (1:1)|          | ij   | ghij | efg  | e              |
|               | V2        | 18.96| 17.53| 20.93| 19.14          |
|               |           | def  | fghi | bcd  | d              |
|               | V3        | 18.73| 25.07| 21.47| 21.76          |
|               |           | efg  | a    | bc   | a              |

The general Effect of planting spaces

|               | 18.23 | 19.70 | 18.42 |
|               | c     | a     | b     |

The general effect of growing media

| Growing × spaces |
|------------------|
| Loam Soil        |
| 16.33            |
| 18.83            |
| 16.51            |
| 17.22            |
| d                |
| bc               |
| d                |
| c                |
| Peat moss        |
| 20.40            |
| 20.45            |
| 19.80            |
| 20.22            |
| a                |
| a                |
| ab               |
| a                |

The general effect of varieties

| Varieties × spaces |
|--------------------|
| V1                 |
| 15.64              |
| 18.53              |
| 17.69              |
| 17.29              |
| f                  |
| de                 |
| e                  |
| c                  |
| Growing media       | Varieties | Planting spaces | Growing × Varieties |
|---------------------|-----------|-----------------|---------------------|
|                     |           | D₁              | D₂              | D₃              |
| Loam Soil           | V₁        | 6.033           | 7.233           | 6.767           | 6.678           |
|                     |           | k               | hi              | ij              | h               |
|                     | V₂        | ghi             | 7.400           | 6.767           | 7.033           | 7.067           |
|                     |           | i               | j               | i               | g               |
|                     | V₃        | 7.267           | 7.433           | 7.467           | 7.389           |
|                     |           | hi              | ghi             | ghi             | f               |
|                     | V₁        | 8.600           | 8.400           | 8.300           | 8.433           |
|                     |           | de              | def             | def             | c               |
| Peat moss           | V₂        | 8.633           | 9.367           | 8.833           | 8.944           |
|                     |           | de              | bc              | cd              | b               |
|                     | V₃        | 9.933           | 10.56           | 9.433           | 9.978           |
|                     |           | b               | a               | bc              | a               |
|                     | V₁        | 7.033           | 6.267           | 7.000           | 6.767           |
|                     |           | i               | jk              | i               | h               |
|                     | V₂        | 7.433           | 8.467           | 8.267           | 8.056           |
|                     |           | ghi             | def             | def             | e               |
|                     | V₃        | 7.967           | 8.900           | 7.867           | 8.244           |
|                     |           | efg             | cd              | fgh             | d               |

* Numbers with same letter means no significant on Duncan test at probability of 5%.

Table 5. Effect of Growing media, planting spaces, Varieties and the interaction in Total soluble solid (%)

| Growing media × Peat moss (1:1) | Planting spaces | Growing × Varieties |
|---------------------------------|-----------------|---------------------|
|                                 | D₁              | D₂              |
| V₁                              | 7.133           | 6.267           |
|                                 | i               | jk              |
| V₂                              | 7.433           | 8.467           |
|                                 | ghi             | def             |
| V₃                              | 7.967           | 8.900           |
|                                 | efg             | cd              |

The general Effect of planting spaces

| Planting spaces | Growing × Varieties |
|-----------------|---------------------|
|                 | D₁              | D₂              |
| b               | 7.811           | 8.156           |
| a               | 7.885           |

The general effect of growing media

| Growing media | Planting spaces | Growing × Varieties |
|---------------|-----------------|---------------------|
| Loam Soil     | 6.900           | 7.144           |
| f             | 7.089           | 7.044           |
| Peat moss     | 9.056           | 9.444           |
| b             | 8.856           | 9.119           |
| Loam Soil × Peat moss (1:1) | 7.478 | 7.878 | 7.711 | 7.689 |
| de            | c               | cd              | b               |

The general effect of varieties

| Varieties × spaces | Growing × Varieties |
|--------------------|---------------------|
| V₁                 | 7.222           | 7.300           |
| d                  | d                | d               |
| V₂                 | 8.389           | 8.967           |
| b                  | a                | a               |
| V₃                 | 7.822           | 8.200           |
| c                  | b                | bc              | a               |

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3.5. Total Acidity (%)

It is noted from Table (5) that the effect of the planting medium treatment which consists of peat moss in this characteristic is significant, as it has outperformed the rest of the media in this characteristic, recording a percentage of 1.335% compared to the medium consisting of loamy soil, which recorded a percentage of 1.152%. As for the general effect of varieties, there is no significant effect in this characteristic, as well as with regard to the general effect of planting distances. We note from the same table that the cultivation of Sweet Charlie in the medium consisting of peat moss has a significant effect on the total acidity by giving it a percentage of 1.460%, which differs significantly from the treatment of cultivation of the

Table 6. Effect of Growing media, planting spaces, Varieties and the interaction in Total Acidity (%)

| Growing media | Varieties | Planting spaces | Growing × Varieties |
|---------------|-----------|-----------------|---------------------|
|               |           | D₁              | D₂                | D₃                |               |
| Loam Soil     | V₁        | 0.893           | 1.177             | 1.107             | 1.059         |
|               | h         | cdefg           | efgh              | c                 |
|               | V₂        | 1.240           | 1.163             | 1.060             | 1.154         |
|               | cdefg     | defg            | fgh               | bc                |
|               | V₃        | 1.335           | 1.187             | 1.210             | 1.243         |
|               | abcddef   | cdefg           | cdefg             | abc               |
|               | V₁        | 1.543           | 1.273             | 1.297             | 1.371         |
| Peat moss     | V₂        | 1.550           | 1.463             | 1.367             | 1.460         |
|               | a         | abc             | abcde             | a                 |
|               | V₃        | 1.187           | 1.240             | 1.093             | 1.173         |
|               | cdefg     | cdefg           | efgh              | bc                |
|               | V₁        | 1.330           | 1.207             | 1.267             | 1.268         |
|               | abcddef   | cdefg           | bcdefg            | abc               |
|               | V₂        | 1.333           | 1.450             | 1.133             | 1.306         |
|               | abcd      | abcd            | efgh              | ab                |
|               | V₃        | 1.003           | 1.127             | 1.330             | 1.153         |
|               | gh        | efgh            | abcd              | bc                |

The general Effect of planting spaces

| Growing × spaces | The general effect of growing media |
|------------------|-----------------------------------|
| 1.268            | a                                 |
| 1.254            | a                                 |
| 1.207            | a                                 |

Growing × spaces

| Growing × spaces | The general effect of growing media |
|------------------|-----------------------------------|
| 1.156            | c                                 |
| 1.176            | bc                                |
| 1.126            | c                                 |
| 1.152            | b                                 |
| 1.427            | ab                                |
| 1.326            | bc                                |
| 1.252            | bc                                |
| 1.335            | a                                 |
| 1.222            | bc                                |
| 1.261            | bc                                |
| 1.243            | bc                                |
| 1.242            | ab                                |

Varieties × spaces

| Varieties × spaces | The general effect of varieties |
|--------------------|---------------------------------|
| V₁                 | abc                             |
| 1.256              | bc                              |
| 1.219              | bc                              |
| 1.223              | bc                              |
| 1.233              | a                               |
| V₂                 | abc                             |
| 1.374              | ab                              |
| 1.359              | c                               |
| 1.187              | a                               |
| 1.307              | a                               |
| V₃                 | abc                             |
| 1.174              | c                               |
| 1.184              | c                               |
| 1.211              | bc                              |
| 1.190              | a                               |

*Numbers with same letter means no significant on Duncan test at probability of 5%. 
*Numbers with same letter means no significant on Duncan test at probability of 5%.
variety Camarosa in the medium consisting of soil only, which recorded the lowest value of 1.059%. As for the dual interaction between media and distances, it is noted that the treatment of planting plants in the middle of peat moss with a distance of 15 cm between one plant and another is significantly superior to the other treatments with a percentage of 1.427%, while the lowest percentage is recorded at 1.126%, which in turn does not differ from the treatment of the interaction between the loamy soil and the distance D₁. Also for the treatment of dual interaction between cultivars and distances, we notice the superiority of Sweet Charlie when planted at a distance of 15 cm between one plant and another, significantly giving a percentage of 1.374% compared to the lowest percentage of 1.174% with the treatment V₃D₁. The triple interaction treatment between planting in the middle of peat moss and Sweet Charlie and the distance D₁ has significantly outperformed the rest of the other interaction treatments by recording a percentage of 1.550%, while the lowest percentage is recorded in the interaction treatment between the loamy soil and the Camarosa variety and the distance D₁ with 0.893%.

4. Conclusion

On the basis of present investigation, it is concluded that peat moss media is best media as compared to other medium taken under study for influencing the growth and yield of strawberry. Ruby gem and Sweet charlie are better than Camarosa in characteristics of growth and yield. The space is 25 is best spacing as compared to other spacing taken under study for influencing the growth and yield of strawberry

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