# *Results and Discussion*

# 4. RESULTS AND DISCUSSION

## 4.1- First experiment :

**Effect of pre-harvest foliar spray with some fungicides and bio-products on vegetative growth, fruit yield and its components as well as fruit quality and disease assessments for Chandler and Sweet Charlie cultivars of strawberry :**

### 4.1.1- Vegetative growth characteristics :

Data presented in Table (3) show the effect of pre-harvest foliar spray with some fungicides and bio-products on vegetative growth characteristics of Chandler and Sweet Charlie strawberry cultivars.

**a) Effect of cultivar :**

Data demonstrated in Table (3) reveal that there are significant differences between the tested cultivars in all studied vegetative growth aspects expressed as fresh weight per plant, average petiole length of leaf and dry weight per plant.

In this regard, cv. Chandler reflected the higher values for all the studied vegetative growth parameters during both seasons of study. Obtained results may be attributed to the variation in genetic potentiality between the studied cultivars. Significant differences in plant growth aspects between different strawberry cultivars were also recorded by **El-Miniawy (1991), Ragab (1991), Paraskevopoulou *et al.* (1995) and Abo El-Ela (2000)**. They reported that there were significant differences among the tested cultivars, *i.e.*, Chandler, Camarosa, Rosa Linda and Sweet Charlie in all studied growth parameter where planting took place as fresh planting system. In this respect, cv. Chandler recorded

Table (3) : Effect of spraying strawberry plants with some fungicides and bio-products on vegetative growth characteristics.

| Treatments | | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Fresh weight /plant (gm) | Dry weight /plant (gm) | Leaf petiole length (cm) | Fresh weight /plant (gm) | Dry weight /plant (gm) | Leaf petiole length (cm) |
| Chandler | | 68.72 | 14.28 | 4.92 | 70.20 | 14.86 | 6.26 |
| Sweet Charlie | | 62.90 | 12.48 | 4.34 | 65.30 | 12.96 | 5.50 |
| L.S.D. at 5 % | | 0.80 | 0.15 | 0.20 | 0.50 | 0.60 | 0.40 |
| Rovral | | 77.30 | 14.85 | 5.90 | 79.00 | 14.48 | 7.50 |
| Euparen | | 72.40 | 14.03 | 5.50 | 74.00 | 14.55 | 6.75 |
| Promote | | 68.8/5 | 13.50 | 4.30 | 71.00 | 13.88 | 5.75 |
| Plant-Guard | | 66.05 | 12.83 | 4.10 | 67.50 | 13.28 | 5.50 |
| Control | | 44.45 | 11.63 | 2.85 | 47.25 | 13.38 | 3.90 |
| L.S.D. at 5 % | | 1.00 | 0.30 | 0.20 | 1.00 | 0.60 | 0.10 |
| Chandler | Rovral | 80.50 | 16.20 | 6.10 | 82.00 | 16.50 | 7.70 |
| | Euparen | 75.50 | 15.15 | 6.00 | 77.00 | 15.60 | 7.00 |
| | Promote | 70.50 | 14.15 | 5.00 | 72.00 | 15.15 | 6.50 |
| | Plant-Guard | 68.60 | 13.50 | 4.50 | 70.00 | 13.95 | 6.00 |
| | Control | 48.50 | 12.00 | 3.00 | 50.00 | 12.75 | 4.10 |
| Sweet Charlie | Rovral | 74.10 | 13.50 | 5.70 | 76.00 | 13.95 | 7.30 |
| | Euparen | 69.30 | 13.05 | 5.00 | 71.00 | 13.50 | 6.50 |
| | Promote | 67.20 | 12.45 | 4.60 | 70.00 | 12.75 | 5.00 |
| | Plant-Guard | 63.50 | 12.15 | 3.70 | 65.00 | 12.60 | 5.00 |
| | Control | 40.40 | 11.25 | 2.70 | 44.50 | 12.00 | 3.70 |
| L.S.D. at 5 % | | 1.90 | 0.45 | 0.20 | 1.20 | 1.20 | 0.40 |

the highest values of fresh and dry weight per plant, followed by Sweet Charlie and other studied cultivars.

**b) Effect of fungicides and bio-products :**

Data in Table (3) clearly show that spraying strawberry plants with either fungicides or bio-products significantly increased all the studied growth aspects compared with the control treatment, during both seasons of study. In addition, the same data show that chemical fungicides were more effective in increasing the plant growth compared with the bio-products. Moreover, Rovral fungicide recorded the highest values in all determined growth parameter followed by Euparen and Promote, while Plant Guard recorded the lowest values compared with used fungicides and biocides. Such superiority of chemical fungicides may be due to the indirect effect to the presence of nitrogen element in their chemical structure and the direct effect through their preventing disease infection especially during the vegetative stage of growth earlier than those of bio-products. Furthermore, the activity and effect of bio-products may be affected by the prevailing environmental conditions. Obtained results concerning the increasing effect for fungicides and bio-products on vegetative growth are in agreement with those reported by **Gaafar *et al.* (1989)** on common bean, **El-Shami *et al.* (1993)** on tomato, **Ragab *et al.* (1996)** on asparagus, **Abd El-Megeed and Khafagi (1998)** on watermelon, **Liu *et al*. (1998)** on strawberry and **Mahmoud and El-Hefny (1999)** on onion.

**c) Effect of the interaction :**

Data presented in Table (3) illustrate the combined effect of fungicides and bio-products as well as strawberry cultivars on vegetative growth of the plant. Such data indicate that fresh weight per plant, average petiole leaf length and dry weight of plant are significantly affected due to the interactional effect between the studied control agents and strawberry cultivars. In this respect, the highest values for all the measured growth parameters were recorded in case of spraying the plant with Rovral followed by Euparen and Promote in both tested cultivars during the two seasons of study.

**4.1.2- Fruit yield and its components :**

Data in Table (4) show the effect of pre-harvest foliar spray with some fungicides and bio-products on total fruit yield and its components expressed as number and weight of fruits per plant, early and marketable yield per feddan as well as percentage of infected fruits for Chandler and Sweet Charlie strawberry cultivars.

**4.1.2.a- Effect of cultivar :**

Data in Table (4) show clearly that there were differences between the tested cultivars in all the studied yield parameters. In this regard, irrespective of early yield per feddan during the first season and total fruit yield during the second season of growth which were significantly affected, all the studied yield components, *i.e.*, number and weight of fruits per plant, early yield either per plant or per feddan, marketable and total fruit yield per feddan as well as the percentage of infected fruits were

**Table (4) : Effect of spraying strawberry plants with some fungicides and bio-products on fruit yield and its components.**

| Treatments | | 1999/2000 | | | | | | | 2000/2001 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. of fruits /plant | Early yield /plant (g) | Total yield /plant (g) | Early yield (ton/ fed.) | Total yield (ton/ fed.) | % of infec-tion * | Mark-table yield (t/fed.) | No.of fruits /plant | Early yield /plant (g) | Total yield /plant (g) | Early yield (ton/ fed.) | Total yield (ton/ fed.) | % of infec-tion * | Mark-table yield (t/fed.) |
| Chandler | | 74.06 | 102 | 367 | 2.512 | 7.893 | 13.34 | 6.840 | 67.42 | 103 | 379 | 2.820 | 8.747 | 11.86 | 7.710 |
| Sweet Charlie | | 116.94 | 148 | 477 | 3.152 | 10.548 | 15.68 | 8.894 | 108.58 | 150 | 480 | 3.508 | 11.070 | 14.84 | 9.427 |
| L.S.D. at 5 % | | 1.314 | 3.0 | 28.83 | 0.356 | 0.497 | 0.911 | 0.874 | 6.943 | 3.0 | 19.72 | 0.086 | 1.293 | 0.447 | 1.975 |
| Rovral | | 107.60 | 150.0 | 477.50 | 3.556 | 10.666 | 5.90 | 10.037 | 91.90 | 147.5 | 492.50 | 3.7333 | 11.519 | 5.15 | 10.926 |
| Euparen | | 96.25 | 135.0 | 457.50 | 3.259 | 10.666 | 8.10 | 9.802 | 90.60 | 142.5 | 467.50 | 3.556 | 10.963 | 6.75 | 10.223 |
| Promote | | 95.50 | 127.5 | 422.50 | 2.667 | 9.185 | 10.8/0 | 8.193 | 90.35 | 132.5 | 452.50 | 3.200 | 10.074 | 9.30 | 9.137 |
| Plant-Guard | | 94.80 | 122.5 | 447.50 | 2.667 | 9.067 | 12.85 | 7.902 | 86.45 | 125.0 | 410.00 | 3.082 | 9.719 | 10.95 | 8.655 |
| Control | | 83.35 | 90.0 | 305.00 | 2.015 | 6.519 | 34.90 | 4.244 | 80.70 | 97.5 | 325.00 | 2.252 | 7.170 | 34.60 | 4.689 |
| L.S.D. at 5 % | | 1.742 | 3.0 | 18.79 | 0.720 | 1.128 | 1.870 | 1.576 | 5.637 | 4.8 | 11.61 | 1.095 | 1.314 | 0.752 | 1.884 |
| Chandler | Rovral | 77.70 | 125 | 425 | 2.963 | 8.888 | 5.30 | 8.417 | 70.50 | 115 | 430 | 3.200 | 10.193 | 4.80 | 9.704 |
| | Euparen | 77.30 | 105 | 390 | 2.963 | 8.888 | 7.40 | 8.230 | 69.50 | 110 | 410 | 3.081 | 9.600 | 6.40 | 9.585 |
| | Promote | 75.00 | 100 | 375 | 2.370 | 8.296 | 9.90 | 7.475 | 70.70 | 105 | 410 | 2.844 | 8.770 | 8.20 | 8.305 |
| | Plant-Guard | 73.60 | 100 | 365 | 2.370 | 7.467 | 11.30 | 6.623 | 63.60 | 100 | 350 | 2.844 | 8.652 | 10.30 | 7.933 |
| | Control | 66.70 | 80 | 280 | 1.896 | 5.926 | 32.80 | 3.982 | 62.80 | 85 | 295 | 2.133 | 6.518 | 29.60 | 5.627 |
| Sweet Charlie | Rovral | 137.50 | 175 | 530 | 4.148 | 12.444 | 6.50 | 11.635 | 113.30 | 180 | 555 | 4.267 | 13.037 | 5.50 | 12.320 |
| | Euparen | 117.40 | 165 | 505 | 3.555 | 12.444 | 8.80 | 11.349 | 111.70 | 175 | 525 | 4.030 | 12.326 | 7.10 | 11.451 |
| | Promote | 115.20 | 155 | 450 | 2.963 | 10.074 | 11.40 | 9.131 | 110.00 | 160 | 495 | 3.555 | 11.378 | 10.40 | 10.195 |
| | Plant-Guard | 114.60 | 145 | 470 | 2.963 | 10.067 | 14.70 | 8.895 | 109.30 | 150 | 470 | 3.319 | 10.785 | 11.60 | 9.534 |
| | Control | 100.00 | 100 | 330 | 2.133 | 7.111 | 37.00 | 4.480 | 98.60 | 110 | 355 | 2.370 | 7.822 | 39.60 | 4.724 |
| L.S.D. at 5 % | | 2.463 | 8.0 | 26.58 | 1.018 | 1.595 | 2.644 | 2.229 | 7.972 | 8.0 | 16.42 | 1.548 | 1.858 | 1.063 | 2.440 |

* Loss of yield = total yield x percentage of infection
Marketable yield = total yield - loss yield

significantly differed between the studied cultivars during both seasons of study. In this connection, cv. Sweet Charlie recorded the higher values for all studied yield characteristics during both seasons of growth. Such superiority in early and total fruit yield either for plant or feddan in case of cv. Sweet Charlie compared with cv. Chandler was connected with the highest number of fruits produced per plant in case of cv. Sweet Charlie. Obtained results are in agreement with those reported by **Ragab (1985), El-Miniawy (1991), Hohne (1996), Chandler *et al.* (1997) and Abo El-Ela (2000)**, concerning the early yield per plant or feddan, and with those of **El-Baz *et al.* (1978), Agamia (1982), Okasha *et al.* (1985), Ragab (1985), Carter *et al.* (1988), Stahler *et al.* (1994), Chandler *et al.* (1997)** and **Abo El-Ela (2000)** regarding the total yield.

**4.1.2.b- Effect of fungicides and bio-products :**

Data presented in Table (4) show clearly that spraying strawberry plants either with fungicides, *i.e.*, Rovral at 2.5 g/L and Euparen at 1.0 g/L or bio- agents, *i.e.*, Promote at 4.0 g/L and Plant Guard at 2.5 ml/L during the flowering period increased the total produced yield and its components expressed as number and weight of fruits per plant, early yield per plant and per feddan as well as total and marketable yield per feddan compared with the unsprayed control treatment. On the other hand, such treatments decreased the percentage of infected fruits compared with the check one. Obtained results are true during both seasons of study. In addition, Rovral and Euparen scored the highest values for total yield and its components compared with Promote and Plant-Guard during the two seasons of growth.

Moreover, Plant-Guard exhibited the lowest values in all the studied yield parameters when compared to other spraying treatments. Such increments in total produced yield and its components due to spraying the plants with fungicides and bio-products are connected with the increase of the vegetative growth of strawberry plants (Table, 3), which might be, consequently, reflected on the productivity of plants. Obtained results agree with those reported by **Gaafar *et al.* (1989) and El-Mogy (2001)** on bean; **Khafagi *et al.* (1995)** on pea; **Ragab *et al.* (1996)** on asparagus; **Eid and Mahdy (1988) and Abd El-Megeed & Khafagi (1998)** on watermelon. In this respect, **Blacharski *et al.* (2001)** reported that weekly application of Captan and Thiram increased the marketable yield of strawberry plants under Florida condition. Moreover, **Abada *et al.* (2002)** found that application of bio-products *B. subtilis, P. fluorescence* and *T. harzianum* significantly increased the strawberry marketable fruit yield compared with the check treatment.

**4.1.2.c- Effect of the interaction :**

As for the interactional effect, it was obvious from the same data in Table (4) that spraying strawberry plants of both cvs. Chandler and Sweet Charlie with either fungicides or bio-products significantly affected total fruit yield and its components during both seasons of this study. In this concept, the highest values in all the studied yield parameters were obtained due to spraying the plants of strawberry cv. Sweet Charlie with either Rovral or Euparen compared with other studied treatments.

**4.1.3- Fruit quality :**

**4.1.3.1- Physical characteristic of fruits :**

Data presented in Table (5) show the effect of cultivar and spraying with fungicides or bio-products as well as their interaction on physical traits of fruits expressed as average fruit weight, length and diameter as well as fruit firmness.

**a- Effect of cultivar :**

Data in Table (5) reveal that, generally, there were significant differences between the studied cultivars in all determined physical characteristics of fruit, *i.e.*, average fruit weight, fruit diameter, fruit length and fruit firmness during both seasons of study. In this respect, cv. Chandler exhibited the higher values in all studied physical fruit aspects compared with cv. Sweet Charlie. Obtained results may be attributed to the genetic factors which control the morphological character of fruits. Higher number of fruits produced by Sweet Charlie plant (Table, 4) might significantly decrease the average fruit weight, length and diameter as well as fruit firmness. Variation in physical fruit characteristics were also reported by **Agamia (1982), Ragab (1985), Beech *et al.* (1988), El-Bassiouny (1992), Albergts *et al.* (1995), Smith *et al.* (1998) and Abo El-Ela (2000)** regarding average fruit weight, and **El-Bassiouny (1992), Chandler and Badiyata (1995) and Lieten (1996)** concerning average fruit length and diameter as well as **Bringhurst and Voth (1984), Ragab (1985), El-Bassiouny (1992), Stahler *et al.* (1994) and Abo El-Ela (2000)** on strawberry fruit firmness.

Table (5) : Effect of spraying strawberry plants with some fungicides and bio-products on fruit physical characteristics.

| Treatments | | 1999/2000 | | | | 2000/2001 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fruit diam. (cm) | Fruit length (cm) | Fruit solidity ($gm/cm^2$) | Fruit weight (g) | Fruit diam. (cm) | Fruit length (cm) | Fruit solidity ($gm/cm^2$) | Fruit weight (g) |
| Chandler | | 2.62 | 2.98 | 99.20 | 3.6 | 2.76 | 3.54 | 100.78 | 6.8 |
| Sweet Charlie | | 2.58 | 2.70 | 57.82 | 3.2 | 2.66 | 2.90 | 58.62 | 5.9 |
| L.S.D. at 5 % | | N.S. | 0.10 | 0.86 | 0.2 | 0.10 | 0.10 | 9.57 | 0.3 |
| Rovral | | 2.80 | 2.90 | 85.05 | 6.5 | 2.90 | 3.30 | 84.00 | 6.9 |
| Euparen | | 2.70 | 2.90 | 79.75 | 6.2 | 2.85 | 3.35 | 82.80 | 6.8 |
| Promote | | 2.60 | 2.85 | 73.70 | 5.9 | 2.75 | 3.30 | 79.70 | 6.4 |
| Plant-Guard | | 2.55 | 2.80 | 76.65 | 5.7 | 2.65 | 3.25 | 78.45 | 6.1 |
| Control | | 2.35 | 2.70 | 72.40 | 5.0 | 2.40 | 2.90 | 73.55 | 5.5 |
| L.S.D. at 5 % | | 0.20 | N.S. | 0.86 | 0.3 | 0.20 | 0.20 | 0.57 | 0.4 |
| Chandler | Rovral | 2.80 | 2.90 | 104.00 | 6.9 | 2.90 | 3.70 | 105.90 | 7.2 |
| | Euparen | 2.70 | 2.50 | 102.20 | 6.7 | 2.90 | 3.80 | 104.40 | 7.3 |
| | Promote | 2.60 | 2.90 | 100.10 | 6.3 | 2.80 | 3.70 | 100.30 | 6.9 |
| | Plant-Guard | 2.60 | 2.80 | 97.20 | 6.0 | 2.70 | 3.60 | 99.40 | 6.5 |
| | Control | 2.40 | 2.80 | 92.50 | 5.5 | 2.50 | 2.90 | 93.40 | 6.0 |
| Sweet Charlie | Rovral | 2.80 | 2.90 | 66.10 | 6.0 | 2.90 | 2.90 | 62.10 | 6.5 |
| | Euparen | 2.70 | 2.70 | 57.30 | 5.7 | 2.80 | 2.90 | 61.20 | 6.2 |
| | Promote | 2.60 | 2.80 | 57.30 | 5.5 | 2.70 | 2.90 | 58.66 | 5.9 |
| | Plant-Guard | 2.50 | 2.80 | 56.10 | 5.3 | 2.60 | 2.90 | 57.50 | 5.7 |
| | Control | 2.30 | 2.50 | 52.50 | 4.5 | 2.30 | 2.90 | 53.70 | 5.0 |
| L.S.D. at 5 % | | 0.30 | 0.20 | 2.10 | 0.4 | 0.10 | 0.30 | 1.03 | 0.7 |

**b- Effect of fungicides and bio-products :**

Data presented in Table (5) indicate that spraying strawberry plants with Rovral and Euparen as fungicides and Promote and Plant-Guard as a bio-product during flowering stage significantly affected all measured physical fruit quality, *i.e.*, average fruit weight, fruit length and diameter as well as fruit firmness during both seasons of growth compared with the control treatment. In this respect, Rovral and Euparen exhibited the highest values for all physical characters of fruits in comparison with the bio-products. Such improving effect on physical fruit quality was also obtained by **Holland *et al.* (1985) and Khafagi (2002)** on strawberry; **Eid and Mahdy (1988)** on watermelon and **Khafagi *et al.* (1995)** on pea.

**c- Effect of the interaction :**

It is obvious from the same data in Table (5) that application of either fungicides or bio-products significantly increased the studied physical characteristics of fruit for both Chandler and Sweet Charlie cultivars compared with the check treatment. In this regard, Rovral exhibited the highest values followed by Euparen and Promote, while Plant-Guard exhibited the lowest values during both seasons of growth.

**4.1.3.2- Chemical characteristics of fruits :**

Data shown in Table (6) indicate the effect of cultivar and spraying with fungicides or bio-products as well as their interaction on chemical constituents of fruits expressed as total soluble solids, total titratable acidity, ascorbic acid and total sugars contents during both seasons of study.

**Table (6) : Effect of spraying strawberry plants with some fungicides and bio-products on chemical components of fruits.**

| Treatments | | 1999/2000 | | | | 2000/2001 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total soluble solids (%) | Total acidity (%) | Ascorbid acid (V.C.) (mg/100 g F.W.) | Total sugars (%) | Total soluble solids (%) | Total acidity (%) | Ascorbid acid (V.C.) (mg/100 g F.W.) | Total sugars (%) |
| Chandler | | 6.02 | 0.80 | 38.60 | 2.94 | 6.66 | 0.85 | 41.40 | 3.02 |
| Sweet Charlie | | 10.82 | 0.96 | 50.18 | 3.70 | 10.26 | 0.82 | 51.50 | 3.80 |
| L.S.D. at 5 % | | 0.01 | 0.05 | 1.80 | 0.20 | 0.20 | 0.06 | 1.21 | 0.20 |
| Rovral | | 10.05 | 0.85 | 47.25 | 3.60 | 9.85 | 0.90 | 49.25 | 3.60 |
| Euparen | | 9.50 | 0.90 | 46.40 | 3.40 | 9.45 | 0.95 | 48.00 | 3.55 |
| Promote | | 8.40 | 0.91 | 44.70 | 3.35 | 8.75 | 1.00 | 46.65 | 3.40 |
| Plant-Guard | | 7.75 | 0.99 | 43.70 | 3.25 | 8.00 | 1.06 | 45.20 | 3.40 |
| Control | | 6.40 | 0.75 | 40.40 | 3.00 | 6.25 | 0.78 | 43.15 | 3.10 |
| L.S.D. at 5 % | | 0.04 | 0.06 | 2.70 | 0.30 | 0.20 | 0.12 | 2.12 | 0.30 |
| Chandler | Rovral | 7.50 | 0.80 | 41.50 | 3.20 | 8.10 | 0.90 | 44.00 | 3.20 |
| | Euparen | 7.00 | 0.81 | 40.30 | 3.00 | 7.60 | 0.89 | 42.50 | 3.10 |
| | Promote | 6.30 | 0.82 | 38.30 | 3.00 | 6.60 | 0.90 | 41.30 | 3.00 |
| | Plant-Guard | 5.50 | 0.89 | 37.30 | 2.90 | 6.50 | 0.92 | 40.00 | 3.00 |
| | Control | 3.80 | 0.70 | 35.86 | 2.60 | 4.50 | 0.65 | 39.00 | 2.80 |
| Sweet Charlie | Rovral | 12.60 | 0.89 | 53.00 | 4.00 | 11.60 | 0.90 | 54.50 | 4.00 |
| | Euparen | 12.00 | 0.99 | 52.50 | 3.80 | 11.30 | 1.00 | 53.50 | 4.00 |
| | Promote | 10.50 | 1.00 | 51.10 | 3.70 | 10.90 | 1.10 | 52.00 | 3.80 |
| | Plant-Guard | 10.00 | 1.10 | 50.10 | 3.60 | 9.50 | 1.20 | 50.40 | 3.80 |
| | Control | 9.00 | 0.80 | 44.20 | 3.40 | 8.00 | 0.90 | 47.30 | 3.40 |
| L.S.D. at 5 % | | 0.10 | 0.10 | 4.00 | 0.30 | 0.50 | 0.13 | 0.27 | 0.50 |

**a- Effect of cultivar :**

Data presented in Table (6) show clearly that there were significant differences between the studied cultivars in all determined chemical constituents of fruit during both seasons of study. In this regard, Sweet Charlie exhibited higher values for all determined chemical constituents of fruits than those of cv. Chandler. Such variation in chemical constituents of fruits between cultivars may be attributed to the differences in genetic and physiological factors that affect the content of such chemical constituents. Differences in total soluble solids, total titratable acidity and ascorbic acid as well as total sugars content of strawberry fruits were also reported by **Foda *et al.* (1977), Agamia (1982), Ragab (1985), El-Miniawy (1991), El-Bassiouny (1992), Moore *et al.* (1995) and Abo El-Ela (2000)** on total soluble solids, **Okasha *et al.* (1985), Ragab (1985), Chandler *et al.* (1997), El-Bassiouny (1992) and Abo El-Ela (2000)** on titratable acidity; **Bringhurst and Voth (1980), Agamia (1982), Kaack (1990), Wang *et al.* (1997)** on ascorbic acid and **El-Bassiouny (1992), Chandler and Badiyala (1996), Wang *et al.* (1997) and Abo El-Ela (2000)** on total sugars content.

**b- Effect of fungicides and bio-products :**

It is evident from data in Table (6) that spraying strawberry plant of cvs. Chandler and Sweet Charlie with either fungicides (Rovral and Euparen) or bio-products (Promote and Plant-Guard) significantly increased all estimated chemical constituents of fruits, *i.e.*, total soluble solids, total titratable acidity, ascorbic acid and total sugars content compared with

untreated plants (check) during the two seasons of growth. In this connection, fungicides compounds reflected the highest values in all estimated chemical constituents of fruits compared with the bio-products. Obtained results may be due to the chemical constituents of such fungicides (Table, 2) that might increase the vegetative growth of plant (Table, 3) and consequently might affect the net rate of photosynthetic assimilation which affects the accumulation of such chemical constituents in the produced fruits. Such increments in chemical constituents of fruits due to the application of fungicides and bio-products were also reported by **Youness (2002)** on strawberry, who pointed out that preharvest treatment of Promote at rates of 3, 5 and 10 g/L significantly increased the values of total solid percentage, total titratable acidity and ascorbic acid content of berries compared with untreated treatment. However, **Eid and Mahdy (1988)** on watermelon mentioned that there were no promotive effects for seed treatment with either fungicides or Promote (*T. harzianum*) on total soluble solids of fruits.

**c- Effect of the interaction :**

The same data in Table (6) reveal that spraying strawberry plants at flowering stage with either fungicides (Rovral and Euparen) or bio-products (Promote and Plant-Guard) increased all estimated chemical constituents of the fruit compared with the control treatment. In this respect, the highest values in total solids, total acidity, ascorbic acid and total sugars were obtained as a result of spraying Sweet Charlie plants with Rovral at a rate

of 1.0 g/L compared with other studied treatments. Such enhancing effect of Rovral on chemical constituents of fruits might be connected with its positive effect on vegetative growth (Table, 3) and consequently on chemical composition of different plant parts especially fruits.

## 4.2- Second experiment :

### Response of vegetative growth, fruit yield and its quality of cv. Sweet Charlie to number of pre-harvest foliar sprays with some fungicides and bio-products :

### 4.2.1- Vegetative growth characteristics :

Data presented in Tables (7 & 8) show the effect of spraying with fungicides and bio-products as well as number of sprayings and their interaction on vegetative growth aspects of strawberry plants cv. Sweet Charlie.

#### 4.2.1.1- Effect of fungicides and bio-products :

Data indicated in Table (7) reveal that spraying Sweet Charlie plants with either fungicides (Rovral at 1.0 g and Euparen at 2.5 g/L ) or bio-products (Promote at 4.0 g/L and Plant-Guard at 2.5 ml/L), significantly, affected all the studied growth traits expressed as fresh and dry weight per plant as well as average leaf petiole length compared with the untreated control plants. In addition, the used mineral fungicides were more effective on all the studied vegetative growth parameters compared with used bio-products. Moreover, Rovral exhibited the highest values in all measured growth aspects, while Plant-Guard reflected the lowest values. Such results were true during both seasons of study. In this respect, the enhancing effect of mineral fungicides compared with the used bio-control agents may be attributed to the quick effect of such fungicides on disease induced agents and consequently keep the plants healthy and vigorous. Obtained results are coincided with those reported by **Liu *et al.* (1998)** on strawberry, **Gaafar *et al.* (1989)** on bean, **El-Shami *et al.* (1993)** on tomatoes, **Ragab *et al.* (1991)** on asparagus, **Abdel-Megeed and Khafagi (1998)** on watermelon and **Mahmoud and El-Hefny (1999)** on onion plants.

**Table (7) : Effect of spraying strawberry plants cv. Sweet Charlie with some fungicides and bio-products as well as number of sprays on vegetative growth characteristics.**

| Treatments<br>Material / No. of sprays | 1999-2000 | | | 2000-2001 | | |
|---|---|---|---|---|---|---|
| | Plant fresh weight (g) | Leaf petiole length (cm) | Plant dry weight (g) | Plant fresh weight (g) | Leaf petiole length (cm) | Plant dry weight (g) |
| Rovral | 67.92 | 5.50 | 14.44 | 70.67 | 7.14 | 15.13 |
| Euparen | 64.50 | 5.20 | 13.95 | 66.33 | 6.44 | 14.60 |
| Promote | 62.17 | 4.57 | 13.21 | 65.63 | 5.96 | 14.14 |
| Plant-Guard | 59.42 | 4.15 | 13.00 | 61.70 | 5.65 | 13.58 |
| L.S.D. at 5 % | 1.35 | 0.23 | 0.41 | 0.65 | 0.31 | 0.41 |
| Spraying once | 40.50 | 3.39 | 13.05 | 44.50 | 4.26 | 13.73 |
| Spraying twice | 48.38 | 4.31 | 13.39 | 49.38 | 5.41 | 14.03 |
| Spraying 3 times | 69.13 | 5.11 | 13.39 | 70.13 | 6.63 | 14.68 |
| Spraying 4 times | 87.88 | 6.24 | 14.36 | 89.88 | 8.03 | 15.34 |
| Spraying 5 times | 95.13 | 7.09 | 15.11 | 98.13 | 9.35 | 15.68 |
| Control | 40.00 | 3.06 | 12.00 | 44.50 | 4.10 | 12.75 |
| L.S.D. at 5 % | 2.46 | 0.55 | 0.93 | 2.32 | 0.89 | 0.58 |

**4.2.1.2- Effect of spraying number :**

Data investigated at Table (7) indicate the effect of spraying number on vegetative growth of strawberry plants expressed as fresh and dry weight of plant as well as petiole length for leaf. Such data reveal that there were positive and significant increase in all the measured growth parameters with increasing number of sprays compared with the unsprayed treatment. In this regard, spraying the plants five times starting at flowering stage and at two week intervals reflected the highest values in all the studied growth characters during both seasons of growth. However, no significant differences among the treatments in which the plants were sprayed four times and those sprayed five times with fungicides or bio-products during the flowering stage of plant especially in dry matter content per plant. Such increase in case of repeating the spray up to four or five times may be due to the preventing of any disease causal organisms to infect the plant and consequently keeping the plants healthy during the productive stage.

Obtained results agree with those reported by **Liu *et al.* (1998)** on strawberry where they reported that spraying strawberry plants with fungicides once a week four times increased the weight of leaves.

**4.2.1.3- Effect of the interaction :**

Data in Table (8) indicate that there were significant differences in plant height, dry weight per plant and the leaf petiole length due to spraying the plants with fungicides and bio-products compared with the check treatment. In this regard,

**Table (8) : Effect of the interaction between used treatments on vegetative growth characteristics of strawberry Sweet Charlie cultivar.**

| Treatments | | 1999-2000 | | | 2000-2001 | | |
|---|---|---|---|---|---|---|---|
| Material | No. of sprays | Plant fresh weight (g) | Leaf petiole length (cm) | Plant dry weight (g) | Plant fresh weight (g) | Leaf petiole length (cm) | Plant dry weight (g) |
| Rovral | Once | 40.0 | 3.80 | 14.25 | 47.5 | 4.90 | 14.85 |
| | Twice | 55.0 | 5.13 | 14.55 | 56.5 | 6.20 | 15.30 |
| | 3-times | 75.5 | 5.86 | 14.85 | 76.5 | 7.93 | 15.45 |
| | 4-times | 90.5 | 6.32 | 15.00 | 92.0 | 8.44 | 16.05 |
| | 5-times | 104.5 | 9.01 | 15.75 | 106.5 | 11.16 | 16.35 |
| | Control | 42.0 | 3.10 | 12.25 | 45.0 | 4.20 | 12.80 |
| Euparen | Once | 44.5 | 3.42 | 13.50 | 45.0 | 4.50 | 13.95 |
| | Twice | 50.5 | 4.73 | 13.95 | 51.0 | 5.86 | 14.25 |
| | 3-times | 65.5 | 5.35 | 14.25 | 66.0 | 6.42 | 14.85 |
| | 4-times | 85.5 | 6.76 | 14.85 | 87.5 | 7.83 | 15.75 |
| | 5-times | 100.0 | 7.99 | 15.30 | 102.5 | 10.06 | 15.85 |
| | Control | 41.0 | 3.02 | 11.85 | 46.0 | 3.96 | 12.95 |
| Promote | Once | 39.5 | 3.23 | 12.00 | 43.5 | 3.36 | 13.20 |
| | Twice | 45.0 | 3.82 | 12.30 | 46.0 | 4.93 | 13.50 |
| | 3-times | 70.0 | 5.07 | 13.80 | 71.5 | 6.92 | 14.45 |
| | 4-times | 90.0 | 6.15 | 14.25 | 92.5 | 8.24 | 15.30 |
| | 5-times | 90.5 | 6.16 | 15.15 | 96.3 | 8.30 | 15.75 |
| | Control | 38.0 | 3.00 | 11.75 | 44.0 | 4.00 | 12.65 |
| Plant-Guard | Once | 38.0 | 3.10 | 12.45 | 42.0 | 4.26 | 12.90 |
| | Twice | 43.0 | 3.56 | 12.75 | 44.0 | 4.63 | 13.05 |
| | 3-times | 65.5 | 4.17 | 13.05 | 66.5 | 5.25 | 13.95 |
| | 4-times | 85.5 | 5.73 | 13.35 | 87.5 | 7.62 | 14.95 |
| | 5-times | 85.5 | 5.25 | 14.25 | 87.2 | 7.87 | 14.75 |
| | Control | 39.0 | 3.11 | 12.15 | 43.0 | 4.24 | 12.60 |
| L.S.D. at 5 % : | | 4.83 | 1.25 | 0.58 | 3.33 | 0.85 | 0.61 |

spraying the plants with either Rovral or Euparen five times during the reproductive stage reflected the highest values of plant growth parameters.

**4.2.2- Fruit yield and its components :**

Data in Tables (9 & 10) show the effect of foliar spray with fungicides and bio-products as well as number of sprayings and their interaction on total fruit yield and its components for cv. Sweet Charlie.

**a) Effect of fungicides and bio-products :**

Data presented in Table (9) indicate that spraying plants with fungicides, *i.e.*, Rovral and Euparen as well as bio-products (Promote and Plant-Guard) significantly affected the total produced yield and its components expressed as number and weight of fruits per plant, early yield per plant as well as the marketable yield per feddan. On the other hand, such treatments significantly reduced the weight percentage of infected fruits. Moreover, foliar spray with fungicides reflected higher increments in all studied yield parameters compared with the bio-products. In this respect, the impact of investigated spraying substance on the total and marketable yield of strawberry crop can be arranged in the following order : Rovral > Euparen > Promote > Plant Guard. Moreover, Rovral and Euparen led to an increase in marketable by 24.22, 14.22 and 14.31, 7.31 % for Rovral and Euparen over Promote during first and second season, respectively. Obtained results may be attributed to the effect of such fungicides on promoting the plant growth (Table, 7). Such results were true during both seasons of growth. Similar results were reported by **Blacharski *et al.* (2001), El-Mogy (2001) and Abada (2002)**, all working on strawberry. They found that using either fungicides or bio-products enhanced the total produced yield and its components.

## Table (9) : Effect of spraying fungicides and biocides on the yield components on cv. Sweet Charlie.

| Treatments | 1999-2000 | | | | | | | 2000/2001 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No.of fruits/ plant | Early yield/ plant (gm) | Yield/ plant fruit wt. (gm) | Total yield (ton/ fed.) | % Infec-ted fruits | Wt.of infec-ted fruits /fed. (tons) | Mark-table yield (ton/ fed.) | No.of fruits/ plant | Early yield/ plant (gm) | Yield/ plant fruit wt. (gm) | Total yield (ton/ fed.) | % Infec-ted fruits | Wt.of infec-ted fruits /fed. (tons) | Mark-table yield (ton/ fed.) |
| Rovral | 41.17 | 28.93 | 162.5 | 9.795 | 23.77 | 2.00 | 7.543 | 40.83 | 30.83 | 170.00 | 10.244 | 25.43 | 2.38 | 7.785 |
| Euparen | 40.33 | 26.07 | 153.3 | 8.996 | 24.32 | 2.10 | 6.936 | 40.67 | 29.38 | 161.17 | 9.722 | 26.20 | 2.42 | 7.305 |
| Promote | 40.79 | 22.83 | 145.0 | 8.250 | 26.65 | 2.20 | 6.072 | 40.50 | 24.30 | 152.50 | 9.077 | 26.43 | 2.55 | 6.810 |
| Plant Guard | 38.83 | 21.52 | 140.0 | 7.858 | 27.73 | 2.35 | 5.872 | 39.33 | 23.97 | 125.00 | 8.665 | 28.93 | 3.02 | 6.206 |
| **L.S.D. at 5 %** | 0.91 | 0.73 | 8.10 | 0.386 | 0.46 | 0.08 | 0.464 | 0.23 | 0.86 | 11.13 | 0.381 | 1.63 | 0.13 | 0.432 |
| One spray | 36.75 | 19.75 | 122.50 | 6.020 | 31.93 | 2.65 | 4.794 | 37.25 | 22.05 | 128.75 | 7.635 | 27.92 | 2.28 | 5.507 |
| Two sprays | 38.75 | 22.83 | 136.25 | 7.816 | 26.15 | 2.28 | 5.803 | 41.00 | 23.55 | 148.75 | 8.218 | 27.32 | 2.35 | 5.975 |
| Three sprays | 42.50 | 26.20 | 157.50 | 9.043 | 23.30 | 2.23 | 6.913 | 43.25 | 28.12 | 165.00 | 9.522 | 23.20 | 2.38 | 7.301 |
| Four sprays | 43.75 | 30.28 | 187.50 | 10.389 | 21.20 | 2.08 | 8.229 | 43.50 | 31.75 | 188.75 | 11.430 | 23.55 | 2.65 | 8.762 |
| Five sprays | 44.50 | 34.68 | 198.95 | 11.915 | 18.33 | 1.98 | 9.824 | 43.00 | 39.45 | 206.25 | 13.130 | 20.60 | 2.78 | 10.462 |
| Control | 33.00 | 15.30 | 100.00 | 6.030 | 33.30 | 2.00 | 4.010 | 34.00 | 17.80 | 110.00 | 6.610 | 37.90 | 2.50 | 4.111 |
| **L.S.D. at 5 %** | 1.85 | 2.13 | 16.31 | 0.562 | 1.33 | 0.02 | 0.634 | 0.93 | 2.01 | 15.37 | 0.568 | 2.36 | 0.51 | 0.612 |

* Increase in marketable yield relative to control (%).

**b) Effect of number of sprays :**

Data in Table (9) show clearly that number and weight of fruits per plant, total yield per feddan as well as marketable fruit yield were affected with increasing the number of sprays up to the fifth one compared with the unsprayed treatment. In addition, a significant difference was noticed among using fungicides and bio-products at four and five times during the flowering periods. On the contrary, increasing number of sprays significantly reduced weight and percentage of infected fruits during both seasons of growth. Such results were true during both seasons of study. Obtained results are in agreement with those found by **Liu *et al.* (1998)** on strawberry, they reported that spraying strawberry plants with fungicides once a week four times increased fruits weight.

**c) Effect of the interaction :**

Data presented in Table (10) show clearly that spraying strawberry plants either with fungicides or bio-products four or five times significantly increased the total fruit yield and its components during both seasons of study. Moreover, using Rovral four or five times during the flowering stage exhibited the highest values in all the studied yield parameters compared with the other used treatments and the control one. The enhancing effect of Rovral on total fruit yield as well as marketable yield may be due to the effect of such fungicide on vegetative growth (Tables 7 & 8) and the average fruit weight and number of fruits per plant (Tables 9 & 10).

**Table (10) : Effect of the interaction between used treatments on yield components of strawberry cv. Sweet Charlie.**

| Treatments | | 1999-2000 | | | | | | | 2000-2001 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material | No. of sprays | Plant fruit wt. (gm) | No. of fruits/ plant | Early yield/ plant (gm) | Total yield (ton/ fed.) | % Infe-cted fruits | Wt.of infe-cted fruits (ton/ fed.) | Mark-etable yield (ton/ fed.) | Plant fruit wt. (gm) | No. of fruits/ plant | Early yield/ plant (gm) | Total yield (ton/ fed.) | % Infe-cted fruits | Wt.of infe-cted fruits (ton/ fed.) | Mark-etable yield (ton/ fed.) |
| Rovral | Once | 130 | 37 | 23.0 | 7.714 | 29.9 | 2.3 | 5.415 | 140 | 37 | 24.7 | 8.303 | 27.7 | 2.1 | 6.017 |
| | Twice | 150 | 41 | 24.9 | 8.514 | 27.1 | 2.1 | 6.225 | 165 | 40 | 26.6 | 8.912 | 23.6 | 2.3 | 6.819 |
| | 3 times | 175 | 45 | 29.8 | 10.010 | 20.0 | 2.1 | 8.019 | 180 | 44 | 31.3 | 10.321 | 22.3 | 2.3 | 8.020 |
| | 4 times | 200 | 44 | 35.7 | 11.612 | 18.1 | 1.9 | 9.519 | 195 | 45 | 39.1 | 12.509 | 20.8 | 2.6 | 9.715 |
| | 5 times | 215 | 45 | 42.9 | 14.020 | 14.3 | 1.8 | 12.019 | 220 | 43 | 44.2 | 14.609 | 18.5 | 2.7 | 11.922 |
| | Cont. | 105 | 35 | 17.3 | 6.361 | 33.2 | 1.8 | 4.058 | 120 | 36 | 19.1 | 6.810 | 39.7 | 2.3 | 4.218 |
| Euparen | Once | 125 | 37 | 17.90 | 7.040 | 28.6 | 2.8 | 5.020 | 130 | 39 | 22.8 | 7.912 | 26.6 | 2.3 | 5.821 |
| | Twice | 140 | 38 | 25.7 | 8.119 | 22.6 | 2.3 | 6.330 | 150 | 43 | 24.9 | 8.421 | 26.2 | 2.3 | 6.206 |
| | 3 times | 160 | 41 | 27.5 | 9.330 | 22.2 | 2.2 | 7.215 | 175 | 44 | 29.7 | 9.631 | 24.0 | 2.4 | 7.305 |
| | 4 times | 195 | 43 | 32.4 | 10.610 | 21.7 | 2.1 | 8.335 | 200 | 42 | 35.5 | 11.520 | 23.5 | 2.5 | 8.815 |
| | 5 times | 200 | 44 | 37.9 | 12.815 | 17.2 | 1.8 | 10.610 | 215 | 43 | 45.4 | 14.315 | 19.6 | 2.6 | 11.517 |
| | Cont. | 100 | 34 | 15.0 | 6.060 | 33.6 | 1.9 | 4.105 | 115 | 33 | 18.0 | 6.531 | 37.3 | 2.4 | 4.165 |
| Promote | Once | 120 | 37 | 19.5 | 6.815 | 35.4 | 2.9 | 4.517 | 125 | 37 | 20.8 | 7.320 | 27.4 | 2.3 | 5.312 |
| | Twice | 130 | 39 | 20.9 | 7.519 | 25.6 | 2.3 | 5.327 | 145 | 41 | 21.9 | 8.019 | 28.8 | 2.4 | 5.715 |
| | 3 times | 150 | 42 | 24.5 | 8.618 | 25.4 | 2.3 | 6.425 | 155 | 41 | 26.5 | 9.305 | 22.6 | 2.4 | 7.210 |
| | 4 times | 180 | 45 | 27.3 | 9.919 | 20.8 | 2.0 | 7.532 | 185 | 44 | 23.2 | 11.209 | 22.3 | 2.7 | 8.719 |
| | 5 times | 195 | 44 | 30.0 | 10.713 | 20.2 | 2.0 | 8.632 | 200 | 43 | 36.1 | 12.204 | 19.7 | 2.9 | 9.810 |
| | Cont. | 95 | 33 | 14.8 | 5.916 | 32.5 | 2.1 | 4.000 | 105 | 34 | 17.3 | 6.406 | 37.8 | 2.6 | 4.096 |
| Plant-Guard | Once | 115 | 36 | 18.6 | 6.510 | 23.8 | 2.6 | 4.225 | 120 | 36 | 19.9 | 7.020 | 30.0 | 2.4 | 4.910 |
| | Twice | 125 | 37 | 19.8 | 7.111 | 29.3 | 2.4 | 5.331 | 135 | 40 | 20.8 | 7.521 | 30.7 | 2.4 | 5.212 |
| | 3 times | 145 | 42 | 23.0 | 8.214 | 25.6 | 2.3 | 6.111 | 150 | 41 | 25.0 | 8.831 | 23.9 | 2.5 | 6.713 |
| | 4 times | 175 | 43 | 25.7 | 9.416 | 24.2 | 2.3 | 7.530 | 175 | 43 | 29.2 | 10.501 | 27.6 | 2.8 | 7.820 |
| | 5 times | 185 | 45 | 27.9 | 10.112 | 19.6 | 2.3 | 8.035 | 190 | 43 | 32.1 | 11.421 | 24.6 | 2.7 | 8.618 |
| | Cont. | 95 | 30 | 14.1 | 5.873 | 33.9 | 2.2 | 3.997 | 100 | 33 | 16.8 | 6.693 | 36.8 | 2.7 | 3.965 |
| L.S.D. 1t 5 % | | 5.67 | 0.63 | 1.6 | 0.67 | 1.8 | 0.53 | 0.508 | 3.99 | 0.41 | 1.9 | 3.45 | 1.9 | 0.72 | 0.485 |

**4.2.3- Fruit quality :**

**4.2.3.1- Physical characteristics of fruit :**

Data presented in Tables (11 & 12) show the effect of fungicides and bioagents as well as number of sprayings and their interaction on physical quality of strawberry fruits cv. Sweet Charlie.

**a- Effect of fungicides and bio-products :**

Data in Table (11) show clearly that there were significant differences in the average fruit weight, length and diameter as well as fruit firmness due to spraying the plants with mineral fungicides (Rovral at 1.0 g and Euparen at 2.5 g/L) and bio-products (Promote at 4.0 g and Plant-Guard at 2.5 ml/L). In this respect, mineral fungicides were superior compared with bio-products during both seasons of study. In addition, Rovral at 1.0 g/L reflected the highest values in all estimated physical fruit traits, while Plant-Guard reflected the lowest values. Similar results were reported by **Eid and Mahdy (1988)** on watermelon, **Khafagi *et al.* (1995)** on pea.

**b- Effect of spraying number :**

The same data in Table (11) indicate that fruit weight, length and diameter as well as fruit firmness were significantly affected with increasing number of sprayings up to the fifth one. Morever, significant differences can be noticed between the fourth and the fifth sprays during both seasons of growth. Such increment effect of increasing number of sprays on physical fruit characteristics may be connected with it positive effect on plant growth, (Table, 9).

Table (11) : **Effect of the interaction between used treatments on fruit physical properties of strawberry cv. Sweet Charlie.**

| Treatments<br>Material / No.of sprays | 1999-2000 | | | | 2000-2001 | | | |
|---|---|---|---|---|---|---|---|---|
| | Fruit wt. (g) | Fruit firm-ness (gm/ cm²) | Fruit diam-eter (cm) | Fruit length (cm) | Fruit wt. (g) | Fruit firm-ness (gm/ cm²) | Fruit diam-eter (cm) | Fruit length (cm) |
| Rovral | 3.93 | 63.3 | 2.74 | 3.00 | 4.08 | 61.0 | 2.82 | 2.95 |
| Euparen | 3.78 | 58.1 | 2.65 | 2.98 | 3.98 | 59.9 | 2.73 | 2.93 |
| Promote | 3.65 | 55.8 | 2.56 | 2.96 | 3.78 | 59.3 | 2.68 | 2.92 |
| Plant-Guard | 3.48 | 55.3 | 2.50 | 2.93 | 3.65 | 56.9 | 2.56 | 2.90 |
| L.S.D. at 5 % | 0.28 | 1.10 | 0.08 | 0.03 | 0.15 | 0.40 | 0.09 | 0.02 |
| One spray | 3.33 | 54.9 | 2.43 | 2.94 | 3.45 | 57.8 | 2.53 | 2.89 |
| Two sprays | 3.53 | 55.8 | 2.58 | 2.95 | 3.60 | 58.0 | 2.68 | 2.90 |
| Three sprays | 3.70 | 57.1 | 2.67 | 2.98 | 3.90 | 58.6 | 2.75 | 2.94 |
| Four sprays | 4.28 | 61.4 | 2.81 | 3.01 | 4.33 | 63.5 | 2.90 | 2.97 |
| Five sprays | 4.45 | 67.4 | 2.90 | 3.02 | 4.78 | 64.0 | 2.98 | 2.99 |
| Control | 3.00 | 52.3 | 2.30 | 2.90 | 3.20 | 53.7 | 2.35 | 2.85 |
| L.S.D. at 5 % | 0.62 | 0.81 | 0.07 | 0.01 | 0.56 | 0.6 | 0.07 | 0.01 |

**c- Effect of the interaction :**

Data shown in Table (12) reveal that all the studied physical fruit characteristics expressed as average fruit weight, length, diameter and fruit firmness were positively affected due to the interaction between foliar spray treatments either with fungicides or bio-products and the number of applications. In this regard, the highest values in all measured physical fruit aspects were obtained in case of spraying the plants with Rovral or Euparen five times during the flowering period in both season of study.

**4.2.3.2- Chemical fruit characteristics :**

Data presented in Tables (13 & 14) show the effect of foliar spray with Rovral at 1.0 g, Euparen at 2.5 g/L, Promote at 4.0 g and Plant-Guard at 2.5 ml/L as well as the number of sprays as well as their interaction on chemical characteristics of fruits expressed as total soluble solids, total titratable acidity, total sugars and vitamin "C" content during both seasons of growth.

**a- Effect of fungicides and bio-products :**

Data in Table (13) indicate that spraying plants with fungicides, *i.e.,* Rovral at 1.0 g and Euparen at 2.5 g/L and bio-products, *i.e.,* Promote at 4.0 g and Plant-Guard at 2.5 ml/L, significantly affected all the assayed chemical constituents (T.S.S., T.A., T.S. and V.C.) during both seasons of study. In addition, such increment did not reach the level of significance in case of total titratable acidity during the first season only. Moreover, the highest values were connected with the use of Rovral and Euparen fungicides. On the other hand, the lowest

**Table (12) : Effect of interaction between used treatments on fruit physical properties of strawberry cv. Sweet Charlie.**

| Treatments | | 1999-2000 | | | | 2000-2001 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No.of spray | Fruit weight (g) | Fruit firm. (gm/ cm²) | Fruit diam. (cm) | Fruit length (cm) | Fruit weight (g) | Fruit firm. (gm/ cm²) | Fruit diam. (cm) | Fruit length (cm) |
| Rovral | Once | 3.5 | 55.7 | 2.50 | 2.95 | 3.6 | 56.8 | 2.60 | 2.90 |
| | Twice | 3.7 | 57.3 | 2.65 | 2.98 | 3.8 | 59.4 | 2.75 | 2.92 |
| | Thrice | 3.9 | 59.4 | 2.80 | 3.00 | 4.1 | 60.5 | 2.90 | 2.97 |
| | Fourth | 4.5 | 65.6 | 2.95 | 3.05 | 4.6 | 67.2 | 3.05 | 3.00 |
| | Fifth | 4.8 | 88.7 | 3.15 | 3.07 | 5.1 | 67.8 | 3.15 | 3.02 |
| | Cont. | 3.2 | 52.9 | 2.41 | 2.94 | 3.3 | 54.1 | 2.45 | 2.90 |
| Euparen | Once | 3.4 | 55.6 | 2.45 | 2.94 | 3.5 | 56.6 | 2.55 | 2.89 |
| | Twice | 3.6 | 56.5 | 2.60 | 2.96 | 3.7 | 58.5 | 2.70 | 2.90 |
| | Thrice | 3.8 | 57.2 | 2.65 | 2.99 | 4.0 | 59.3 | 2.75 | 2.95 |
| | Fourth | 4.3 | 63.1 | 2.90 | 3.01 | 4.4 | 65.4 | 2.95 | 2.98 |
| | Fifth | 4.5 | 63.4 | 2.95 | 3.02 | 5.0 | 65.8 | 3.05 | 3.00 |
| | Cont. | 3.1 | 52.5 | 2.36 | 2.93 | 3.3 | 53.9 | 2.40 | 2.86 |
| Promote | Once | 3.3 | 59.0 | 2.40 | 2.93 | 3.4 | 65.4 | 2.50 | 2.88 |
| | Twice | 3.5 | 55.3 | 2.55 | 2.94 | 3.5 | 56.5 | 2.65 | 2.89 |
| | Thrice | 3.6 | 56.4 | 2.60 | 2.97 | 3.8 | 58.3 | 2.70 | 2.93 |
| | Fourth | 4.2 | 58.6 | 2.75 | 2.99 | 4.2 | 61.2 | 2.90 | 2.97 |
| | Fifth | 4.3 | 58.6 | 2.80 | 3.00 | 4.6 | 61.7 | 2.95 | 2.99 |
| | Cont. | 3.0 | 52.1 | 2.25 | 2.90 | 3.2 | 53.8 | 2.35 | 2.83 |
| Plant-Guard | Once | 3.1 | 53.9 | 2.35 | 2.92 | 3.3 | 59.5 | 2.45 | 2.87 |
| | Twice | 3.3 | 54.1 | 2.50 | 2.93 | 3.4 | 56.6 | 2.60 | 2.88 |
| | Thrice | 3.5 | 55.2 | 2.60 | 2.95 | 3.7 | 56.4 | 2.65 | 2.91 |
| | Fourth | 4.1 | 58.3 | 2.65 | 2.97 | 4.1 | 60.3 | 2.70 | 2.94 |
| | Fifth | 4.2 | 58.7 | 2.70 | 2.99 | 4.4 | 60.8 | 2.75 | 2.96 |
| | Cont. | 2.7 | 51.7 | 2.18 | 2.83 | 3.0 | 53.0 | 2.20 | 2.81 |
| L.S.D. at 5% | | 0.81 | 1.33 | 0.57 | 0.52 | 0.63 | 0.41 | 0.71 | 0.18 |

**Table (13) : Effect of spraying strawberry plants with some fungicides and bio-products as well as number of spraying on fruit nutritional value.**

| Treatments<br>Material / No. of sprays | 1999-2000 | | | | 2000-2001 | | | |
|---|---|---|---|---|---|---|---|---|
| | T.S.S. % | T.A. % | T.S. % | V.C. mg/100 gm | T.S.S. % | T.A. % | T.S. % | V.C. mg/100 gm |
| Rovral | 11.00 | 1.05 | 3.89 | 40.67 | 12.03 | 1.18 | 3.95 | 42.28 |
| Euparen | 10.77 | 0.98 | 3.80 | 39.15 | 11.45 | 1.13 | 3.88 | 41.37 |
| Promote | 10.38 | 0.92 | 3.67 | 37.68 | 10.30 | 1.05 | 3.79 | 39.85 |
| Plant-Guard | 9.20 | 0.85 | 3.59 | 36.98 | 9.80 | 0.98 | 3.67 | 38.55 |
| L.S.D. at 5 % | 0.46 | 0.02 | 0.21 | 0.81 | 0.43 | 0.16 | 3.45 | 37.50 |
| One spray | 10.10 | 0.86 | 3.93 | 37.63 | 10.33 | 1.00 | 3.73 | 40.00 |
| Two spray | 10.40 | 0.89 | 3.72 | 38.70 | 10.90 | 1.05 | 3.80 | 40.58 |
| Three sprays | 10.83 | 0.95 | 3.81 | 39.15 | 11.43 | 1.09 | 3.91 | 41.00 |
| Four sprays | 11.15 | 1.05 | 3.86 | 39.75 | 11.65 | 1.19 | 3.98 | 41.75 |
| Five sprays | 11.55 | 1.15 | 3.92 | 39.96 | 12.03 | 1.44 | 4.05 | 42.25 |
| Control | 8.00 | 0.80 | 3.40 | 36.60 | 9.00 | 0.95 | 3.45 | 37.50 |
| L.S.D. at 5 % | 0.30 | 0.15 | 0.13 | 0.83 | 0.38 | 0.16 | 0.07 | 0.76 |

values were obtained in case of using the Plant-Guard bio-agent. Obtained results are in agreement with those reported by **Eid and Mahdy (1988)** on watermelon regarding T.S.S. and **Youness (2002)** on strawberry concerning T.S.S., T.A., T.S. and vitamin "C" content.

**b- Effect of spraying number :**

Data in Table (13) pointed out that all the assayed chemical fruit constituents were steadily and continuously increased with increasing number of sprays from one up to five during both seasons of growth. However, no significant differences were noticed among using fungicides and bio-products four or five times in most chemical fruit constituents.

**c- Effect of the interaction :**

Data in Table (14) show clearly that the total soluble solids, total titratable acidity, total sugars and vitamin "C" contents were significantly affected due to the interaction during both seasons of study. In this respect, the highest values were obtained as a result of spraying plants with Rovral
or Euparen five times during the flowering period. However, Plant-Guard exhibited the lowest values in all studied chemical fruit constituents, but these values were higher than those of check treatment.

**Table (14) : Effect of the interaction between used treatments on T.S.S., T.A., T.S. and V.C. of strawberry cv. Sweet Charlie.**

| Treatments Material | No.of sprays | 1999-2000 T.S.S. % | T.A. % | T.S. % | V.C. (mg/100 gm) | 2000-2001 T.S.S. % | T.A. % | T.S. % | V.C. (mg/100 gm) |
|---|---|---|---|---|---|---|---|---|---|
| Rovral | Once | 11.1 | 0.90 | 3.95 | 39.50 | 11.7 | 1.10 | 3.80 | 42.00 |
| | Twice | 11.12 | 0.95 | 3.80 | 41.00 | 12.3 | 1.15 | 3.90 | 42.60 |
| | 3 times | 11.3 | 1.05 | 3.95 | 41.70 | 12.7 | 1.20 | 4.00 | 43.00 |
| | 4 times | 11.7 | 1.20 | 4.00 | 42.00 | 12.9 | 1.25 | 4.10 | 43.50 |
| | 5 times | 12.5 | 0.89 | 4.10 | 42.30 | 13.2 | 1.30 | 4.15 | 44.00 |
| | Cont. | 8.3 | 1.30 | 3.55 | 37.50 | 9.4 | 1.05 | 3.75 | 38.60 |
| Euparen | Once | 10.5 | 0.88 | 3.70 | 38.00 | 10.7 | 1.00 | 3.75 | 41.00 |
| | Twice | 11.0 | 0.90 | 3.75 | 39.30 | 11.8 | 1.05 | 3.85 | 41.60 |
| | 3 times | 11.4 | 1.00 | 3.90 | 39.50 | 12.1 | 1.10 | 3.95 | 42.00 |
| | 4 times | 11.7 | 1.10 | 3.95 | 40.00 | 12.3 | 1.30 | 4.00 | 42.50 |
| | 5 times | 11.9 | 1.15 | 4.00 | 41.10 | 12.6 | 1.35 | 4.10 | 43.00 |
| | Cont. | 8.1 | 0.85 | 3.50 | 37.00 | 9.2 | 1.00 | 3.60 | 38.10 |
| Promote | Once | 10.0 | 0.83 | 3.65 | 37.00 | 9.6 | 0.95 | 3.70 | 39.00 |
| | Twice | 10.5 | 0.86 | 3.68 | 37.50 | 9.8 | 1.00 | 3.75 | 39.60 |
| | 3 times | 11.0 | 0.90 | 3.70 | 38.10 | 10.8 | 1.05 | 3.85 | 40.00 |
| | 4 times | 11.3 | 1.00 | 3.75 | 39.00 | 10.9 | 1.10 | 3.95 | 41.50 |
| | 5 times | 11.5 | 1.10 | 3.80 | 37.70 | 11.5 | 1.25 | 4.00 | 42.00 |
| | Cont. | 8.0 | 0.81 | 3.45 | 36.80 | 9.0 | 0.95 | 3.50 | 37.00 |
| Plant-Guard | Once | 8.8 | 0.81 | 3.60 | 36.00 | 9.3 | 0.93 | 3.65 | 38.00 |
| | Twice | 9.0 | 0.83 | 3.63 | 37.00 | 9.7 | 0.99 | 3.70 | 38.50 |
| | 3 times | 9.6 | 0.86 | 3.68 | 37.30 | 10.1 | 1.00 | 3.85 | 39.00 |
| | 4 times | 9.9 | 0.89 | 3.73 | 38.00 | 10.5 | 1.05 | 3.90 | 39.50 |
| | 5 times | 10.3 | 1.05 | 3.78 | 38.50 | 10.8 | 1.10 | 3.95 | 40.00 |
| | Cont. | 7.6 | 0.65 | 3.10 | 35.10 | 8.4 | 0.80 | 2.95 | 36.30 |
| L.S.D. at 5 % | | 1.73 | 0.31 | 0.68 | 2.94 | 1.61 | 0.18 | 0.37 | 1.90 |

## 4.3- Third experiment :

**Effect of pre-harvest spray with some fungicides and bio-products on the storageability of two strawberry cultivars :**

### 4.3.1- Weight loss and decay percentage :

Data presented in Tables (15-21) show the effect of pre-harvest foliar spray of Chandler and Sweet Charlie strawberry plants with some fungicides and bio-products and their interaction on weight loss and decay percentage of fruits, during storage.

Concerning the effect of cultivar, data in Table (15) show that there were significant differences between the studied cultivars in weight loss and decay percentages of fruits during the storage period. In this respect, the lowest values for weight loss and decay percentages of fruits after 3, 6 and 9 days of storage were obtained in case of Chandler fruits during both seasons of study. After 9 days in storage, the total loss in weight of Chandler reached 55.9 % and 44.3 %, while that of Sweet Charlie was 60.5 % and 51.0 % during both seasons of study, respectively. In addition, the same data also show that the highest percentages of accepted fruit for marketing at the end of holding period was obtained in case of Chandler fruits. Obtained results might be due to hereditary differences between the two tested cultivars. Obtained results agree with those reported by **El-Bassiouny (1992)** on strawberry, **El-Sheikh *et al*, (1993)** and **Abdel-Rahman *et al.* (1994)** all working on eggplant, **Youssef *et al.* (1999)** on sweet pepper and **El-Sheikh and El-Doweny (1997)** on cucumber.

**Table (15) : Effect of two strawberry cultivars on percent of loss in weight and decay during storage.**

| Cultivars | 1999/2000 | | | | | | 2000/2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days in storage : | | | | | | | | | | | |
| | 3 days | | 6 days | | 9 days | | 3 days | | 6 days | | 9 days | |
| | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. |
| Chandler | 10.14 | 8.1 | 21.6 | 11.1 | 33.4 | 22.5 | 7.9 | 5.7 | 14.5 | 9.5 | 30.0 | 14.33 |
| Sweet Charlie | 11.2 | 11.4 | 22.3 | 13.2 | 36.3 | 24.2 | 10.2 | 8.2 | 23.6 | 12.0 | 33.8 | 17.2 |
| L.S.D. at 5 % : | 0.30 | 1.1 | 1.5 | 0.4 | 1.6 | 0.7 | 0.5 | 0.4 | 0.6 | 0.5 | 0.7 | 0.7 |

**Table (16) : Effect of some fungicides and biocides on decay and weight loss percentages of two straberry cultivars during storage.**

| Treatments | 1999/2000 | | | | | | 2000/2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days in storage : | | | | | | | | | | | |
| | 3 days | | 6 days | | 9 days | | 3 days | | 6 days | | 9 days | |
| | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. |
| **Rovral** | 8.8 | 7.1 | 18.1 | 9.2 | 31.3 | 20.8 | 7.0 | 5.2 | 17.2 | 7.6 | 29.7 | 12.9 |
| **Euparen** | 9.4 | 6.8 | 19.3 | 9.5 | 32.2 | 20.9 | 8.1 | 6.2 | 17.2 | 8.7 | 30.5 | 13.6 |
| **Promote** | 9.7 | 8.5 | 21.2 | 10.9 | 32.9 | 22.0 | 8.7 | 6.4 | 17.6 | 9.3 | 30.6 | 15.1 |
| **Plant Guard** | 10.3 | 8.8 | 25.0 | 19.6 | 33.4 | 22.5 | 9.0 | 7.5 | 18.9 | 10.8 | 32.4 | 15.8 |
| **Control** | 15.2 | 12.5 | 26.2 | 11.7 | 43.6 | 30.2 | 12.0 | 9.0 | 23.8 | 17.7 | 36.2 | 21.4 |
| **L.S.D. at 5 % :** | 0.2 | 0.7 | 1.0 | 0.3 | 1.0 | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.4 |

**Table (17) : Effect of storage temperatures on weight loss and decay percentages of fruits of two straberry cultivars during storage.**

| Temperature (°C) | 1999/2000 | | | | | | 2000/2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days in storage : | | | | | | | | | | | |
| | 3 days | | 6 days | | 9 days | | 3 days | | 6 days | | 9 days | |
| | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. |
| 0°C | 9.6 | 7.5 | 17.1 | 10.9 | 31.4 | 22.2 | 8.5 | 6.4 | 17.5 | 10.3 | 31.7 | 14.8 |
| 5°C | 11.7 | 10.1 | 26.8 | 13.4 | 38.3 | 23.3 | 9.5 | 7.4 | 20.3 | 11.3 | 34.0 | 16.7 |
| L.S.D. at 5 % : | 0.2 | 0.8 | 1.1 | 0.3 | 1.2 | 0.5 | 0.4 | 0.3 | 0.5 | 0.4 | 0.6 | 0.4 |

**Table (18) : Interaction of strawberry cultivars within storage temperature on weight loss and decay percentages during storage.**

| Cultivars | Temp. (°C) | 1999/2000 | | | | | | 2000/2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Days in storage : | | | | | | | | | | | |
| | | 3 days | | 6 days | | 9 days | | 3 days | | 6 days | | 9 days | |
| | | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. |
| Chandler | 0°C | 9.1 | 6.9 | 16.1 | 10.2 | 29.9 | 21.3 | 7.5 | 5.0 | 12.9 | 9.1 | 28.7 | 13.1 |
| | 5°C | 11.2 | 9.5 | 27.1 | 12.1 | 36.9 | 23.5 | 8.3 | 6.0 | 15.7 | 10.0 | 31.3 | 15.6 |
| Sweet | 0°C | 10.2 | 8.1 | 18.1 | 11.7 | 33.0 | 23.1 | 9.6 | 7.8 | 22.2 | 11.5 | 34.7 | 16.5 |
| Charlie | 5°C | 12.3 | 10.7 | 26.6 | 14.7 | 39.6 | 25.4 | 10.7 | 8.9 | 24.9 | 12.7 | 36.8 | 17.8 |
| L.S.D. at 5 % : | | 0.3 | 1.2 | 1.6 | 0.5 | 1.7 | 0.7 | 0.6 | 0.4 | 0.7 | 0.6 | 0.8 | 0.7 |

**Table (19) : Interaction effect of spraying strawberry with some fungicides and biocides within storage temperature on storageability and marketable fruits during storage.**

| Treatments | Temp. (°C) | 1999/2000 | | | | | | 2000/2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Days in storage : | | | | | | | | | | | |
| | | 3 days | | 6 days | | 9 days | | 3 days | | 6 days | | 9 days | |
| | | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. |
| Rovral | 0°C | 8.3 | 5.2 | 15.7 | 9.4 | 28.1 | 20.2 | 6.7 | 4.7 | 15.8 | 7.2 | 29.3 | 11.7 |
| | 5°C | 9.3 | 8.5 | 22.9 | 9.9 | 34.5 | 21.5 | 7.4 | 5.8 | 18.7 | 8.0 | 32.0 | 14.0 |
| Euparen | 0°C | 7.4 | 6.0 | 16.6 | 9.4 | 29.1 | 20.0 | 7.4 | 5.9 | 16.1 | 8.4 | 28.2 | 12.9 |
| | 5°C | 12.0 | 8.3 | 25.8 | 10.6 | 35.4 | 21.8 | 8.9 | 6.8 | 18.3 | 9.1 | 31.2 | 14.3 |
| Promote | 0°C | 8.0 | 7.2 | 14.5 | 9.5 | 30.2 | 20.6 | 8.0 | 5.4 | 16.5 | 8.7 | 29.7 | 14.0 |
| | 5°C | 10.8 | 9.8 | 21.5 | 10.7 | 35.7 | 23.4 | 9.4 | 7.4 | 18.7 | 9.9 | 35.5 | 16.3 |
| Plant-Guard | 0°C | 9.3 | 7.9 | 17.7 | 11.1 | 31.2 | 21.5 | 9.4 | 7.2 | 17.1 | 10.0 | 31.3 | 15.1 |
| | 5°C | 11.4 | 10.3 | 32.3 | 12.4 | 37.7 | 24.5 | 9.4 | 7.9 | 20.6 | 11.7 | 33.6 | 16.6 |
| Control | 0°C | 15.2 | 9.7 | 21.0 | 15.4 | 38.6 | 29.0 | 11.4 | 8.9 | 22.3 | 17.3 | 40.6 | 20.4 |
| | 5°C | 15.3 | 13.8 | 31.5 | 23.3 | 48.5 | 31.4 | 12.7 | 9.6 | 25.3 | 18.1 | 42.3 | 22.4 |
| L.S.D. at 5 % for % | | 0.5 | 1.2 | 1.6 | 0.5 | 1.7 | 0.7 | 0.6 | 0.4 | 0.7 | 0.6 | 0.8 | 0.7 |

**Table (20) : Interaction effect of spraying with some fungicides and biocides on two strawberry cultivars on weight loss and decay percentages of fruits during storage.**

| | | 1999/2000 | | | | | | 2000/2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Days in storage : | | | | | | | | | | | |
| | | 3 days | | 6 days | | 9 days | | 3 days | | 6 days | | 9 days | |
| | | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. |
| **Chandler** | Rovral | 8.7 | 6.5 | 18.8 | 8.4 | 30.5 | 19.8 | 6.0 | 4.2 | 11.5 | 7.1 | 26.7 | 12.1 |
| | Euparen | 9.4 | 6.6 | 20.3 | 8.6 | 30.6 | 19.9 | 6.7 | 4.7 | 12.7 | 7.2 | 26.9 | 12.7 |
| | Promote | 10.0 | 8.1 | 16.9 | 10.1 | 31.6 | 21.7 | 7.4 | 4.7 | 13.8 | 7.6 | 29.5 | 14.3 |
| | Plant-Guard | 10.0 | 8.3 | 26.8 | 10.2 | 32.7 | 22.7 | 8.0 | 6.3 | 15.1 | 9.5 | 29.8 | 15.0 |
| | Control | 12.7 | 11.4 | 25.2 | 18.3 | 41.7 | 28.5 | 11.4 | 7.5 | 18.5 | 16.3 | 37.1 | 17.7 |
| **Sweet Charlie** | Rovral | 8.9 | 7.1 | 19.3 | 9.9 | 32.0 | 21.4 | 8.0 | 5.8 | 20.2 | 8.1 | 31.5 | 13.6 |
| | Euparen | 9.4 | 7.8 | 19.8 | 10.6 | 33.9 | 21.8 | 8.9 | 8.1 | 21.8 | 9.8 | 32.5 | 14.9 |
| | Promote | 9.4 | 8.5 | 22.2 | 11.9 | 34.3 | 22.1 | 10.7 | 8.2 | 22.9 | 11.4 | 34.2 | 16.0 |
| | Plant-Guard | 10.7 | 10.1 | 23.2 | 13.4 | 36.2 | 24.3 | 10.7 | 8.8 | 32.9 | 12.2 | 35.3 | 16.7 |
| | Control | 17.8 | 13.7 | 27.3 | 20.4 | 45.5 | 31.9 | 12.7 | 11.0 | 29.1 | 19.1 | 45.3 | 25.2 |
| **L.S.D. at 5 % :** | | 0.2 | 1.4 | 0.4 | 0.4 | 1.4 | 0.6 | 0.5 | 0.4 | 0.6 | 0.5 | 0.7 | 0.6 |

**Table (21) : Interaction efffect of spraying two strawberry cultivars with some fungicides and biocides within storage temperature on weight loss and decay percentage of fruits during storage.**

| Cultivars | Treatments | Temp. (°C) | 1999/2000 | | | | | | 2000/2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Days in storage : | | | | | | | | | | | |
| | | | 3 days | | 6 days | | 9 days | | 3 days | | 6 days | | 9 days | |
| | | | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. | Decay | Loss in wt. |
| **Chandler** | Rovral | 0°C | 8.0 | 5.4 | 13.2 | 8.5 | 27.5 | 18.9 | 5.3 | 3.9 | 10. | 6.7 | 25.9 | 10.7 |
| | | 5°C | 9.3 | 7.6 | 20.5 | 8.7 | 33.5 | 20.6 | 6.7 | 4.5 | 12.9 | 7.5 | 27.9 | 13.9 |
| | Euparen | 0°C | 9.3 | 4.9 | 15.4 | 8.0 | 27.1 | 19.0 | 6.7 | 3.8 | 11.2 | 7.0 | 25.4 | 12.1 |
| | | 5°C | 9.5 | 8.2 | 22.1 | 8.7 | 34.1 | 20.7 | 6.7 | 5.5 | 14.2 | 7.4 | 28.3 | 13.3 |
| | Promote | 0°C | 9.3 | 7.2 | 15.8 | 9.7 | 28.6 | 20.6 | 6.7 | 3.7 | 11.6 | 7.0 | 27.9 | 12.7 |
| | | 5°C | 10.7 | 8.9 | 24.7 | 10.4 | 34.6 | 22.6 | 8.0 | 5.7 | 15.9 | 8.2 | 31.1 | 15.9 |
| | Plant-Guard | 0°C | 6.7 | 6.3 | 16.3 | 9.8 | 29.6 | 21.1 | 8.0 | 6.0 | 14.2 | 8.9 | 28.3 | 13.8 |
| | | 5°C | 13.3 | 10.5 | 37.3 | 10.5 | 35.8 | 24.2 | 8.0 | 6.5 | 15.9 | 10.0 | 31.2 | 16.1 |
| | Control | 0°C | 12.0 | 10.4 | 19.7 | 14.8 | 36.5 | 27.1 | 10.7 | 7.4 | 17.3 | 15.9 | 36.3 | 16.2 |
| | | 5°C | 13.3 | 12.3 | 30.7 | 21.7 | 46.8 | 29.8 | 12.0 | 7.6 | 19.7 | 16.7 | 37:8 | 19.1 |
| **Sweet Charlie** | Rovral | 0°C | 8.5 | 6.5 | 15.8 | 9.0 | 28.6 | 21.1 | 8.0 | 5.5 | 18.8 | 7.7 | 30.3 | 12.7 |
| | | 5°C | 9.3 | 9.0 | 22.7 | 10.7 | 35.4 | 22.6 | 8.0 | 6.1 | 21.5 | 8.5 | 32.7 | 14.5 |
| | Euparen | 0°C | 8.0 | 5.4 | 16.0 | 10.2 | 31.1 | 21.1 | 8.0 | 7.0 | 203 | 9.7 | 30.9 | 13.7 |
| | | 5°C | 10.7 | 8.7 | 23.6 | 11.0 | 36.6 | 23.0 | 9.7 | 9.1 | 23.2 | 9.9 | 34.1 | 15.3 |
| | Promote | 0°C | 6.7 | 8.0 | 17.4 | 11.0 | 31.7 | 21.3 | 9.3 | 7.8 | 22.1 | 10.4 | 34.6 | 15.3 |
| | | 5°C | 12.0 | 9.0 | 26.9 | 12.7 | 36.8 | 22.3 | 12.0 | 8.6 | 23.6 | 12.4 | 36.0 | 16.6 |
| | Plant-Guard | 0°C | 9.3 | 8.5 | 19.1 | 12.4 | 32.7 | 22.3 | 10.7 | 6.3 | 22.5 | 11.1 | 34.0 | 16.4 |
| | | 5°C | 120 | 11.6 | 27.3 | 14.3 | 39.6 | 26.3 | 10.7 | 9.3 | 25.5 | 13.3 | 34.6 | 17.0 |
| | Control | 0°C | 17.3 | 12.1 | 22.2 | 15.9 | 40.7 | 30.8 | 12.0 | 10.4 | 27.3 | 18.6 | 43.8 | 24.6 |
| | | 5°C | 18.3 | 15.3 | 32.3 | 24.8 | 50.2 | 32.9 | 13.3 | 11.5 | 30.8 | 19.5 | 26.7 | 25.7 |
| **L.S.D. at 5 % for :** | | | 0.4 | 1.6 | 2.2 | 0.7 | 2.4 | 1.0 | 0.8 | 0.6 | 1.0 | 0.8 | 1.1 | 1.0 |

With regard to the effect of pre-harvest spray treatments, data in Table (16) show clearly that spraying strawberry plants with either fungicides or bio-products significantly decreased decay and loss in weight during the storage period, *i.e.*, after 3, 6 and 9 days, compared with the control treatment. Hence, such treatment increased the percentage of marketable fruits at the end of storage period. Obtained results are true during both seasons of study. In this respect, fungicides (Rovral and Euparen) reflected the lowest values of loss in weight and therefore the highest percentage of marketable fruits at the end of holding period during both seasons of study. Such results may be due to the effect of such tested fungicides and bio-agents on increasing fruit firmness (Table, 17), and may reduce the growth of decay microorganisms.

As for the effect of storage temperature, data illustrated in Table (17) indicate that there were significant differences in fruit weight loss and decay percentages at the two used storage temperatures (0 and 5°C) during the two seasons of study. In this regard, fruits held at 0°C showed the lowest values of weight loss and decay percentages and consequently the highest percentage of marketable fruits at the end of storage period (9 days), compared with that stored at 5°C.

The decreasing effect of 0°C on fruit weight loss and decay may be attributed to the effect of low temperature on decreasing the rate of water loss and respiration during the storage and consequently increased the storage ability of fruits. The present findings are in accordance with those found by **Youssef *et al.* (1989)** on sweet pepper hybrids.

Regarding the effect of the interaction between the studied cultivars and foliar spray treatments, data recorded in Table (19) revealed that the fruit weight loss and decay percentage were significantly affected during both seasons of study. In this respect, spraying plants with fungicides Rovral or Euparen reflected the lowest percentage for both loss in weight and decay. As a result of this, the highest percentage of marketable fruits after nine days of storage was obtained. Such results were true during the two seasons of study.

As for the combining effect of cultivars and storage temperature on fruit weight loss and decay percentages of fruits, data in Table (18) reveal that cv. Chandler under the two studied storage temperatures (0 and 5°C) showed the lowest values for weight loss and decay percentage during the holding periods (9 days) compared with cv. Sweet Charlie. In this respect, it is expected to have the highest marketable fruit percentage at the end of storage periods. This trend was true during the two seasons of study. Such superiority of cv. Chandler may be attributed to the highest firmness of fruit compared with Sweet Charlie.

Concerning the interactional effect of fungicides and bio-products as a foliar spray and the storage temperature, data in Table (20) indicate that using fungicides or bio-products under both the studied degrees of temperatures decreased the weight loss and decay percentages compared with the control treatment during the storage period. In this regard, Rovral and Euparen as fungicides under the lower storage temperature (0°C) showed the lowest weight loss and decay percentage and consequently the highest marketable fruit percentages compared with other studied treatments either at 0° or 5°C during the storage. Obtained results were the same during the two seasons of study.

With regard to the triple interaction between the studied cultivars, pre-harvest foliar spray with fungicides and bio-products as well as the post-harvest storage temperature, data in Table (21) show clearly that spraying strawberry plant for both the studied cultivars with Rovral and Promote as pre-harvest storage treatment and storage the produced fruits under lower temperature (0°C) reflected the lowest fruit weight loss and decay percentages and consequently the highest percentage of marketable fruits compared with other treatments and the control one during both seasons of study.

**4.3.2- Fruit firmness :**

Data presented in Tables (22-28) show the effect of studied cultivars, pre-harvest foliar spray with fungicides bio-products and storage temperatures as well as their different combinations on fruit firmness during the storage (3, 6 and 9 days). Data in Table (22) show that fruit firmness, as physical fruit character, was significantly affected by the studied cultivars during the two seasons of study. In this respect, fruits of cv. Chandler had higher values of firmness compared with cv. Sweet Charlie during the storage period. Such result may be due to the differences in genetic components that affect fruit firmness. In addition, the fresh fruits at harvest had the highest firmness values (99.2, 100.8 and 57.8, 58.6) for Chandler and Sweet Charlie during the two seasons respectively (Table 9). Such firmness was gradually and consistently decreased with prolongation of the storage period and reached the lowest value at the end of holding period (9 days) during the two seasons of study. Moreover, after nine days of storage the average fruit firmness values were 85.97, 78.67 and 54.28, 49.74 for cv.

**Table (22) : Effect of strawberry cultivars on fruit firmness ($g/cm^2$) during storage.**

| Cultivars | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | 88.25 | 85.84 | 83.97 | 88.52 | 86.22 | 78.67 |
| Sweet Charlie | 59.69 | 57.85 | 54.28 | 58.18 | 56.70 | 49.74 |
| L.S.D. at 5 % : | 0.09 | 0.12 | 0.72 | 0.12 | 1.40 | 0.86 |

**Table (23) : Effect of spraying strawberry plants with some fungicides and bio-products on fruit firmness ($g/cm^2$) during storage.**

| Treatments | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Rovral | 76.59 | 73.68 | 71.43 | 77.51 | 73.21 | 67.34 |
| Euparen | 74.79 | 73.05 | 70.63 | 75.18 | 92.41 | 65.60 |
| Promote | 73.61 | 71.80 | 70.00 | 74.18 | 72.41 | 64.34 |
| Plant Guard | 73.38 | 71.24 | 68.86 | 73.43 | 71.66 | 64.20 |
| Control | 71.48 | 69.45 | 64.70 | 67.60 | 65.91 | 59.55 |
| L.S.D. at 5 % : | 0.06 | 0.09 | 0.54 | 0.09 | 1.07 | 0.52 |

**Table (24) : Effect of storage temperatures on strawberry fruit firmness (g/cm²) during storage.**

| Temperatures | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| 0°C | 80.63 | 70.57 | 75.82 | 78.94 | 77.15 | 70.01 |
| 5°C | 67.31 | 65.12 | 62.43 | 67.73 | 65.77 | 58.40 |
| L.S.D. at 5 % : | 0.06 | 0.08 | 0.46 | 0.08 | 0.93 | 0.56 |

**Table (25) : Interaction of strawberry cultivars and storage temperature on fruit firmness (g/cm²).**

| Cultivars | Temp. (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage : | | | | | |
| | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | 0°C | 91.41 | 89.00 | 87.48 | 91.65 | 89.42 | 84.08 |
| | 5°C | 68.63 | 82.67 | 80.45 | 85.39 | 83.01 | 73.26 |
| Sweet Charlie | 0°C | 69.84 | 68.14 | 64.16 | 54.02 | 64.23 | 55.94 |
| | 5°C | 49.53 | 47.56 | 44.40 | 50.06 | 48.53 | 43.54 |
| L.S.D. at 5 % : | | 0.08 | 0.11 | 0.65 | 0.11 | 1.31 | 0.79 |

**Table (26) : Reaction of spraying strawberry plants with some fungicides and bio-products and storage temperature on fruit firmness ($g/cm^2$) during storage.**

| Cultivars | Temp (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage | | | | | |
| | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Rovral | 0°C | 83.48 | 80.68 | 79.03 | 82.58 | 80.83 | 74.18 |
| | 5°C | 69.70 | 66.68 | 63.83 | 69.95 | 67.40 | 60.50 |
| Euparen | 0°C | 81.43 | 79.75 | 78.10 | 81.85 | 80.15 | 71.75 |
| | 5°C | 68.15 | 66.35 | 63.15 | 68.50 | 66.28 | 59.45 |
| Promote | 0°C | 80.10 | 78.15 | 75.93 | 80.43 | 78.60 | 70.23 |
| | 5°C | 66.65 | 64.33 | 64.08 | 68.13 | 66.23 | 58.45 |
| Plant-Guard | 0°C | 80.08 | 78.53 | 76.05 | 79.43 | 77.90 | 71.00 |
| | 5°C | 67.15 | 65.08 | 61.68 | 67.45 | 65.40 | 57.45 |
| Control | 0°C | 78.05 | 75.75 | 70.00 | 70.40 | 68.28 | 62.90 |
| | 5°C | 64.90 | 63.15 | 59.40 | 64.80 | 63.55 | 56.20 |
| L.S.D. at 5 % : | | 0.09 | 0.12 | 0.76 | 0.12 | 1.52 | 0.73 |

**Table (27) : Interaction of spraying plants of two strawberry cultivars with some fungicides and bio-products on fruit firmness (g/cm²) during storage.**

| Cultivars | Treatments | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage | | | | | |
| | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | Rovral | 90.75 | 87.63 | 85.88 | 90.85 | 87.88 | 81.78 |
| | Euparen | 89.10 | 87.60 | 84.90 | 89.45 | 87.10 | 79.40 |
| | Promote | 87.58 | 85.40 | 83.75 | 88.48 | 86.25 | 78.18 |
| | Plant-Guard | 80.03 | 85.35 | 83.65 | 87.73 | 85.65 | 77.40 |
| | Control | 85.80 | 83.55 | 81.65 | 86.10 | 84.20 | 76.60 |
| Sweet-Charlie | Rovral | 62.43 | 59.73 | 56.98 | 61.68 | 60.35 | 52.90 |
| | Euparen | 60.48 | 58.85 | 56.35 | 60.90 | 59.33 | 51.80 |
| | Promote | 59.65 | 58.25 | 56.25 | 60.08 | 58.58 | 51.00 |
| | Plant-Guard | 58.73 | 57.08 | 54.08 | 59.15 | 57.65 | 50.50 |
| | Control | 57.15 | 55.35 | 47.75 | 49.10 | 47.63 | 42.50 |
| L.S.D. at 5 % : | | 0.09 | 0.12 | 0.76 | 0.12 | 1.52 | 0.74 |

**Table (28) : Interaction of two strawberry cultivars, spraying with some fungicides and bio-products within storage temperature on fruit firmness (g/cm²).**

| Cultivars | Treatments | Temp. (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|---|
| | | | Days in storage : | | | | | |
| | | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| **Chandler** | Rovral | 0°C | 93.70 | 91.40 | 90.30 | 93.90 | 91.50 | 88.25 |
| | | 5°C | 87.80 | 83.85 | 81.45 | 87.80 | 84.25 | 75.30 |
| | Euparen | 0°C | 90.95 | 90.60 | 89.30 | 93.10 | 90.90 | 84.40 |
| | | 5°C | 85.10 | 83.90 | 80.50 | 85.80 | 83.30 | 74.40 |
| | Promote | 0°C | 90.35 | 88.40 | 86.10 | 91.10 | 88.80 | 82.75 |
| | | 5°C | 84.80 | 82.40 | 81.40 | 85.85 | 83.70 | 73.60 |
| | Plant-Guard | 0°C | 92.75 | 88.30 | 87.20 | 90.55 | 88.60 | 83.70 |
| | | 5°C | 85.45 | 82.40 | 80.10 | 84.90 | 82.70 | 71.10 |
| | Control | 0°C | 89.30 | 86.30 | 84.50 | 89.60 | 87.30 | 81.30 |
| | | 5°C | 52.30 | 80.80 | 78.80 | 82.60 | 81.10 | 71.90 |
| **Sweet-Charlie** | Rovral | 0°C | 73.25 | 69.95 | 67.75 | 71.25 | 70.15 | 60.10 |
| | | 5°C | 51.60 | 49.50 | 46.20 | 52.10 | 50.55 | 45.70 |
| | Euparen | 0°C | 69.80 | 68.90 | 66.90 | 70.60 | 69.40 | 57.70 |
| | | 5°C | 49.50 | 48.80 | 45.80 | 51.20 | 49.25 | 44.50 |
| | Promote | 0°C | 69.25 | 68.75 | 65.75 | 69.75 | 68.40 | 58.30 |
| | | 5°C | 48.20 | 47.75 | 46.75 | 50.40 | 48.75 | 43.70 |
| | Plant Guard | 0°C | 70.10 | 69.70 | 64.90 | 68.30 | 67.20 | 57.70 |
| | | 5°C | 50.85 | 46.25 | 43.25 | 50.00 | 48.10 | 43.30 |
| | Control | 0°C | 66.80 | 65.20 | 55.50 | 51.20 | 49.25 | 44.50 |
| | | 5°C | 47.50 | 45.50 | 40.00 | 47.00 | 46.06 | 40.50 |
| **L.S.D. at 5 % :** | | | 0.13 | 0.17 | 1.07 | 0.17 | 2.15 | 1.04 |

and Sweet Charlie during the two seasons of study, respectively. In this regard, softening of fruits may be attributed to the change of protopection into soluble pectin and the conversion of insoluble carbohydrates to soluble sugars. Obtained results agree with those reported by **El-Bassiouny (1992)** on strawberry, **Youssef *et al.* (1989)** on sweet pepper, **El-Sheikh *et al.* (1993)** and **Abdel-Rahman *et al.* (1999)** all working on eggplant and **El-Sheikh and El-Doweny (1997)** on cucumber.

With regard to the effect of pre-harvest foliar spray with fungicides (Euparen and Rovral) and bio-products (Plant-Guard and Promote) on fruit firmness, data recorded in Table (23) indicate that spraying strawberry plants with either fungicides or bio-products significantly increased fruit firmness compared with the control treatment during the storage periods in the two seasons of study. In this respect, Rovral at a rate of 1 g/L reflected the highest values of fruit firmness followed by Euparen, Promote and Plant-Guard. In addition, there were continuous decreases in fruit firmness with the prolongation of storage period up to nine days of storage. The decrement in fruit firmness with the prolongation of storage period was similar to those reported by **El-Bassiouny (1992)** on strawberry, who stated that stored fruits showed a gradual significant reduction in fruit firmness as storage period extended.

Concerning the effect of storage temperature, data recorded in Table (24) show clearly that fruit firmness was significantly affected with storage temperature. In this respect, stored fruits at 0°C had higher firmness values during the different storage periods (3, 6 and 9 days of storage) compared with fruits stored at 5°C. Such effect may be owing to the effect of lower temp-

erature on the enzyme activities that related to the conversion of protopectin. These explanations are mentioned by **Youssef *et al.* (1989)** on sweet pepper.

As for the interaction between cultivar and foliar spray with fungicides and bio-products, data in Table (27) indicate that spraying Chandler plants with Rovral during the two seasons of growth reflected the highest values in fruit firmness during the different periods of storage compared with the other tested treatments and the control.

Regarding the interaction between cultivars and storage temperatures, data in Table (25) reveal that the highest values of fruit firmness were recorded with Chandler fruits stored at 0°C when compared with fruits of the same cultivar stored at 5°C cv. Sweet Charlie stored at 0° or 5°C. Moreover, there were a gradual decrease in fruit firmness under 0° and 5°C of storage condition, with the prolongation of storage period.

The interaction between foliar spray treatments (fungicides and bio-products) and storage temperature (0 and 5°C) as shown in Table (26) was significant during both seasons of study. Spraying plants with Rovral and storing the produced fruits at 0°C recorded the highest values for fruit firmness during the storage period (9 days) compared with the other tested treatments. Obtained results may be due to the effect of low temperature (0°C) and spray treatments which play role as antiseptic substances that interfere with the activity of analytic enzymes responsible for changing protopectin to soluble pectin and consequently fruits kept its solidity during the storage period. Such results are in conformity with those reported by

**Eman (1999)** on green onion, who reported that post-harvest treatments including antisepticing, hydrocooling are required for maintaining the quality of green onion during storage.

With regard to the effect of the interaction between pre-harvest (cultivars and spray agents) and post-harvest treatments (storage temperature), data in Table (28) show that under cold storage conditions, spraying cv. Chandler with Rovral and Sweet Charlie with Euparen or Rovral at flowering stage in the field make the fruit keep well with its physical character (firmness) during the storage compared with the other tested treatments during both seasons of study. However, from the safety point of view the use of bio-products (Promote and Plant-Guard) can be performed in this respect to reduce the environmental contamination and the fungicides residues in fruits which had bad effect on the health of human being.

**4.3.3- Total soluble solids :**

Data presented in Tables (29-35) show the effect of pre-harvest treatments (cultivars and spray agents) and post-harvest storage temperature as well as their different interactions on total soluble solids (T.S.S.) content of fruits during the storage.

As for the effect of cultivars, data in Table (29) show clearly that cv. Sweet Charlie gave fruits with higher total soluble solids contents compared to those of cv. Chandler. These results were true in the two seasons of study. Such higher values of T.S.S. in cv. Sweet Charlie fruits may be connected with higher sugar content. In addition, the same data reveal that there were constant and gradual decreases in T.S.S. content with prolongation storage period until 9 days. Such decrease in T.S.S.

content during storage might owe to the utilization of soluble solids especially sugars in respiration. Similar results were reported by **Kamooh *et al.* (1996) and El-Sheikh and El-Doweny (1997)** on cucumber. They reported that there were significant differences among the studied cultivars in total soluble solids content during the storage. However, **El-Bassiouny (1992)** on strawberry showed that T.S.S. was not significantly affected by storage among the studied cultivars.

With regard to the effect of pre-harvest foliar spray with fungicides, *i.e.*, Euparen and Rovral and bio-products, *i.e.*, Plant-Guard and Promote on T.S.S. content of fruits during the storage, data in Table (30) show that there were significant reductions in total soluble solids contents with the prolongation of storage period from 3 up to 9 days and spraying the plants with different tested fungicides and bio-products compared with the control treatment during both seasons of study. The highest content of total soluble solids in case of check treatment compared with the tested fungicides and bio-products might owe to the highest conversion of insoluble compounds to simple soluble substances and the highest loss of moisture from the fruit through evaporation and transpiration.

Concerning the effect of storage temperature, data in Table (31) indicate that under cold storage temperature, fruits stored at 5°C gave higher values of total soluble solids content compared with those stored at 0°C during both seasons of study. In addition, there is a continuous reduction in the content of T.S.S. with the prolongation of the storage period. Obtained results may be attributed to the higher rate of conversion in complex substance to soluble material than the rate of use of

soluble substances in respiration at 5°C storage, compared with the storage at 0°C.

With regard to the interaction effect between the tested cultivars and foliar spray treatments (fungicides and bio-products) on total soluble solid content of fruits during the storage, it is obvious from data in Table (32) that during the different periods of storage (3, 6 and 9 days), the control treatment in case of the two tested cultivars reflected the highest values of total soluble solid content compared with spraying plants with different studied fungicides and bio-products. Obtained results were true during both seasons of study. In this respect, the highest values of T.S.S. during the storage were resulted in case of non-sprayed Sweet Charlie fruits.

Concerning the interaction effect between the tested cultivar, *i.e.,* Chandler and Sweet Charlie, and storage temperature, data presented in Table (33) indicate clearly that under cold storage conditions fruits stored at 5°C for both tested cultivars gave the highest values of total soluble solids compared with fruits stored at 0°C. In addition, Sweet Charlie fruits reflected the higher values during different period of storage and in the two seasons of study. Moreover, there were continuous reduction in T.S.S. content with the prolongation of storage period from 3 up to 9 days of storage.

As for the effect of the interaction between spray treatments, *i.e.,* fungicides and bio-products, and storage temperature, data in Table (34) show that total soluble solid content was significantly affected during the different periods of storage and in the two seasons of study by the interaction

effect. In this respect, unsprayed fruits stored either at 0° or 5°C possessed the highest values of T.S.S. during different periods of storage compared with those sprayed with either fungicides or bio-products. Such results were true during the two seasons of the experiment. Obtained results may be due to the highest rate of water loss and convertion of complex substances to soluble simple materials in case of control treatment stored at 5 and 0°C compared with other sprayed ones.

Regarding the triple interaction effect among cultivars, pre-harvest spraying treatments and postharvest storing temperatures (0 and 5°C), data in Table (35) declare that under cold storage conditions fruits produced from plants sprayed with Plant-Guard or Promote for both cvs. Chandler and Sweet Charlie gave the lowest soluble solid content at the end of storage period (9 days) compared with fruits sprayed with fungicides and control treatments. On the other hand, fruits of the control treatment had the highest total soluble solids content at the end of storage period (9 days). In addition, fruits kept at 5°C possessed higher total soluble solids compared with those stored at 0°C during the different periods of storage and in the two seasons of study.

**Table (29) : Effect of two strawberry cultivars on total soluble solids (%) of fruits during storage.**

| Cultivars | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | 9.94 | 8.88 | 7.87 | 10.26 | 9.18 | 8.16 |
| Sweet Charlie | 10.2 | 9.06 | 7.96 | 10.73 | 9.58 | 8.70 |
| L.S.D. at 5 % : | 0.13 | 0.10 | 0.04 | 0.25 | 0.07 | 0.09 |

**Table (30) : Effect of spraying with some fungicides and bio-products on total soluble solids (%) of strawberry fruits during storage.**

| Treatments | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Rovral | 9.90 | 8.66 | 7.64 | 10.31 | 9.06 | 8.05 |
| Euparen | 9.85 | 8.64 | 7.62 | 10.29 | 9.06 | 8.00 |
| Promote | 9.84 | 8.61 | 7.55 | 10.28 | 8.99 | 7.98 |
| Plant Guard | 9.84 | 8.61 | 7.46 | 10.25 | 8.57 | 7.88 |
| Control | 10.93 | 10.33 | 9.33 | 11.33 | 10.73 | 10.23 |
| L.S.D. at 5 % : | 0.07 | 0.07 | 0.03 | 0.03 | 0.05 | 0.07 |

**Table (31) : Effect of storage temperatures on total soluble solids (%) of strawberry fruits during storage.**

| Temperatures | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| 0°C | 9.95 | 8.79 | 7.62 | 10.36 | 9.26 | 8.26 |
| 5°C | 10.19 | 9.15 | 8.22 | 10.62 | 9.50 | 8.59 |
| L.S.D. at 5 % : | 0.06 | 0.06 | 0.02 | 0.02 | 0.05 | 0.06 |

**Table (32) : Interaction of strawberry cultivars and spraying with some fungicides and bio-products on fruit total soluble solids (%) during storage.**

| Cultivars | Treatments | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage | | | | | |
| | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | Rovral | 9.80 | 8.67 | 7.63 | 10.10 | 9.00 | 7.95 |
| | Euparen | 9.73 | 8.60. | 7.52 | 10.08 | 8.90 | 7.83 |
| | Promote | 9.70 | 8.50 | 7.40 | 10.05 | 8.75 | 7.65 |
| | Plant-Guard | 9.70 | 8.45 | 7.37 | 10.05 | 8.25 | 7.60 |
| | Control | 10.75 | 10.20 | 9.45 | 11.05 | 10.50 | 9.75 |
| Sweet-Charlie | Rovral | 10.90 | 8.77 | 7.70 | 10.53 | 9.37 | 8.38 |
| | Euparen | 10.00 | 8.73 | 7.70 | 10.53 | 9.23 | 8.30 |
| | Promote | 9.92 | 8.73 | 7.65 | 12.53 | 9.23 | 8.15 |
| | Plant-Guard | 9.95 | 8.60 | 7.55 | 10.54 | 9.13 | 7.65 |
| | Control | 11.10 | 10.45 | 9.20 | 11.60 | 10.95 | 10.70 |
| L.S.D. at 5 % : | | 0.10 | 0.11 | 0.04 | 0.04 | 0.07 | 0.10 |

**Table (33) : Interaction of strawberry cultivars and storage temperatures on total soluble solids (%) of fruits during storage period.**

| Cultivars | Temp. (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage : | | | | | |
| | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | 0°C | 9.78 | 8.70 | 7.69 | 8.38 | 9.02 | 7.94 |
| | 5°C | 10.09 | 9.03 | 7.88 | 10.09 | 9.34 | 6.75 |
| Sweet Charlie | 0°C | 8.14 | 8.85 | 7.54 | 10.63 | 9.50 | 8.58 |
| | 5°C | 9.26 | 9.26 | 8.38 | 10.82 | 9.66 | 8.81 |
| L.S.D. at 5 % : | | 0.08 | 0.09 | 0.03 | 0.03 | 0.06 | 0.08 |

**Table (34) : Interaction of storage tempertures and spraying with some fungicides and bio-products on total soluble solids (%) of fruits during storage.**

| Cultivars | Temp. (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage | | | | | |
| | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Rovral | 0°C | 9.78 | 7.55 | 7.48 | 10.15 | 9.03 | 8.08 |
| | 5°C | 10.03 | 8.78 | 8.00 | 10.40 | 9.05 | 8.03 |
| Euparen | 0°C | 9.73 | 8.47 | 7.45 | 10.15 | 9.12 | 7.85 |
| | 5°C | 9.98 | 8.81 | 7.75 | 10.35 | 9.00 | 8.15 |
| Promote | 0°C | 9.75 | 8.50 | 7.45 | 10.18 | 8.90 | 7.88 |
| | 5°C | 9.93 | 8.73 | 7.65 | 10.40 | 9.23 | 8.08 |
| Plant-Guard | 0°C | 9.75 | 8.50 | 7.30 | 10.18 | 8.85 | 7.70 |
| | 5°C | 9.93 | 8.73 | 7.63 | 10.45 | 9.13 | 8.05 |
| Control | 0°C | 10.75 | 9.95 | 8.40 | 11.15 | 10.35 | 9.80 |
| | 5°C | 11.10 | 10.70 | 10.25 | 11.50 | 11.10 | 10.65 |
| L.S.D. at 5 % : | | 0.10 | 0.11 | 0.04 | 0.04 | 0.07 | 0.10 |

**Table (35) : Interaction of two strawberry cultivars and spraying with some fungicides and bio-products within storage temperature on fruits total soluble solids (%) during the storag.**

| Cultivars | Treatments | Temp. (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|---|
| | | | Days in storage : | | | | | |
| | | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| **Chandler** | Rovral | 0°C | 9.60 | 8.58 | 7.50 | 9.90 | 8.80 | 7.80 |
| | | 5°C | 10.00 | 8.76 | 7.74 | 10.30 | 9.10 | 8.10 |
| | Euparen | 0°C | 9.60 | 8.50 | 7.40 | 9.90 | 8.80 | 7.70 |
| | | 5°C | 9.80 | 8.70 | 7.65 | 10.20 | 9.00 | 7.95 |
| | Promote | 0°C | 9.55 | 8.40 | 7.30 | 9.90 | 8.60 | 7.40 |
| | | 5°C | 9.85 | 8.60 | 7.50 | 10.20 | 8.90 | 7.80 |
| | Plant-Guard | 0°C | 9.55 | 8.30 | 7.25 | 9.85 | 8.60 | 7.50 |
| | | 5°C | 9.90 | 8.60 | 7.50 | 10.20 | 8.90 | 7.80 |
| | Control | 0°C | 10.60 | 9.90 | 9.00 | 10.90 | 10.20 | 9.30 |
| | | 5°C | 10.90 | 10.50 | 9.90 | 11.20 | 10.80 | 10.20 |
| **Sweet-Charlie** | Rovral | 0°C | 9.95 | 8.70 | 7.50 | 10.45 | 9.20 | 8.25 |
| | | 5°C | 10.05 | 8.85 | 7.90 | 10.60 | 9.55 | 8.35 |
| | Euparen | 0°C | 9.90 | 8.60 | 7.60 | 10.45 | 9.10 | 8.35 |
| | | 5°C | 10.10 | 8.85 | 7.80 | 10.60 | 9.35 | 7.95 |
| | Promote | 0°C | 9.90 | 8.60 | 7.45 | 10.45 | 9.35 | 8.00 |
| | | 5°C | 10.10 | 8.85 | 7.85 | 10.60 | 9.10 | 8.35 |
| | Plant Guard | 0°C | 9.90 | 8.35 | 7.35 | 10.40 | 9.35 | 8.00 |
| | | 5°C | 10.05 | 8.85 | 7.75 | 10.50 | 8.90 | 8.30 |
| | Control | 0°C | 10.90 | 10.00 | 7.80 | 11.40 | 10.50 | 10.30 |
| | | 5°C | 11.30 | 10.90 | 10.60 | 11.80 | 11.40 | 11.10 |
| **L.S.D. at 5 % :** | | | 0.14 | 0.15 | 0.05 | 0.05 | 0.11 | 0.14 |

**4.3.4- Total titratable acidity (T.A.) :**

Data indicated in Tables (36-42) show the effect of pre-harvest treatments (cultivars and spray treatments) and post-harvest storage temperature as well as their different combinations on total acidity of stored fruits.

Data in Table (36) show that Sweet Charlie fruits had significantly higher acidity than Chandler fruits during the different periods of storage. Such trend was similar during both seasons of study. The higher acidity content of Sweet Charlie fruits may be due to sugars which was the immediate precursors of organic acids. In this respect, **El-Bassiouny (1992)** on strawberry found that strawberry fruits showed a decline in acidity during the storage. In addition, Pajaro fruits had significantly lower acidity than Sequoia.

As for the effect of spray treatments, *i.e.*, fungicides and bio-products, it is clear from data in Table (37) that pre-harvest spray with Rovral and Euparen as fungicides and Promote and Plant-Guard as bio-products had a significantly decreasing effect on total titratable acidity during the different periods of storage compared with the control treatment in both seasons of study. Such highest content of total acidity in unsprayed fruits was connected with the highest T.S.S. content. However, no significant differences were noticed among the studied spray treatments in this respect during storage. On the contrary, **Abada *et al.* (2002)** on strawberry found that application of bio-products increased the values of total titratable acidity of treated fruits compared with control treatment.

Regarding the effect of storage temperature, data in Table (38) indicate that generally fruits stored fruits at 5°C had lower values of titratable acidity than those stored at 0°C. Such lower content at higher storage temperature may be due to the utilization of organic acids in respiration and metabolic activities of fruit cells. This indicates that holding fruits at 0°C was the best and recommended storage temperature for maintaining fruit quality for long period.

With regard to the interaction between tested cultivars and spraying with fungicides and bio-products, data reported in Table (39) show that irrespective of the control treatment which significantly differed during the different periods of storage (3, 6 and 9 days) in the two seasons of study, no significant differences can be noticed among the tested spray treatments in this respect. However, fruits of Sweet Charlie contained more total acidity than that of Chandler during the different storage periods.

Concerning the interaction effect between the tested cultivars and storage temperature, the presented data in Table (40) indicate that under cold storage temperature the highest values for total titratable acidity at the end of storage period (9 days) were found in fruits of Sweet Charlie during both seasons of study. In addition, the highest acidity content was found when fruits were stored at 0°C. Regarding the interaction effect between spray treatments and storage temperature on acidity content reported data in Table (41) reveal that spraying the plants at flowering stage with either fungicides (Euparen and Rovral) or bio-products (Promote and Plant-Guard) and storing the fruits under cold storage conditions (0 or 5°C) significantly decreased the total titratable acidity content compared with the control

treatment. In this respect, the lowest values during the different periods of storage (3, 6 and 9 days) were connected, in general, with using Euparen fungicide and holding the fruits at 5°C in the two seasons of study.

As for the effect of the trible interaction between pre-harvest (cultivars and spraying agents) and post-harvest (storage temperature) treatments on acidity content, data presented in Table (42) indicate that spraying the strawberry plants of both tested cultivars with fungicides, *i.e.,* Euparen or Rovral and bio-products, *i.e.,* Promote or Plant-Guard decreased the total acidity in produced fruits when stored under cold storage temperature compared with the unsprayed control treatment during the different periods of storage (3, 6 and 9 days). In this respect, control treatment reflected the highest values of acidity during both seasons of study. However, no significant differences can be noticed among the spraying treatments in this concept.

Table (36) : **Effect of two strawberry cultivars on Fruit titratable acidity (%) fruit during storage.**

| Cultivars | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | 0.85 | 0.84 | 0.80 | 1.17 | 1.14 | 1.10 |
| Sweet Charlie | 0.95 | 0.94 | 0.91 | 1.47 | 1.44 | 1.44 |
| L.S.D. at 5 % : | 0.06 | 0.04 | 0.09 | 0.06 | 0.04 | 0.05 |

Table (37) : Effect of spraying strawberry plants with some fungicides and bio-products on fruit titratable acidity (%) during storage.

| Treatments | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Rovral | 0.83 | 0.81 | 0.79 | 1.28 | 1.25 | 1.23 |
| Euparen | 0.86 | 0.84 | 0.83 | 1.29 | 1.25 | 1.24 |
| Promote | 0.88 | 0.87 | 0.83 | 1.30 | 1.26 | 1.24 |
| Plant Guard | 0.89 | 0.88 | 0.83 | 1.30 | 1.28 | 1.26 |
| Control | 1.04 | 1.02 | 1.03 | 1.44 | 1.42 | 1.40 |
| L.S.D. at 5 % : | 0.67 | 0.03 | 0.07 | 0.04 | 0.03 | 0.05 |

Table (38) : Effect of storage temperatures on titratable acidity degree of strawberry fruits.

| Temperatures | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|
| | Days in storage : | | | | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| 0°C | 0.93 | 0.92 | 0.88 | 1.34 | 1.32 | 1.28 |
| 5°C | 0.87 | 0.85 | 0.83 | 1.31 | 1.27 | 1.27 |
| L.S.D. at 5 % : | 0.04 | 0.02 | 0.06 | N.S. | 0.02 | N.S. |

Table (39) : Interaction of two strawberry cultivars and spraying with some fungicides and bio-products on titratable acidity on fruits (%) during storage.

| Cultivars | Treatment | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage | | | | | |
| | | 3 Days | 6 Days | 9 Days | 3 Days | 6 Days | 9 Days |
| Chandler | Rovral | 0.78 | 0.76 | 0.74 | 1.13 | 1.10 | 1.02 |
| | Euparen | 0.78 | 0.79 | 0.74 | 1.13 | 1.10 | 1.05 |
| | Promote | 0.82 | 0.80 | 0.75 | 1.13 | 1.10 | 1.05 |
| | Plant-Guard | 0.83 | 0.82 | 0.75 | 1.14 | 1.10 | 1.09 |
| | Control | 1.05 | 1.03 | 1.02 | 1.36 | 1.34 | 1.32 |
| Sweet Charlie | Rovral | 0.89 | 0.87 | 0.83 | 1.43 | 1.41 | 1.42 |
| | Euparen | 0.94 | 0.92 | 0.91 | 1.46 | 1.41 | 1.43 |
| | Promote | 0.95 | 0.93 | 0.92 | 1.47 | 1.43 | 1.43. |
| | Plant-Guard | 0.96 | 0.94 | 0.92 | 1.47 | 1.46 | 1.45 |
| | Control | 1.03 | 1.02 | 0.99 | 1.53 | 1.51 | 1.49 |
| L.S.D. at 5 % : | | 0.06 | 0.03 | 0.10 | 0.05 | 0.04 | 0.05 |

Table (40) : Interaction of two strawberry cultivars and storage temperatures on titratable acidity (%) on fruit during storage.

| Cultivars | Temp. (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage : | | | | | |
| | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | 0°C | 0.83 | 0.82 | 0.78 | 1.16 | 1.13 | 1.10 |
| | 5°C | 0.87 | 0.86 | 0.81 | 1.19 | 1.16 | 1.11 |
| Sweet Charlie | 0°C | 0.92 | 0.89 | 0.88 | 1.46 | 1.40 | 1.44 |
| | 5°C | 0.98 | 0.97 | 0.94 | 1.48 | 1.48 | 1.44 |
| L.S.D. at 5 % : | | 0.06 | 0.03 | 0.08 | 0.05 | 0.03 | 0.04 |

Table (41) : Interaction of spraying with some fungicides and bio-products and storage temperature on titratable acidity (%) on fruit during storage.

| Cultivars | Temp. (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|
| | | Days in storage | | | | | |
| | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Rovral | 0°C | 0.78 | 0.75 | 0.80 | 1.15 | 1.21 | 1.21 |
| | 5°C | 0.89 | 0.88 | 0.85 | 1.26 | 1.29 | 1.26 |
| Euparen | 0°C | 0.82 | 0.81 | 0.82 | 1.28 | 1.21 | 1.23 |
| | 5°C | 0.90 | 0.87 | 0.85 | 1.31 | 1.30 | 1.25 |
| Promote | 0°C | 0.85 | 0.84 | 0.82 | 1.28 | 1.24 | 1.23 |
| | 5°C | 0.89 | 0.90 | 0.85 | 1.31 | 1.28 | 1.25 |
| Plant-Guard | 0°C | 0.86 | 0.83 | 0.75 | 1.29 | 1.26 | 1.25 |
| | 5°C | 0.91 | 0.92 | 0.84 | 1.32 | 1.29 | 1.27 |
| Control | 0°C | 1.03 | 1.02 | 1.00 | 1.43 | 1.41 | 1.39 |
| | 5°C | 1.05 | 1.03 | 1.01 | 1.46 | 1.44 | 1.42 |
| L.S.D. at 5 % : | | 0.10 | 0.4 | 0.10 | 0.05 | 0.04 | 0.05 |

**Table (42) : Interaction of two strawberry cultivars, spraying with some fungicides and bioacudity (%) during storage.**

| Cultivars | Treatments | Temp. (°C) | 1999/2000 | | | 2000/2001 | | |
|---|---|---|---|---|---|---|---|---|
| | | | Days in storage : | | | | | |
| | | | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| Chandler | Rovral | 0°C | 0.75 | 0.73 | 0.70 | 1.11 | 1.08 | 1.00 |
| | | 5°C | 0.80 | 0.79 | 0.77 | 1.14 | 1.11 | 1.04 |
| | Euparen | 0°C | 0.74 | 0.77 | 0.73 | 1.11 | 1.08 | 1.04 |
| | | 5°C | 0.81 | 0.81 | 0.76 | 1.14 | 1.11 | 1.06 |
| | Promote | 0°C | 0.80 | 0.78 | 0.74 | 1.11 | 1.08 | 1.04 |
| | | 5°C | 0.84 | 0.81 | 0.76 | 1.14 | 1.11 | 1.06 |
| | Plant-Guard | 0°C | 0.81 | 0.77 | 0.74 | 1.12 | 1.08 | 1.07 |
| | | 5°C | 0.84 | 0.87 | 0.76 | 1.14 | 1.12 | 1.10 |
| | Control | 0°C | 1.04 | 1.03 | 1.01 | 1.34 | 1.32 | 1.30 |
| | | 5°C | 1.06 | 1.05 | 1.02 | 1.37 | 1.35 | 1.38 |
| Sweet-Charlie | Rovral | 0°C | 0.82 | 0.78 | 0.75 | 1.41 | 1.34 | 1.41 |
| | | 5°C | 0.95 | 0.95 | 0.91 | 1.45 | 1.47 | 1.43 |
| | Euparen | 0°C | 0.91 | 0.89 | 0.89 | 1.45 | 1.34 | 1.41 |
| | | 5°C | 0.97 | 0.98 | 0.93 | 1.47 | 1.48 | 1.44 |
| | Promote | 0°C | 0.91 | 0.89 | 0.89 | 1.45 | 1.40 | 1.42 |
| | | 5°C | 0.98 | 0.95 | 0.94 | 1.48 | 1.45 | 1.45 |
| | Plant Guard | 0°C | 0.94 | 0.89 | 0.90 | 1.45 | 1.44 | 1.41 |
| | | 5°C | 0.98 | 0.97 | 0.93 | 1.48 | 1.46 | 1.48 |
| | Control | 0°C | 1.02 | 1.01 | 0.98 | 1.52 | 1.50 | 1.48 |
| | | 5°C | 1.04 | 1.02 | 1.00 | 1.54 | 1.52 | 1.50 |
| L.S.D. at 5 % : | | | N.S. | 0.05 | N.S. | 0.07 | 0.05 | 0.07 |