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PROSPECTS FOR A MODIFIED CULTURAL SYSTEM FOR STRAWBERRY NURSERIES IN RELATION TO SUBSEQUENT FRUIT PRODUCTION UNDER LOW PLASTIC TUNNELS

2- PLANT GROWTH, PRODUCTIVITY AND FRUIT QUALITY

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ABSTRACT

This study was carried out at the Strawberry and Non-Traditional Crops Research Station, Nobaria, Behaira Governorate during the two successive seasons 2000 / 2001 and 2001/2002. The aim of this study was to investigate the effects of cultivar, nursery planting system and nursery plant spacing on the subsequent vegetative growth characters, yield and fruit quality of fresh strawberry plantations.
Results demonstrated that leaf area and root length increased significantly in Camarosa as compared with Sweet Charlie cultivar. On the other hand, number of roots increased significantly in Sweet Charlie than Camarosa in the two tested seasons. Results showed also that producing strawberry transplants on raised beds increased significantly number of leaves/plant, leaf area, number of roots and root length than those obtained from flat planting method. Significant increment in all studied growth characters was observed with increasing nursery plant spacing in the two seasons except number of leaves in the second season which was insignificant. Transplant of Sweet Charlie produced on raised beds at the largest plant spacing nursery showed significant increments in roots number. Moreover, those of Comarosa on raised beds at the largest spacings showed the longest roots. Significant increments were noticed in total yield and average fruit weight for Camarosa cultivar as compared with those of Sweet Charlie. On the other hand, Sweet Charlie reflected significant increase in early yield and TSS as compared with Camarosa in the two tested seasons. Transplants produced from raised beds reflected significant increments in early and total yield and average fruit weight in both tested seasons. The widest nursery spacing (2m) reflected significant enhancement on early and total yield and, average fruit weight in the two growing seasons. Sweet Charlie transplants that grown on raised beds in the widest nursery spacing gave the highest early yield. Camarosa transplants produced from raised bed showed the greatest mean value of total yield and average fruit weight. Sweet Charlie produced from flat or raised beds nurseries showed significantly higher TSS as compared with Camarosa produced in either flat or raised beds. Results showed also that Sweet Charlie transplants produced on flat or raised beds at all used spacings gave the highest values of total and reducing sugars and ascorbic acid in the fruiting fields while Camarosa planted on raised beds at all spacings showed the highest total acidity in the fruits. The results confirmed the potential of intensive strawberry transplant production on raised beds with the use of large mother plant spacing.
Keywords: Strawberry, Transplants quality, Subsequent yield, Fruit quality.

INTRODUCTION

Annual soil -mulched strawberry in Egypt has received significant attention in the last few years since this production technique was developed to induce early and high quality fruit production for exportation. Transplant

quality can have a major effect on the productivity of strawberry. Reekie *et al.* (2002) found that increasing plant height subjected petioles to break during transportation and planting, whereas, leaf tissue damage can adversely affect crop earliness and significantly decrease overall strawberry fruit yield. Dana (1980) reported that up to 50- 90% of the strawberry roots are concentrated in the upper 10-15 cm of the soil.

Crown size at planting and the effect of chilling temperatures on nursery production fields have shown to influence early season yield of strawberry (Chandler *et al.*, 1989; Kirschbaum *et al.*, 1998; Ragab *et al.*, 2000). However the influences of nursery planting system and mother plants (Super Elit) densities on subsequent strawberry yields have not been determined. Strawberry cultivars varied in average fruit weight and early and total yield as found by Libek (2002) and Khalaf (2003). In this respect, Camarosa yielded higher than Sweet Charlie as reported by Ilgin *et al.* (2002). Some strawberry growers did not pay much attention to the plant size. Nevertheless, the crown diameter of the plants which strongly influence production could be improved from 5 to 36 % by using plants with a large crown diameter (Faby, 1997; Meesters and Ptsioudis, 1997). Galletta and Bringhurst (1990) pointed out to the importance of the reserve storage capacity measured as crown diameter and crown weight. Palha *et al.* (2002) found that there was a positive relationship suggests that the production of the first fruits is depended on the plant carbohydrate status existed in the thicker transplants at digging, and confirms the importance of the quality of strawberry plants in the winter planting system. Caglar and Paydas (2002) reported that significant differences were detected among some strawberry cultivars in fruit firmness, TSS and acidity.

The objectives of this work were to investigate the effects of cultivar, nursery planting system and nursery spacings on subsequent vegetative growth characters, yield and fruit quality of fresh strawberry plantations

MATERIALS AND METHODS

This study was carried out at the Strawberry and Non-Traditional Crops Research Station, Nobaria, Behaira Governorate during the two successive seasons 2000/2001 and 2001/2002. The objectives of this work were to investigate the effects of cultivar, transplants produced under two planting systems, i.e., raised or flat beds, and different nursery spacings and their interaction on subsequent vegetative growth characters, yield and fruit quality of soil-mulched strawberry plantations planted under low tunnels.

In the former paper, sixteen nursery treatments (combination among 2 cultivars, 2 nursery planting systems and 4 spacings) were carried out. After digging, marketable transplants (crown diameter more than 0.5cm) were randomly taken from all above mentioned nursery treatments. Transplants were immediately transplanted on 17 and 22 September in the two seasons respectively in a split split plot design with three replications. The main plots were assigned to the two cultivars, i.e., Sweet Charlie and Camarosa, while the sub-plots were allocated to transplants from the two nursery planting systems, i.e., flat and raised beds, and the sub-sub-plots were occupied by the transplants from different nursery spacings, i.e., 1.0, 1.25,1.5 and 2 m.

Each sub–sub plot consisted of four beds each 10m long and 120 cm width with 50 cm between beds. Each bed has 4 rows at within row spacing of 30 cm and distance between plants was 25 cm apart. Plot area was 68m^2. On October 15, beds were covered with 40 micron plastic mulch with 180 cm width. In November, the plants were covered with 80 micron plastic tunnels (70 cm height and 220 cm width). Sprinkler irrigation took place in the first month after planting, then drip irrigation was used after mulching until the end of the season. The soil texture was sandy with pH 7.8 and EC 1.06. All replicates received similar agricultural practices as regards cultivation, fertilization, irrigation, pest and disease control as commonly followed in the district. Data on vegetative growth, yield and its components and physical and chemical fruit characteristics were recorded as follows:

1-**Vegetative growth characters**: Random samples of ten plants from each experimental plot were taken after 50 days from planting and number of leaves, leaf area, number and length of roots were recorded.

2- **Early and total yield:** Early yield was determined from each experimental plot as weight of all harvested fruits during November, December and January months. All harvested fruits collected from each plot all over the season were weighed as total yield. Averages early and total yield per feddan were then calculated.

3- **Fruit characteristics:** Random samples of 25 fruits from each experimental plot were taken after 6 weeks from the first harvest and average fruit weight were then calculated. Total soluble solid content was recorded in five full ripe fruits using the hand refractometer. Total titratable acidity and ascorbic acid content were determined in ten fruits according to the methods described in Association of Official Agricultural Chemists (1990). Total and reducing sugars were determined by the method described by Shales and Schales (1945).

4- **Statistical analysis:** Analysis of data was done according to Duncan (1955).

RESULTS AND DISCUSSION

1- Vegetative growth characters :

It is clear from results presented in Table (1) that significant increments in leaf area and root length were observed for Camarosa plants as compared with those of Sweet Charlie. While Sweet Charlie plants showed a significant increase in number of roots as compared with the other tested cultivar. As for the main effect of nursery plant system, results indicated that establishment of nursery on raised beds reflected significant increments in number of leaves, leaf area, number of roots and root length in the two tested seasons. These results agree with those of Dana (1980). The enhancing effect of the afore-mentioned treatment could be expected since raised beds reflected promoting effects on the morphology and/or physiology of root system which in turn encouraged the vegetative growth to go forward. As respect to the main effect of mother plant spacing, results showed that number of leaves was not affected with nursery spacing in the two tested seasons. On the other and, there were significant increments in leaf area, number of roots and root length of plants with increasing nursery plant distance.

Table (1): **Main effects of cultivar, nursery planting system and mother plant spacing on number of leaves, leaf area, number of roots and root length of strawberry plants.**

Cultivar	Planting system	Nursery spacing	No. of leaves/plant	Leaf area (cm^2)	No. of Roots/plant	Root length (cm)
			2000/2001			
SC			15.38a	45.89b	34.65a	18.66b
C			16.00a	52.17a	30.27b	21.26a
	F		13.73b	45.15b	29.59b	17.96b
	Rb		17.65a	52.92a	35.34a	22.02a
		D1	15.26a	44.66c	30.27b	16.71d
		D2	15.68a	48.19b	30.79b	19.13c
		D3	15.66a	50.83a	32.40b	20.29b
		D4	16.18a	52.46a	36.39a	23.70a
			2001/2002			
SC			15.52b	46.83b	34.73a	19.03b
C			16.28a	52.63a	30.86b	22.25a
	F		13.46b	45.88b	30.06b	18.26b
	Rb		18.33a	53.58a	35.53a	23.02a
		D1	15.42a	44.97c	29.92d	16.71d
		D2	15.98a	48.72b	31.85c	19.81c
		D3	15.98a	51.22ab	33.37b	21.40b
		D4	16.21a	54.01a	36.04a	24.64a

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1= 1.0 m D2 = 1.25 m D3 = 1.50 m D4 = 2.0 m

SC= Sweet Charlie C = Camarosa F = Flat Rb = Raised bed

Results in Table (2) showed that the interaction between cultivar and planting system was significant, the highest values of number of leaves were detected for Sweet Charlie or Camarosa when transplants produced on raised beds were used. The lowest value of leaf area was obtained from Sweet Charlie plants grown from transplants produced by flat bed planting system. This decrement was significant in the first year. The highest number of roots was detected to Sweet Charlie plants grown from transplants produced on raised bed in two tested seasons. The high number of roots may help in root structure and reflect high content of carbohydrates stored in roots which may affect positively plant growth and productivity as mentioned by Dana (1980). Results showed also that the highest values of root length was obtained from Camarosa planted with transplants produced on raised beds in the two tested seasons. Such increment in root length increased average fruit weight and explained the increase of total yield of this cultivar as shown from Table (5).

As for the interaction among the three studied factors, results presented in Table (3) showed clearly that the highest values of number of leaves were obtained from Camarosa plants which planted with transplants produced from raised beds at all different distances in both tested seasons.

Table (2): Effects of the interaction between each two factors of cultivar, nursery planting system and mother plant spacing on number of leaves, leaf area, number of roots and root length of transplants.

Cultivar	Planting system	Nursery spacing	No. of leaves/plant	Leaf area (cm^2)	No. of Roots/plant	Root length (cm)
			2000/2001			
SC	F		13.60b	39.72b	31.85b	16.73d
	Rb		17.16 a	52.07a	37.46a	20.59b
C	F		13.85b	50.58a	27.33c	19.07c
	Rb		18.14a	53.78a	33.22b	23.45a
SC		D1	14.77b	42.03c	33.52b	16.17e
		D2	15.38ab	47.22b	32.13bc	18.83c
		D3	15.43ab	46.70b	33.78b	19.00c
		D4	15.93ab	47.62b	39.18a	20.63b
C		D1	15.75ab	47.28b	27.03d	17.25d
		D2	15.97ab	49.17b	29.45cd	19.43c
		D3	15.88ab	54.95a	31.02bc	21.58b
		D4	16.38a	57.30a	33.60b	26.77a
	F	D1	13.27b	41.53d	29.25b	15.55f
		D2	13.43b	43.80d	28.65b	16.93e
		D3	14.13b	46.72c	28.73b	18.02d
		D4	14.07b	48.53c	31.72cb	21.08c
	Rb	D1	17.25a	47.78c	31.30cb	17.87de
		D2	17.92a	52.58b	32.93bc	21.33c
		D3	17.18a	54.93ab	36.07b	22.57b
		D4	18.25a	56.38a	41.07a	26.32a
			2001/2002			
SC	F		12.98 b	40.97a	32.09b	17.02d
	Rb		18.05 a	52.68ab	37.37a	21.03b
C	F		13.94 b	50.79b	28.02c	19.50c
	Rb		18.62 a	54.47a	33.69b	25.01a
SC		D1	14.20b	43.72c	33.18b	15.92g
		D2	15.80ab	47.08bc	32.97b	18.95e
		D3	15.85ab	46.73bc	34.13b	19.97de
		D4	16.22ab	49.78b	38.63a	21.27c
C		D1	16.63a	46.22bc	28.65d	17.50f
		D2	16.17ab	50.37b	30.73c	20.67cd
		D3	16.12ab	55.70a	32.60b	22.83b
		D4	16.20ab	58.23a	33.45b	28.02a
	F	D1	12.20b	43.05e	29.75d	15.38f
		D2	13.92b	43.82e	30.13d	17.42e
		D3	13.82b	47.08de	30.02d	19.00d
		D4	13.92b	49.58cd	30.33d	21.23c
	Rb	D1	18.63a	46.88de	30.08d	18.03de
		D2	18.05a	53.63bc	33.57c	22.20c
		D3	18.15a	55.35ab	36.72b	23.80b
		D4	18.50a	58.43a	41.75a	28.05a

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1= 1.0 m D2 = 1.25 m D3 = 1.50 m D4 = 2.0 m

SC= Sweet Charlie C = Camarosa F = Flat Rb = Raised bed

Table (3): Effects of the interaction among cultivar, nursery planting system and mother plant spacing on number of leaves, leaf area, number of roots and root length of transplants.

Cultivar	Planting system	Density	No. of leaves/plant	Leaf area (cm^2)	No .of Roots/plant	Root length (cm)
			200/2001			
SC	F	D1	13.13c	38.00f	32.50c-f	14.77h
		D2	13.20c	41.20f	30.47d-h	16.27gh
		D3	14.30c	38.70f	30.02-h	16.73gh
		D4	13.77c	40.97f	34.40b-d	19.13ef
	Rb	D1	16.40b	46.07de	34.53b-d	17.57fg
		D2	17.57ab	53.23bc	33.80b-e	21.40cd
		D3	16.57ab	54.70ab	37.53bc	21.27cde
		D4	18.10ab	54.27b	43.97a	22.13bc
C	F	D1	13.40c	45.07e	26.00h	16.33gh
		D2	13.57c	46.40de	26.83gh	17.60fg
		D3	13.97c	54.73ab	27.43fgh	19.30def
		D4	14.37c	56.10ab	29.03e-h	23.03bc
	Rb	D1	18.10ab	49.50cd	26.07fgh	18.17fg
		D2	18.27ab	51.93bc	32.07d-g	21.27cde
		D3	17.80ab	55.17ab	34.80bcd	23.87b
		D4	18.40a	58.50a	38.17b	30.50a
			2001/2002			
SC	F	D1	10.43c	40.07f	33.57de	14.60j
		D2	13.87b	39.90f	31.83de	16.63hi
		D3	13.80b	40.33f	31.23ef	17.93ghi
		D4	13.83b	43.60ef	31.73de	18.90fg
	Rb	D1	17.97a	47.37de	32.80de	17.23ghi
		D2	17.73a	54.27bc	34.10cd	21.27de
		D3	17.90a	53.13bcd	37.03b	22.00cd
		D4	18.60a	55.97ab	45.53a	23.63c
C	F	D1	13.97b	46.03ef	25.93h	16.17ij
		D2	13.97b	47.73cde	28.43g	18.20fgh
		D3	13.83b	53.83bcd	28.80fg	20.07ef
		D4	14.00b	55.57ab	28.93fg	23.57c
	Rb	D1	19.30a	46.40ef	27.37gh	18.83fg
		D2	18.37a	53.00bcd	33.03de	23.13c
		D3	18.40a	57.57ab	36.40bc	25.60b
		D4	18.40a	60.90a	37.97b	32.47a

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1= 1.0 m **D2 = 1.25 m** **D3 = 1.50 m** **D4 = 2.0 m**

SC= Sweet Charlie **C = Camarosa** **F = Flat** **Rb = Raised bed**

Concerning leaf area, the lowest values were detected to Sweet Charlie planted with transplants produced on flat bed nursery at all used nursery spacing. On the other hand, the highest values were recorded to Sweet Charlie or Camarosa planted with transplants produced on raised bed from the two widest spacing.

Regarding number of roots, results of the two seasons showed clearly that the highest values were obtained from Sweet Charlie plants which planted with transplants produced on raised beds at 2 m plant spacing. With respect to the effect of cultivar, nursery planting system and nursery spacing on root length throughout the production period, results in Table (3) indicated that the best combination treatment that gave the highest mean value of root length was appeared to be that involved Camarosa planted with transplants from raised beds produced at the largest plant spacing (2m) in the two tested seasons.

2- Early and total yield, average fruit weight and total soluble solids

Data in Table (4) showed the effects of the three main factors, i.e., cultivar, nursery planting method and nursery plant spacing, on yield and some fruit characters in the production stage. The results clearly indicated that there was higher significant increments in total yield and average fruit weight for Camarosa cultivar as compared with Sweet Charlie. Similar findings were found by Ilgin (2002) On the other hand, Sweet Charlie reflected significant increase in early yield and TSS as compared with Camarosa in the two tested seasons. Similar results were obtained by Caglar and Paydas (2002), Libek (2002) and Khalaf (2003). Results showed also that using transplants from raised bed showed significant increments in early and total yield, average fruit weight and TSS in the two tested seasons. The increment was non-significant for TSS in the first season. Such detected enhancing effects might be related to the role of ridging on activity of plant growth and crown diameter and carbohydrate content of roots and crowns of transplant which correlated positively with yield as mentioned by Chandler *et al.* (1989), Kirschbaum *et al.* (1998) and Ragab *et al.* (2000). In Table (4) results showed also that the widest nursery spacing (2m) reflected significant enhancement on early and total yield, average fruit weight in the two growing seasons. Such results confirm those of Reekiie *et al.* (2002). Transplants produced from D3 and D2 gave the lowest values of TSS in the first and second season, respectively.

Table (4): Main effects of cultivar, nursery planting system and mother plant spacing on early and, total yield, average, fruit weight, and total soluble solids.

Cultivar	Planting system	Nursery spacing	Early yield (ton/fed.)	Total yield (ton/fed.)	Average fruit weight (g)	TSS %
			2000/2001			
SC			2.71a	16.23b	19.67b	10.15a
C			2.28b	22.80a	25.63a	9.55b
	F		2.15b	17.67b	21.49b	9.82a
	Rb		2.85a	21.36a	23.81a	9.88a
		D1	2.29d	18.13d	20.2d	9.88a
		D2	2.41c	18.90c	21.61c	9.86ab
		D3	2.51b	19.99b	23.43b	9.77b
		D4	2.79a	21.03a	25.35a	9.89a
			2001/2002			
SC			2.82a	16.97b	20.39b	10.24a
C			2.49b	23.09a	27.40a	9.50b
	F		2.27b	18.26b	22.50b	9.75b
	Rb		3.04a	21.8a	25.29a	9.99a
		D1	2.42d	15.19d	21.65d	9.80b
		D2	2.54c	18.75c	22.94c	9.83ab
		D3	2.75b	21.33b	24.24b	9.93a
		D4	2.92a	24.84a	26.76a	9.93a

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1= 1.0 m D2 = 1.25 m D3 = 1.50 m D4 = 2.0 m

SC= Sweet Charlie C = Camarosa F = Flat Rb = Raised bed

The interaction between each two factors of the nursery studied factors on early and total yield, average fruit weight and TSS are shown in Table (5).

Table (5): Effects of the interaction between each two factors of cultivar, nursery planting system and mother plant spacing on early and total yield, average fruit weight, and total soluble solids.

Cultivar	Planting system	Nursery spacing	Early yield (ton/fed.)	Total yield (ton/fed.)	Average fruit weight (g)	TSS %
			2000/2001			
SC	F		2.23b	14.34c	18.73a	10.11a
	Rb		3.21a	18.13b	20.61a	10.19a
C	F		2.08b	21.00b	24.24a	9.53b
	Rb		2.49b	24.60a	27.01a	9.58b
SC		D1	2.47bcd	14.74f	17.67e	10.15a
		D2	2.61bc	15.86ef	18.62e	10.13a
		D3	2.71ab	16.65de	20.35de	10.13a
		D4	3.08a	17.68d	22.05cd	10.18a
C		D1	2.12d	21.52c	22.73cd	9.62b
		D2	2.71cd	21.95bc	24.6bc	9.59b
		D3	2.30bcd	23.35ab	26.52ab	9.40c
		D4	2.50bcd	24.38a	28.65a	9.60b
	F	D1	1.95e	16.29h	18.98e	9.85ab
		D2	2.08e	17.13g	20.73de	9.83ab
		D3	2.18de	18.12c	22.23cd	9.73b
		D4	2.38cde	19.15d	24bc	9.85ab
	Rb	D1	2.60bcd	19.98e	21.42d	9.92a
		D2	2.74bc	20.68f	22.48cd	9.88ab
		D3	2.84ab	21.88b	24.63b	9.80ab
		D4	3.21a	22. 91a	28.7a	9.93a
			2001/2002			
SC	F		2.34b	15.19d	19.44a	10.13a
	Rb		3.30a	18.76c	21.34a	10.34a
C	F		2.20b	21.33b	25.57a	9.38c
	Rb		2.78b	24.85a	29.24a	9.63b
SC		D1	2.62bc	14.74f	18.52e	10.15b
		D2	2.72abc	15.86ef	19.72de	10.23ab
		D3	2.85ab	16.65de	20.68de	10.32a
		D4	3.10a	17.68d	22.65cd	10.25ab
C		D1	2.22d	21.52c	24.78bc	9.45d
		D2	2.36cd	21.95bc	26.17bc	9.43d
		D3	2.64bc	23.35ab	27.80ab	9.53cd
		D4	2.76ab	24.38a	30.87a	9.60c
	F	D1	2.05f	17.10g	20.37f	9.67e
		D2	2.18ef	17.68f	21.65e	9.72de
		D3	2.34de	18.61e	22.67de	9.83bcd
		D4	2.50d	19.64d	25.33bc	9.80cde
	Rb	D1	2.78c	20.65c	22.93d	9.93abc
		D2	2.90bc	21.04c	24.23c	9.95ab
		D3	3.15ab	22.24b	25.82b	10.02a
		D4	3.34a	23.27a	28.18a	10.05a

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1= 1.0 m D2 = 1.25 m D3= 1.50 m D4= 2.0 m

SC= Sweet Charlie C = Camarosa F = Flat Rb = Raised bed

Results showed that the interaction between cultivar and nursery planting system affected early yield. Whereas, Sweet Charlie planted on raised beds showed significantly the highest early yield in the two tested seasons. As for interaction effect between cultivar and distances, results in Table (5) showed that Sweet Charlie transplants that grown in the widest nursery spacing gave plants which produced the highest early yield. Results in Table (5) showed clearly that transplants grown on raised beds at 1.5 or 2 m spacing produced plants which showed the highest values of early yield in fruiting field. As for total yield, results in Table (5) indicated that Camarosa

transplants produced from raised bed gave plants produced the greatest value of total yield on the other hands, Sweet Charlie combined with flat bed showed the lowest values. Camarosa cultivar gave the highest total yield and average fruit weight when planted with transplants established at 2 m apart in the nursery. Similar results were obtained by Meesters and Ptsioudis (1997) and Ragab *et al.* (2000). Planting on raised beds in widest spacing in the nursery showed the highest values of total yield as well as average fruit weight.

As for TSS, Sweet Charlie plants produced from flat or raised bed nurseries showed significantly higher TSS as compared with Camarosa produced in either flat or raised beds (Table 5). Results showed also that using Sweet Charlie transplants produced at all plant distances showed the highest TSS. On the other hand, Camarosa plant produced from all nursery spacing gave the lowest TSS. With respect to the second degree of interaction, results in Table (6) showed that Sweet Charlie mother plants produced on raised beds at 2 m plant spacing gave the highest values of early yield in the two tested years.

Table (6): Effects of the interaction among cultivar, nursery planting system and mother plant spacing on early and total yield, average fruit weight, and total soluble solids.

Cultivar	Planting system	Nursery spacing	Early yield (ton/fed.)	Total yield (ton/fed.)	Average fruit weight(g) (g)	TSS %
			2000/2001			
SC	F	D1	2.02f	12.68l	17.2h	10.10a
		D2	2.19ef	13.93kl	17.83gh	10.10a
		D3	2.28ef	14.89jk	19.1fgh	10.07a
		D4	2.43c-f	15.88ij	20.8efg	10.17a
	Rb	D1	2.92bcd	16.81hi	18.13gh	10.20a
		D2	3.03bc	17.81gh	19.4fgh	10.17a
		D3	3.14ab	18.41fg	21.6def	10.20a
		D4	3.74a	19.48ef	23.3cde	10.20a
C	F	D1	1.96f	19.90def	20.77efg	9.60bc
		D2	1.97f	20.35de	23.63cde	9.57bc
		D3	2.07ef	21.35cd	25.37bc	9.40c
		D4	2.32def	22.41bc	27.2ab	9.53bc
	Rb	D1	2.28ef	23.15b	24.7bcd	9.63b
		D2	2.46c-f	23.55b	25.57bc	9.60bc
		D3	2.54b-e	25.35a	27.67ab	9.40c
		D4	2.68b-e	26.34a	30.1a	9.67b
			2001/2002			
SC	F	D1	2.16k	14.21l	18.13l	10.10bc
		D2	2.26j	14.53kl	19.03hi	10.17bc
		D3	2.35l	15.61jk	19.33ghi	10.20bc
		D4	2.75fg	16.42ij	21.27ghi	10.07c
	Rb	D1	3.07d	17.35hi	18.9hi	10.20bc
		D2	3.18c	18.08h	20.4ghi	10.30ab
		D3	3.34b	19.47g	22.03fgh	10.43a
		D4	3.62a	20.12fg	24.03def	10.43a
C	F	D1	1.94l	20.00fg	22.8efg	9.23e
		D2	2.10k	20.84ef	24.26def	9.27e
		D3	2.34l	21.62de	26cde	9.47d
		D4	2.44h	22.86cd	29.4abc	9.53d
	Rb	D1	2.50gh	23.95bc	26.97bcd	9.67d
		D2	2.82f	24.00bc	28.07bc	9.60d
		D3	2.95e	25.01b	29.6ab	9.60d
		D4	3.07d	26.43a	32.33a	9.67d

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1= 1.0 m D2 = 1.25 m D3= 1.50 m D4= 2.0 m

SC= Sweet Charlie C = Camarosa F = Flat Rb = Raised bed

Moreover, Camarosa planted on raised beds at 2 m recorded the highest value of total yield and average fruit weight in both seasons. Such increases in early or total yield could be related to the enhancing effects of each involved factors on the development of vegetative growth, which consequently increased the productivity per plant. Similar results were obtained by Galletta and Bringhurst (1990), Faby (1997), Meesters and Ptsioudis (1997) and Palha *et al.* (2002).

3- Chemical constituents of fruits:-

Results presented in Table (7) showed the main effect of the three studied factors on the analyzed chemical constituents of the strawberry fruits. The results of the two seasons showed that significant higher values in total and reducing sugars and ascorbic acid content in Sweet Charlie fruits as compared with those of Camarosa. On the other hand, total titratable acidity was significantly higher in Camarosa fruits when compared to those of Sweet Charlie, in the two tested seasons. Similar results were obtained by Caglar and Paydas (2002) and Khalaf (2003).

Table (7): Main effects of cultivar, nursery planting system and mother plant spacing on total and, reducing sugars, total titratable acidity and ascorbic acid content.

Cultivar	Planting system	Nursery spacing	Total sugars %	Reducing sugars %	Total titratable acidity %	Ascorbic acid (mg/100g F.W.)
			2000/2001			
SC			6.67a	3.11a	0.77b	71.73a
C			4.15b	2.17b	0.85 a	67.30b
	F		5.41a	2.64a	0.80 b	68.99b
	Rb		5.41a	2.64a	0.83a	70.05a
		D1	5.42a	2.63a	0.81d	68.94d
		D2	5.43a	2.63a	0.81c	69.03c
		D3	5.39a	2.65a	0.81b	69.68b
		D4	5.41a	2.65a	0.82a	70.42a
			2001/2002			
SC			6.69a	3.13a	0.78b	72.99a
C			4.17b	2.18b	0.87a	68.23b
	F		5.43a	2.66a	0.82b	69.89b
	Rb		5.43a	2.64a	0.84a	71.32a
		D1	5.43a	2.65a	0.82c	70.69b
		D2	5.43a	2.63a	0.84b	70.14c
		D3	5.43a	2.65a	0.83b	70.97a
		D4	5.43a	2.68a	0.83a	70.63b

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1=1.0 m D2 = 1.25 m D3=1.50 m D4 =2.0 m

SC= Sweet Charlie C = Camarosa F = Flat Rb = Raised bed

As for the effect of nursery planting system on some fruit chemical constituents, results in Table (7) demonstrated clearly that it had no significant effects on total and reducing sugars while significant increments in total acidity and ascorbic were noticed as a result of raised bed plants in the two growing seasons. As for the main effect of nursery planting spacing, results in Table (7) indicated clearly that the four nursery spacing were not significantly differed in their effects on total and reducing sugars of the fruits. Meanwhile, increments in titratable acidity and ascorbic acid were obtained by increasing plant spacing.

Concerning the interaction between each two factors from the three studied factors results in Table (8) showed that using Sweet Charlie transplants produced either on flat or raised beds resulted in significant increases in total and reducing sugars of fruits. On the other hand, the interaction between cultivar and nursery planting system did not affect total acidity in both tested season. As for ascorbic acid content, it was significantly affected in the second season and was not significantly affected by this interaction in the first season.

It is clear from results presented in Table (8) that sweet Charlie fruits had significantly higher values in total and reducing sugars and ascorbic acid content using all tested nursery planting distances without significant differences among them. On the other hand, Camarosa cultivar plants from all nursery plant spacings had fruits with the highest values of total acidity. With respect to the interaction between nursery planting system and spacing, results in Table (8) showed that it did not show any significant effect on total and reducing sugars and ascorbic acid content in the two tested seasons, except for ascorbic acid in the first season.

Regarding the interaction among the three studies factors, results in Table (9) showed that the best treatment combinations which gave the highest values of total and reducing sugars was Sweet Charlie plants produced from transplants grown on either flat or raised bed nursery combined with all nursery plant spacing in the two tested years. As for total acidity, results demonstrated in Table (9) showed clearly that the highest values were obtained from Camarosa cultivar planted with transplants produced on raised bed nurseries regardless plant distances in the two experimental years. With regards ascorbic acid content, results tabulated in Table (9) indicated that Sweet Charlie cultivar planted with transplants produced on flat or raised bed nurseries at all tested plant spacings gave higher values of ascorbic acid as compared with Comarosa combined with all tested factors in both seasons.

Table (8): Effects of the interaction between each two factors of cultivar, nursery planting system and mother plant spacing on total and reducing sugars, total titratable acidity and ascorbic acid content.

Cultivar	Planting system	Nursery spacing	Total sugars %	Reducing sugars %	Total titratable acidity %	Ascorbic acid (mg/100g F.W.)
			2000/2001			
SC	F		6.66a	3.12a	0.77a	70.95a
	Rb		6.68a	3.1a	0.78a	72.52a
C	F		4.16b	2.16b	0.83a	67.03a
	Rb		4.15b	2.18b	0.88a	67.57a
SC		D1	6.68a	3.1a	0.77b	71.37a
		D2	6.7a	3.13a	0.77b	71.25a
		D3	6.65a	3.08a	0.78b	71.8a
		D4	6.63a	3.12a	0.78b	72.52a
C		D1	4.15b	2.15b	0.85a	66.52c
		D2	4.15b	2.13b	0.85a	66.82c
		D3	4.13b	2.217b	0.85a	67.57bc
		D4	4.18b	2.18b	0.86a	68.32b
	F	D1	5.45a	2.65a	0.80b	68.63c
		D2	5.43a	2.6a	0.80b	68.47c
		D3	5.35a	2.63a	0.80b	69.07bc
		D4	5.4a	2.67a	0.81ab	69.8abc
	Rb	D1	5.38a	2.6a	0.82ab	69.25bc
		D2	5.42a	2.67a	0.83a	69.6bc
		D3	5.43a	2.67a	0.83a	70.3ab
		D4	5.42a	2.63a	0.83a	71.03a
			2001/2002			
SC	F		6.7a	3.11a	0.77a	72.28b
	Rb		6.68a	3.14a	0.79a	73.7a
C	F		4.15b	2.21a	0.85a	67.51d
	Rb		4.19b	2.14a	0.99a	68.94c
SC		D1	6.72a	3.13a	0.78b	72.98a
		D2	6.63a	3.1a	0.78b	72.45a
		D3	6.72a	3.12a	0.78b	73.25a
		D4	6.68a	3.15a	0.79b	73.27a
C		D1	4.15b	2.17b	0.86a	68.4b
		D2	4.22b	2.15b	0.87a	67.83b
		D3	4.13b	2.18b	0.87a	68.68b
		D4	4.18b	2.2b	0.78a	67.98b
	F	D1	5.4a	2.65a	0.78ab	70.25a
		D2	5.45a	2.62a	0.77b	69.33a
		D3	5.42a	2.67a	0.77ab	70.48a
		D4	5.43a	2.7a	0.79ab	69.5a
	Rb	D1	5.47a	2.65a	0.78ab	71.13a
		D2	5.4a	2.63a	0.79ab	70.95a
		D3	5.43a	2.63a	0.79ab	71.45a
		D4	5.43a	2.65a	0.80a	71.75a

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1=1.0 m D2 = 1.25 m D3=1.50 m D4=2.0 m

SC= Sweet Charlie C = Camarosa F = Flat Rb = Raised bed

Table (9): Effects of the interaction among cultivar, nursery planting system and mother plant spacing on total and reducing sugars, total titratable acidity and ascorbic acid content.

Cultivar	Planting system	Nursery spacing	Total sugars %	Reducing sugars %	Total titratable acidity %	Ascorbic acid (mg/100g F.W.)
			2000/2001			
SC	F	D1	6.73a	3.1a	0.76c	70.9a-d
		D2	6.67a	3.13a	0.76c	70.93a-d
		D3	6.6a	3.1a	0.77c	70.63a-d
		D4	6.63a	3.13a	0.78c	71.33abc
	Rb	D1	6.63a	3.1a	0.77c	71.83ab
		D2	6.73a	3.13a	0.78c	71.57abc
		D3	6.7a	3.07a	0.79c	72.97a
		D4	6.63a	3.1a	0.78c	73.7a
C	F	D1	4.17b	2.2b	0.83b	66.37e
		D2	4.2b	2.07b	0.83b	66e
		D3	4.1b	2.17b	0.82b	67.5de
		D4	4.17b	2.2b	0.84b	68.27cde
	Rb	D1	4.13b	2.1b	0.87a	66.67e
		D2	4.1b	2.2b	0.87a	67.63de
		D3	4.17b	2.27b	0.88a	67.63de
		D4	4.2b	2.17b	0.88a	68.37b-e
			2001/2002			
SC	F	D1	6.7a	3.1a	0.78ef	72.1ab
		D2	6.67ab	3.1a	0.78f	72.27ab
		D3	6.73a	3.1a	0.77ef	72.5ab
		D4	6.7a	3.13a	0.79ef	72.23ab
	Rb	D1	6.73a	3.17a	0.77ef	73.87a
		D2	6.6b	3.1a	0.79ef	72.63ab
		D3	6.7a	3.13a	0.79ef	74a
		D4	6.67ab	3.17a	0.79e	74.3a
C	F	D1	4.1d	2.2b	0.85d	68.4bc
		D2	4.23c	2.13b	0.80bcd	66.4c
		D3	4.1d	2.23b	0.85cd	68.47bc
		D4	4.17cd	2.27b	0.80cd	66.77c
	Rb	D1	4.2c	2.13b	0.88abc	68.4bc
		D2	4.2c	2.17b	0.89ab	69.27bc
		D3	4.17cd	2.13b	0.89a	68.9bc
		D4	4.2c	2.13b	0.89a	69.2bc

Any means within column followed by the same letter are not statistically different at 5% level. (Duncan's multiple range test).

D1=1.0 m D2 = 1.25 m D3=1.50 m D4 =2.0 m

SC= Sweet Charlie C = Camarosa F = Flat Rb = Raised bed

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توقعات النجاح لنظام زراعي معدل لمشاتل الفراولة وعلاقته بإنتاج الثمار تحت الأقبية البلاستيكية المنخفضة

٢- نمو النبات والإنتاجية وجودة الثمار

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أجريت هذه الدراسة في مزرعة تجارب مركز تنمية الفراولة بالنوبارية خلال موسمي ٢٠٠٠/ ٢٠٠١ و ٢٠٠١/٢٠٠٢ في تربة رملية حديثة الاستزراع بهدف دراسة تأثير الصنف وطريقة زراعة المشتل ومسافة زراعة الأمهات في المشتل على بعض صفات نمو النبات والمحصول ومواصفات الثمار بعد زراعة تلك الشتلات بنظام الزراعة الفرش (بعد تقليع الشتلات دون تجميد) تحت الأقبية البلاستيكية.

توضح النتائج زيادة عدد الأوراق لنبات ومساحة سطح الورقة وعدد الجذور وطولها عند زراعتها بشتلات كانت نامية على مصاطب مقارنة بتلك المنزرعة بشتلات ناتجة في التربة المنبسطة وكانت هناك زيادة معنوية في كل صفات النمو الخضري المدروسة بزيادة مسافة زراعة الأمهات في المشتل خلال موسمي الدراسة ما عدا عدد الأوراق في الموسم الثاني وأظهرت شتلات الصنف سويت شارلي الناتجة على مصاطب زيادة في عدد الجذور.

أعطت شتلات صنف الكماروزا الناتجة على مصاطب على أكبر مسافة زراعة (٢م) أعلى القيم في طول جذور النبات . توضح النتائج وجود زيادة معنوية في المحصول الكلي ومتوسط وزن الثمرة في الصنف كماروزا مقارنة بصنف سويت شارلي ومن ناحية أخرى أعطت نباتات الصنف سويت شارلي زيادة معنوية في المحصول المبكر والمواد الصلبة الذائبة خلال موسمي الدراسة .

تظهر النتائج وجود زيادة معنوية في كل من المحصول المبكر والكلي ووزن الثمرة عند الزراعة بشتلات ناتجة بطريقة المصاطب وقد عكست مسافات الزراعة الواسعة في المشتل زيادة معنوية في المحصول المبكر والكلي ومتوسط وزن الثمرة خلال موسمي الزراعة.

يظهر التفاعل أن شتلات صنف سويت شارلي الناتجة من مشاتل تم زراعتها بطريقة المصاطب على مسافة زراعة في المشتل قدرها ٢ متر أعطت أعلى محصول مبكر بينما أعطت شتلات الكماروزا المنزرعة على مصاطب أعلى محصول كلي ومتوسط وزن الثمرة. أظهرت نباتات الصنف سويت شارلي المنزرعة بطريقة المصاطب أو الطريقة التقليدية المسطحة أعلى نسبة مواد صلبة ذائبة في الثمار. توضح النتائج أيضا أن شتلات الصنف سويت شارلي الناتجة سواء بطريقة المصاطب أو الأرض المسطحة وعلى جميع مسافات الزراعة أعطت أعلى القيم للسكريات الكلية والمختزنة وحمض الأسكوربيك في الثمار بينما أعطت نباتات الكماروزا الناتجة من مشاتل زرعت بنظام المصاطب في جميع مسافات الزراعة المستخدمة أعلى حموضة كلية في الثمار .

تبرز النتائج أهمية زراعة مشاتل الفراولة بطريقة المصاطب وعلى مسافات واسعة لما لهذا من تأثير موجب على تحسين صفات الجودة في الشتلات والذى ينعكس أثره على تحسين نمو النبات وإنتاج وجودة الثمار عند زراعة الفراولة في حقول الإنتاج تحت الأنفاق .