Egypt. J. Hort. 29, No 3-4 pp. 441 – 459 (2002)

Effect of Growing Levels, Cultivation Side and Transplant Production Method on Production and Quality of Strawberry Grown in Nutrient Film Technique (NFT) Using "A- Shape" System

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THE EXPERIMENT was conducted in the Central Laboratory for Agriculture Climate Experimental Station, EL-Dokki, Cairo, Egypt to investigate the effect of growing levels, cultivation side and transplants production method on production and quality of strawberry (*Fragaria* x *ananassa)* cv Camarosa. The experiment was carried out during 1999/2000 and 2000/2001 seasons. The experiment included three growing levels of NFT channels by using "A- SHAPE" system (top, middle and bottom), two cultivation sides (north and south) and two transplant production methods: Conventional transplants (runners separated from the mother plants and propagated in the nursery) and plugged transplant (runners left connected with mother plants and cultivated in bags filled with substrates until rooted).

Results indicated that there was an effect for growing levels on strawberry vegetative growth and production where, the top level gave the highest vegetative growth and yield followed by the bottom then the middle level.

Cultivation side also had an effect on vegetative growth and production where the plant cultivated in the south side (facing sun) gave the highest growth and yield.

Production method of the transplanting also affected the growth and yield where the plugged transplant gave the highest growth and yield compared to conventional transplant.

The treatments also affected the fruit quality where the plants faced the sun (south side) produced fruits with high vitamin C, but with low acidity, low firmness and vice versa for the plants in the north side.

No significant differences were observed among the treatments concerning total leaves area and TSS.

Strawberry is one of the most important crops in Egypt for export. The most important problem facing strawberry production is the loss of plants due to soil pathogens and nematodes. These problems resulted from the intensive cultivation and continuous cropping which inevitably leads to pests and disease problems in the soil. The accumulation of these problems may lead to a loss of yield and eventually failure of the crop. Cropping can only continue if some form of soil sterilization is economically viable. For this reason, soil disinfection is a common practice in strawberry production, even in the open field. Soil disinfection is carried out by using chemicals, especially methyl bromide (Ozeker *et al.*, 1999). Owing to the bromine residues in soil, underground water and crops, using methyl bromide for soil disinfection is banned or minimized in many countries (Jensen & Collins, 1985 and Benoit, 1989) and it will not be permitted after few years in Egypt. However, alternatives to methyl bromide can also have adverse effects on human health and environment (Ozeker *et al.*, 1999).

For the production to continue, there is inevitably a trend towards some forms of soilless or soil replacement cultivation. This does not, however, remove all the problems; it simply creates a new set (Burrage, 1999).

Soilless cultivation of strawberry can be good alternative to solve the problems of soil sterilization and also has some further advantages related to the improvement of plant growth, yield and earliness (Granquvist, 1981 and Van Winden, 1988).

On the other hand, the efficient use of available water in the Mediterranean country becomes important. Traditional techniques may be highly productive but their relative use of water may be high due to run off and infiltration. As a result of that, the relative water use efficiency will be lower. Soilless techniques also offer a way of improving water use efficiency and obtaining better water management in crop production.

There are many methods of growing strawberry in soilless culture such as pipe system (Lieten, 1997) vertical bag (Ozeker, 1999) and A-Shape NFT system, (EL Behairy *et al.*, 2001a).

Vertical soilless systems provide a possibility of increasing plant density in greenhouse more effectively. It has been reported that planting density could be increased three times with the vertical bag system of 240000 plants/ha compared to the conventional system of 80000 plants/ha (Köseoğu *et al.*, 1997). Nevertheless, substrates used in vertical bags should have higher water holding capacity, well aeration and lower bulk density to avoid weight loads to the greenhouse construction (Paraskevopoulov *et al.*, 1990).

"A-Shape " system can be also a good method of increasing plant density in greenhouses but this system also has some problems such as the effect of the cultivation side on the yield. EL Behairy *et al.* (2001b) mentioned that plants cultivated in the south side (facing the sun under Egyptian condition) had produced higher yield than plant cultivated in the north side.

On the other hand, propagation method of the transplants affect strawberry growth and yield positively, Bish *et al.* (1997) reported that strawberry grown in plug for 2 weeks prior to planting date give higher yield comparing with the plant cultivated with conventional method. Furthermore, Hennion *et al.* (1997) reported that yield from strawberry planted by plugged runner gave a higher yield than the field grown strawberry transplant, though the high costs of producing such plugged transplants, could offset by the yield and the ease of establishment.

The aim of this experiment was to study the effect of growing level, cultivation side and transplant production methods on strawberry yield and fruit quailty.

Material and methods

The experiment was conducted at Central Laboratory for Agricultural Climate Research Station, Dokki, Egypt during 1999/2000 and 2000 /2001 seasons.

Strawberry transplants c.v Camarosa were used for this experiment. Transplants were produced with two methods. The first method (conventional transplant) was used by taking the runners from the mother plants then placed in fungicide (Rhizolix) for 20 min then, planted in small bottom perforated plastic bags (about 250 mill) filled with peat +vermiculite 1:1 (v/v). Bags were kept under mist condition for one week until the roots appeared. Transplants were kept under low tunnel cover with shading materials for another week. In the second method of propagation (plugged transplants), runners connected with the mother plant were planted in perforated plastic bags filled with peat +vermiculite 1:1 (v/v) until the seedling rooted then seedlings were cut off from the mother plants, and kept under low tunnel until transplants were completely rooted.

Nutrient Film technique NFT consisted of A-shape iron frame, as described by El-Behairy (2000) with dimensions of 100 * 100 * 80 cm, then aluminum gullies with dimensions of 11 * 10 * 11 cm and 3 m length, lined with black polyethylene 750 micron, where fixed on this frames on 40 cm for the following distance from soil surface to perform the bottom level, 25 cm from the bottom

level to preform the middle level and 25 cm from the middle level to preform the top level, *i.e.* three growing levels.

The nutrient solution used in this experiment was the nutrient solution described by El -Behairy (1994). The desired initial concentration of the nutrient solution was attained by suitable dilution of the stock solutions with tap water. The solution volume was adjusted twice a week. The electrical conductivity was adjusted to 2.5 m mhos using Orion portable meter Type 150 and the pH was adjusted to 6.0 using Orion pH meter Type 230.

Number of leaves, total leaf area, early and total yields and fruit firmness, acidity, vitamin C and TSS were measured in the ripe fruits according to the methods described by ADAS/MAFF (1987).

The experiments were arranged in factorial randomized block design with four replicates of 14 plants in each plot. Analysis of variance was conducted according to Snedecor & Cochran (1989). Statistical analysis was carried out by M-state program at the computer unit in ALARU. F-test was carried out by performing the analysis of variance (ANOVA) of the data collected at 0.05 levels and L.S.D.was estimated to compare the treatment means.

Results

Figure 1 illustrated the effect of cultivation side and growing levels on quantum received by strawberry plants grown in "A-shape". Data showed that the side exposed to the south received more quantum than the plants cultivated in the north side. On the other hand, plant grown on the top level received more quantum than the middle, then the bottom level. The highest plants received quantum were the plants grown in the top level cultivated in the south side, which received more than 650μ mol/m^2/sec that is favorable to the photosynthesis

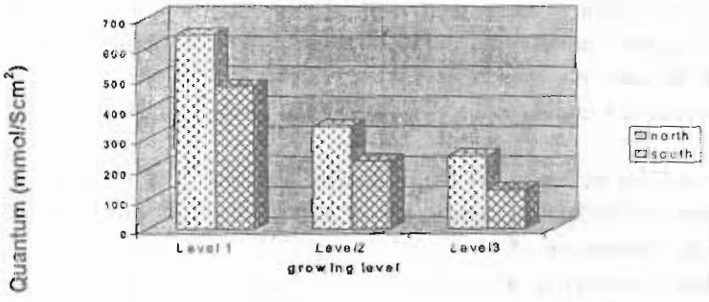

Fig 1. The effect of different growing levels, orientation on quantum received by strawberry grown in 'A-shape".

The effect of different growing levels, cultivation side and propagation method of transplants on number of leaves for strawberry grown in "A-Shape" system is presented in Table 1. Data showed that there was no significant difference regarding the cultivation side on number of strawberry leaves. On the contrary, the highest number of leaves was obtained in the top level comparing with the other two levels. There were no significant differences between the top and bottom level. Regarding transplant production method, data showed that using the plugged transplants gave the highest number of leaves/plant. Regarding the interaction between the cultivation side and level, data showed that there was no significant difference between the two sides of cultivations in all levels. The plants cultivated in the south side on the top level followed by the north side on the top level also obtained the highest number of leaves. The differences between these two treatments and the other treatments were significant.

There were no significant differences regarding the interaction between the cultivation side, cultivation levels and propagation methods.

Similar trend was obtained in the second season regarding number of strawberry leaves.

Table 2 illustrated the effect of different growing levels; cultivation side and transplant production method on total leaves area of strawberry grown in "A-Shape." Data showed that as found in number of leaves, there was no effect for cultivation side on total leaves area. On the other hand, the plant grown in the top level gave the highest total leaves area comparing with the other two levels. There was no significant difference between the other two levels. Transplant production method also affected the total leaves area where the plugged plants gave the highest total leaves area comparing with the conventional ones. There was effect for the interaction between the cultivation side and the growing level where the highest total leaves area was obtained by the plants cultivated in the south on the top level. The differences between this treatment and the other treatments were significant. No effects were observed concerning the other interactions among the experimental factors. Similar trend was observed in the second season.

TABLE 1. The effect of different growing levels, cultivation side and transplants production method on number of leaves for strawberry grown in 'A-shape".

Prodion method	Cultivation side	Growing levels			
		Top	Middle	Bottom	Mean
First season					
Plugged	North	16.45	9.72	11.57	12.58
	South	23.81	16.31	11.56	17.26
	Mean	20.13	13.02	11.61	14.92
Conventional	North	11.93	9.33	8.89	10.05
	South	11.19	8.59	10.44	10.07
	Mean	11.56	8.96	9.67	10.06
Orientation*levels interaction					
	North	14.19	9.53	10.23	11.32
	South	17.50	12.45	11.05	13.67
Levels mean		15.84	10.99	10.64	12.49
Second season					
Plugged	North	18.00	10.20	12.30	13.50
	South	25.30	17.20	12.30	18.27
	Mean	21.65	13.70	12.30	15.88
Conventional	North	10.90	10.00	9.00	9.97
	South	12.30	9.30	11.30	10.97
	Mean	11.60	9.65	10.15	10.47
Orientation*levels interaction					
	North	14.45	10.10	10.65	11.73
	South	18.8	13.25	11.80	14.62
Levels mean		16.63	11.68	11.23	13.18

	First season	Second season
LSD for	5%	5%
Cultivation side (C)	n.s	n.s
Levels (L)	3.00	2.50
Propagation methods (P)	2.45	2.04
C*L	4.24	3.53
C*P	n.s	n.s
L*P	n.s	n.s
C*L*P	n.s	n.s

TABLE 2. The effect of different growing levels, cultivation side and transplants production method on total leaves area of strawberry grown in 'A-shape".

Transplant Production method	Cultivation side	Growing levels			
		Top	Middle	Bottom	Mean
First season					
Plugged	North	2550.3	1700.3	1200.5	1817.1
	South	3210.7	1020.0	1300.0	1840.6
	Mean	2876.0	1360.2	1250.3	1828.8
Conventional	North	1200.6	950.2	1090.8	1080.5
	South	2300.5	1015.2	950.0	1421.9
	Mean	1750.6	982.7	1020.4	1251.2
Orientation*levels interaction					
	North	1875.5	1325.3	1145.7	1448.8
	South	2751.1	1017.6	1125.0	1631.2
Levels mean		2313.3	1171.4	1135.33	1540.0
Second season					
Plugged	North	2547.9	1679.8	1211.4	1813.0
	South	3175.9	1050.0	1226.9	1811.6
	Mean	2852.9	1364.9	1219.1	1812.3
Conventional	North	1196.8	885.0	1086.2	1056.0
	South	2289.8	1008.0	942.2	1412.3
	Mean	1743.3	946.5	1014.2	1234.7
Orientation*levels interaction					
	North	2723.9	1029.0	1084.5	1612.5
	South	2723.9	1029.0	1084.5	1612.5
Levels mean		2298.1	1155.7	1116.7	1523.5

		First season		Second season
LSD for:		5%		5%
Cultivation side (C)	:	n.s		n.s
Levels (L)			424.9	354.2
Propagation methods (P)	:	346.9		289.3
C*L	:	600.9		500.9
C*P	:	n.s		n.s
L*P	:	n.s		n.s
C*L*P	:	n.s		n.s

Table 3 presented the effect of different treatments on early yield of strawberry. Regarding the cultivation side in the first season, data showed that there was a significant increase of early yield when the plants were cultivated in the south comparing with that cultivated in the north. Regarding the growing level, it is clear that the plants cultivated in the top level obtained the highest early yield followed by the middle level then the bottom level. The differences among the treatments were significant . On the other hand, using plugged plants gave higher early yield compared to using the conventional transplants. The difference was significant. Regarding the interaction between the cultivation sides and growing level, data showed that the highest early yield was obtained by growing the plants on the top level oriented to the south followed by plants grown on the top also but cultivated in the north. The difference between these two treatments was significant. On the other hand, the differences between these two treatments and the other treatments were significant. Data also showed that using the plugged transplants cultivated in the south gave the highest early yield followed by the plugged plants cultivated in the north then the other treatments.

There was a significant increase in the first treatment compared to the other treatments. Using plugged plants on all levels gave the highest early yield compared to the conventional seedlings. Also, there was a gradual reduction in the early yield when the plants cultivated from the top to the bottom. The differences were significant in the plugged plants in different levels and only in the top level with conventional transplants. Three was no significant difference between the middle and the bottom levels with conventional seedlings.

The interaction among the cultivation side, growing level and transplant production method was significant where, the highest early yield was obtained by growing plugged plants on the top level cultivated in the south followed the same type of plants on the same level but cultivated in the north. On the contrary, the conventional transplants grown in the bottom level cultivated in the north on the lowest yield.

Similar trend was obtained in the second season except that there was no significant difference regarding the effect of the cultivation side on the early yield.

Similar trends as the early yield were found in both seasons regarding the total yield where the highest total yield was obtained by using the plugged plants grown on the top level cultivated in the south (Table 4).

TABLE 3. The effect of different growing levels, cultivation side and transplants production method on early yield of strawberry grown in 'A-shape"

Transplant Production method	Cultivation side	Growing levels			
		Top	Middle	Bottom	Mean
First season					
Plugged	North	172.5	125.0	140.0	145.8
	South	255.0	145.0	110.5	170.2
	Mean	213.8	135.0	125.3	158.0
Conventional	North	37.50	32.00	19.50	29.67
	South	69.50	24.00	30.50	41.33
	Mean	53.50	28.00	25.00	35.50
Orientation*levels interaction					
	North	105.0	78.50	79.80	78.80
	South	162.3	81.50	70.50	105.8
Levels mean		133.6	81.50	75.13	96.75
Second season					
Plugged	North	175.0	130.0	142.0	149.0
	South	265.0	154.0	120.0	179.7
	Mean	220.0	142.0	131.0	164.3
Conventional	North	40.00	32.00	23.00	31.67
	South	69.50	52.00	62.00	61.17
	Mean	54.75	42.00	42.50	46.42
Orientation*levels interaction					
	North	107.5	81.00	82.50	90.33
	South	167.3	103.0	91.0	120.42
Levels mean		137.4	92.00	86.75	105.4

LSD for:		Second season 5%	First season 5%
Cultivation side (C)	:	2.64	n.s
Levels (L)	:	3.24	3.05
Propagation methods (P)	:	2.64	2.49
C*L	:	4.31	4.58
C*P	:	4.31	4.58
L*P	:	4.31	4.58
C*L*P	:	6.48	6.10

TABLE 4. The effect of different growing levels, cultivation side and transplants production method on total yield of strawberry grown in 'A-shape".

Transplant Production method	Cultivation side	Growing levels			
		Top	Middle	Bottom	Mean
First season					
Plugged	North	739.0	626.6	495.6	620.4
	South	990.0	784.0	681.0	818.3
	Mean	864.5	705.3	588.3	719.4
Conventional	North	502.6	413.3	330.2	415.4
	South	663.6	529.5	465.3	552.8
	Mean	583.1	471.4	397.8	484.1
Orientation*levels interaction					
	North	620.8	520.0	412.9	517.9
	South	826.8	656.8	573.2	686.6
Levels mean		723.8	588.4	493.1	601.7
Second season					
Plugged	North	732.0	621.3	486.3	613.2
	South	1003.6	807.5	696.6	835.9
	Mean	867.8	714.4	591.5	724.6
Conventional	North	509.3	418.5	331.20	419.7
	South	671.6	538.0	469.6	559.7
	Mean	590.5	478.3	400.4	489.7
Orientation*levels interaction					
	North	620.7	519.9	408.8	516.4
	South	837.6	672.8	583.1	697.8
Levels mean		729.1	596.3	495.9	607.1

	First season	Second season
LSD for:	5%	5%
Cultivation side (C) :	46.17	44.22
Levels (L) :	56.54	54.16
Propagation methods (P)	46.17	44.22
C*L :	79.97	76.60
C*P :	79.97	76.60
L*P	79.97	76.60
C*L*P	n.s	n.s

The effect of different growing levels cultivation side and propagation methods on fruit firmness is illustrated in Table 5. Data showed that only the cultivation side and the growing levels had the effect on strawberry firmness where cultivating the plants in the north increased fruit firmness significantly compared to the cultivation in the south. Also, growing the plants in the bottom level increased the fruit firmness significantly compared to the top level. There was no significant effect of the other factors on the fruit firmness. Similar trend was obtained in the second season.

Regarding the effect of the treatments on total soluble solids, data showed that there was no effect of all the treatments on TSS (Table 6).

On the contrary, fruit acidity was affected by the treatments where, by cultivating the plants in the north the fruit acidity increased. Also, growing the plants towards the bottom increased fruit acidity significantly (Table 7). On the other hand, using the plugged plants redueed fruit acidity significantly compared to conventional transplants.

Regarding the interaction between the cultivation side and the levels, data showed that acidity increased when the plants were grown in the bottom and in the middle compared to the top level. Also, cultivating the plants in the north increased fruit acidity.

There were no significant effects of the interaction between the cultivation side, propagation methods and growing level on fruit acidity.

The effect of the treatments on vitamin C contents of strawberry fruits is illustrated in Table 8 . Data showed that only the cultivation sides, levels, and the interaction between them had affected the vitamin C contents of strawberry fruits significantly where cultivating the plants in the south increased vitamin C contents significantly comparing with the south. On the other hand, strawberry fruits produced from plants on the top level had a higher vitamin C contents comparing with the other treatments. On the contrary, there was no significant difference between the fruits produced from plants in the middle and bottom levels. Regarding the interaction between the cultivation side and the level on vitamin C contents in the fruits, data showed that the highest contents obtained in the fruits produced on the top cultivated in the south followed by plants in the bottom and middle cultivated in the south. There was a significant increase among the treatments.

TABLE 5. The effect of different growing levels, cultivation side and transplants production method on fruit firmness of strawberry grown in 'A-shape".

Transplant Production method	Cultivation side	Growing levels			
		Top	Middle	Bottom	Mean
First season					
Plugged	North	7.57	7.93	8.76	8.08
	South	6.30	5.70	6.07	6.02
	Mean	6.93	6.82	7.40	7.05
Conventional	North	7.37	7.23	8.43	7.68
	South	6.37	6.07	7.00	6.48
	Mean	6.87	6.65	7.72	7.08
Orientation*levels interaction					
	North	7.47	7.58	8.58	7.88
	South	6.33	5.88	6.53	6.25
Levels mean		6.90	6.73	7.56	7.06
Second season					
Plugged	North	7.70	7.88	8.88	8.16
	South	6.13	5.60	5.73	5.82
	Mean	6.92	6.74	7.31	6.99
Conventional	North	7.57	7.63	8.53	7.91
	South	6.17	5.75	5.98	5.97
	Mean	6.87	6.69	7.26	6.94
Orientation*levels interaction					
	North	7.63	7.76	8.71	8.03
	South	6.15	5.68	5.86	5.89
Levels mean		6.89	6.72	7.28	6.69

LSD for:		First season 5%	Second season 5%
Cultivation side (C)	:	0.54	0.56
Levels (L)	:	0.66	0.69
Propagation methods (P)		n.s	n.s
C*L	:	n.s	n.s
C*P		n.s	n.s
L*P		n.s	n.s
C*L*P		n.s	n.s

TABLE 6. The effect of different growing levels, cultivation side and transplants production method on fruit TSS of strawberry grown in 'A-shape"$_z$

Transplant Production method	Cultivation side	Growing levels			
		Top	Middle	Bottom	Mean
First season					
Plugged	North	7.00	6.88	7.38	7.09
	South	7.32	6.62	6.95	6.96
	Mean	7.16	6.75	7.17	7.03
Conventional	North	7.28	6.68	7.12	7.03
	South	7.48	6.60	6.65	6.91
	Mean	7.38	6.64	6.88	6.97
Orientation*levels interaction					
	North	7.14	6.78	7.25	7.06
	South	7.40	6.61	6.80	6.94
Levels mean		7.27	6.70	7.03	7.00
Second season					
Plugged	North	6.90	7.00	7.20	7.03
	South	7.10	6.50	6.80	6.80
	Mean	7.00	6.75	7.00	6.92
Conventional	North	7.20	6.50	7.20	6.97
	South	7.50	6.30	6.90	6.90
	Mean	7.35	6.40	7.05	6.93
Orientation*levels interaction					
	North	7.05	6.75	7.20	7.00
	South	7.30	6.40	6.85	6.85
Levels mean		7.18	6.58	7.03	6.93

		First season	Second season
LSD for:		5%	5%
Cultivation side (*C*)	:	n.s	n.s
Levels (*L*)	:	n.s	n.s
Propagation methods (P)	:	n.s	n.s
C*L	:	n.s	n.s
C*P	:	n.s	n.s
L*P	:	n.s	n.s
C*L*P	:	n.s	n.s

TABLE 7. The effect of different growing levels, cultivation side and transplants production method on fruit acidity of strawberry grown in 'A-shape".

Transplant Production method	Cultivation side	Growing levels			
		Top	Middle	Bottom	Mean
First season					
Plugged	North	12.18	15.08	15.78	14.35
	South	10.00	8.60	12.50	10.37
	Mean	11.09	11.84	14.14	12.36
Conventional	North	12.72	16.83	16.27	15.27
	South	13.50	12.47	12.77	12.91
	Mean	13.11	14.65	14.52	14.09
Orientation*levels interaction					
	North	12.45	15.96	16.03	14.81
	South	11.75	10.53	12.63	11.64
Levels mean		12.10	13.25	14.33	13.23
Second season					
Plugged	North	11.78	14.89	15.00	13.69
	South	9.89	9.59	12.93	10.80
	Mean	10.84	11.94	13.97	12.25
Conventional	North	12.54	17.92	17.85	16.10
	South	13.71	12.98	13.00	13.23
	Mean	13.13	15.45	15.43	14.67
Orientation*levels interaction					
	North	12.16	16.11	16.43	14.90
	South	11.80	11.29	12.97	12.02
Levels mean		11.98	13.70	17.70	13.46

LSD for:		First season 5%	Second season 5%
Cutlivation side (C)	:	0.89	0.75
Levels (L)	:	1.09	0.92
Propagation methods (P)	:	0.89	0.75
C*L	:	1.54	1.30
C*P	:	n.s	n.s
L*P	:	n.s	n.s
C*L*P	:	n.s	n.s

TABLE 8. The effect of different growing levels, cultivation side and transplants production method on vitamin C contents of strawberry grown in 'A-shape".

Transplant Production method	Cultivation side	Growing levels			
		Top	Middle	Bottom	Mean
First season					
Plugged	North	68.20	59.20	60.00	62.47
	South	73.00	70.00	74.00	72.33
	Mean	70.60	64.60	67.00	67.40
Conventional	North	65.00	62.00	60.00	62.33
	South	75.00	72.00	71.00	72.67
	Mean	70.00	67.00	65.50	67.50
Orientation*levels interaction					
	North	66.60	60.60	60.00	62.40
	South	74.00	71.00	72.50	72.50
Levels mean		70.30	65.80	66.25	67.45
Second season					
Plugged	North	68.65	60.57	59.83	63.02
	South	72.17	73.83	67.83	71.28
	Mean	70.41	67.20	63.83	67.15
Conventional	North	68.88	61.00	57.17	62.35
	South	73.27	71.87	70.10	71.74
	Mean	71.08	66.43	63.63	67.05
Orientation*levels interaction					
	North	68.77	60.78	58.50	62.68
	South	72.72	72.85	68.97	71.51
Levels mean		70.74	66.82	63.73	67.10

LSD for:		First season 5%	1%	Second season 5%	1%
Cultivation side (C)	:	1.47	2.00	2.41	3.27
Levels (L)	:	1.81	2.45	2.95	4.01
Propagation methods (P)	:	n.s	n.s	n.s	n.s
C*L	:	2.55	3.47	4.17	5.67
C*P	:	n.s	n.s	n.s	n.s
L*P	:	n.s	n.s	n.s	n.s
C*L*P	:	n.s	n.s	n.s	n.s

Discussion

The previous results indicated that there were positive effects for transplant propagation method, orientation and growing levels on strawberry plant growth and fruit yield. Using plugged plants in NFT system increased early and total yield, number of leaves and leaves area. These increases could be explained as the favourable growth of the plugged plant where plants were planted in the system with intact roots without any damage to the roots, while the root in the conventional transplant was damaged during the cut off from the nursery. Thus the transplants were much smaller than the plugged ones and the root produced under mist propagation was not enough to compensate the damaged roots. Bish *et al.* (1997) and Hennion *et al.* (1997) found that starting the cultivation using the plugged transplants produced higher yield and higher plant growth and they suggested that bigger plants gave higher leaves area increased the photosynthesis, which reflected on the yield. On the other hand, growing levels had a positive effect on the early & total yield and also plant growth where the plants grown in the top level gave plant growth and early and total yield than those grown in the other levels. The results could be attributed to the amount of solar radiation received by the plants in the upper level than the other levels. High light intensity is required (more than 650 μ mol/m^2/sec) for increasing leaves area (Ceulemans *et al.*, 1986). The increases of the plant growth with the higher light intensity increase the early and total yield. Meanwhile, cultivation side had an effect on the yield where plants cultivated in the south exposed to more sun that encourage plant growth and the yield compared to cultivation in the north. On the other hand, exposing the fruit to the sun reduced fruit firmness and acidity and increased vitamin C without affecting the TSS.

Conclusion

It can be concluded that using plugged strawberry transplants in NFT could be more profitable in NFT than conventional transplants, also exposing strawberry plant to more sun produced more fruits. This can obtained under the Egyptian condition by changing the orientation of the "A shape" 30° towards the East to get more even distribution of the sun in both sides.

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(*Received* 6/9/2002)

تأثير مستوى النمو و اتجاه الزراعة و طريقة انتاج الشتلات على نمو وإنتاجية وجودة ثمار نباتات الفراولة النامية فى نظام تقنية الغشاء المغذى هرمية الشكل

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تم أجراء التجربة فى صوبة الأبحاث الخاصة بالمعمل المركزى للمناخ الزراعى بالدقى وذلك لدراسة تأثير مستوى الزراعة وإتجاه الزراعة و (شمال وشرق) وطريقة انتاج شتلة الفراولة على انتاجية وجودة ثمار الفراولة صنف كماروزا . تم إجراء التجربة فى موسمى ١٩٩٩– ٢٠٠٠ الى ٢٠٠١و قد إشتملت التجربة على المعاملات التالية :

١– تنمية الشتلات فى ثلاثة مستويات من الزراعة فى نظام تقنية الغشاء المغذية نمط المزارع الهرمية (مستوى علوى – مستوى سفلى)

٢– إتجاهين للزراعة (جهة الشمال – جهة الجنوب)

٣– نوعين من الشتلات منتجة بطريقتين وهما : أ الطريقة العادية حيث تترك المدادات لتجذر فى التربة وتقلع هذه المدادات بعد ذلك . ب – الطريقة المعدلة وهى بأن توجه المدادات لتجذر فى أكياس محتوية على بيئة الزراعة .

وقد اوضحت التجارب ما يلى :–

١– كان هناك تأثير معنوى لمستوى الزراعة على المجموع الخضرى حيث سجلت النباتات النامية فى الدور العلوى أعلى درجة نمو ومحصول متبوعة بالدور السفلى ثم بعد ذلك الدور الأوسط .

٢– اتجاه الزراعة كان لها تأثير على النمو والانتاجية للنبات حيث النباتات النامية فى إتجاه الجنوب (مواجهه الشمس) سجلت أعلى مستوى نمو ومحصول مقارنة بالنباتات النامية فى إتجاه الشمال وكان محتوى الثمار الناتجة من فيتامين ج مرتفع مقارنة بالنباتات النامية فى جهه الشمالية فى حين انخفضت حموضة وصلابة هذة الثمار .

٣– كان لطريقة انتاج الشتلة المنتجة تأثير واضح على نمو النباتات و إنتاجية النباتات حيث الشتلات المنتجة بالطريقة المعدلة (المجذرة فى بيئات صناعية) سجلت اعلى معدل نمو ومحصول لنبات .

لم يكن لى من المعاملات السابقة أى تأثير على مساحة الورقة الكلى وكذلك محتوى الثمار من المواد الذائبة الصلبة الكلية .