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## Effects of the Different Growing Media on the Yield and Quality of Some Strawberry (*Fragaria × ananassa*) Cultivars

M. Ilgın, A. Çolak and N. Kaşka  
Department of Horticulture, Faculty of Agriculture,  
Kahramanmaraş Sutcu Imam University,  
Kahramanmaraş, Turkey

**Abstract:** This study was carried out during 1998-99 and 1999-2000 vegetation periods under a glasshouse in K. Maras/Turkey. In the first year Early Glow, Cavendish and Douglas were used and in the second year Camarosa was introduced instead of Early Glow. In the experiment the effects of 3 different growing media, 1) Perlite+Sand+Farm Yard Manure, 2) Turf+Sand+Orchard soil, 3) Turf+Sand) on the yield and quality of those cultivars were investigated. The effect of cultivar or growing media on total yield/plant in 1999 was not significant. Douglas produced a significantly higher yield than Cavendish in 2000. The highest yield/plant was obtained from Douglas in 1999. Some of the highest fruit weights were recovered from T+S+S media although season average results were not significantly different.

**Key words:** Sack culture, productivity, Cavendish, Douglas, Earliglow, Camarosa

### INTRODUCTION

Strawberry is an important temperate zone berry fruit. When it is marketed in winter and early spring it can be sold for high prices therefore it is assumed to be a profitable fruit. Beside it is being a table fruit, it can be used several purposes such as jam, marmalade, juice, ice cream and frozen fruit industries.

Since it is adaptable and fruit can be obtained almost all seasons, strawberry has an expanded culture in the world. On the other hand since the fruits can be obtained early in the season when there is no fresh fruits in the markets its marketability is high. Another important aspect is that it can bring back the investment in a short period therefore it is suitable for family farming. Apart from these, the incomes per unit area is high in strawberry cultures. Due to all these advantages in production and marketing strawberry area is gradually increasing in Turkey (Kaşka *et al.*, 1986).

Strawberry production in Turkey is becoming more popular and total yearly production has reached to 130 000 t recently (Anonymous, 2000).

Most of the strawberry production in Mediterranean Region in Turkey is under plastic covers to achieve early yield. In Turkish conditions, earliness means harvesting berries during January, February and March where the prices are high. Planting times and growing media can affect earliness (Özdemir, 2003; Özdemir and Kaşka,

1997a,b). Favourable effects of sack culture over classical production were reported from a study conducted under Mediterranean conditions (Özdemir and Gündüz, 2004). Similarly, there are reports indicating a positive effect of sack culture on yield and quality (Palha *et al.*, 2002; Paraskevopoulou-Paroussi *et al.*, 1995). Most researchers have been used sack cultures and different mediums for the strawberry growth and have been reached different results (Özdemir and Kaşka, 1996; Paraskevopoulou-Paroussi *et al.*, 1995; Özdemir *et al.*, 1995b). From an environmental point of view, K. Maras is located between Mediterranean and Southeast Anotolia and has a good chance for successful strawberry production. If production can be combined with earliness, it would be even more profitable. Therefore, we designed a study to investigate the effects of cultivars, glasshouse conditions and growing media on the yield and quality.

### MATERIAL AND METHODS

This research was carried out during the 1998-99 and 1999-2000 growing periods at K. Maras Sutcu Imam University under unheated glasshouse conditions. Kahramanmaraş is located on the southeast part of Turkey and is between 37° 36' N latitude and 36° 56' E longitudes. The average altitude of the province 568 m and the average temperature is 16.5°C. K. Maras has 14.327 km<sup>2</sup> and 13th biggest province in Turkey.

Earliglow, Douglas and Cavendish were used in the first year and Earliglow was replaced by Camarosa in the second year. The plant material for these cultivars was purchased from a local nursery, Çiltar, Adana, Turkey.

The experiment was set up as summer planting with a factorial design. The factors include 3 cultivars, 3 growing media with 3 replications. In each replication 12 plants were grown. The following growing media were tested: 1 = Perlite + Sand + FYM Farm (FYM Farm = Yard Manure) (P+S+ FYM), 2=Turf + Sand + Orchard soil (T+S+S), 3 = Turf + Sand (T+S) were used. Each media was prepared in 1+1+1 or 1+1 ratios. The turf utilized in the experiment was supplied from Bolu province. The turf has 30% organic matter content on average, depending of the portion of the plant material content in turf. Perlite is utilized to manage air and water content of the media. Farm yard manure is well-scalded burned cattle manure. The soil is a local soil which is a red soil and rich in alluvial. These media were filled into plastic sacks of 60×90×20 cm dimensions (sack culture). To each sack 4 plants were planted. Irrigation was performed by drip method.

The plants were put on the rooting media on July 15. These materials were planted on the experimental site on September 20. The dimension of the sacks utilized as containers were 60×90 cm and the sacks were made of black plastic. Irrigations were conducted by drip irrigation. Fertilization was done at 15 day intervals during the vegetation period. The plants were given urea (various concentration) and Fe (Sequestrene 138; 10 g 10 L water).

The following phenological and pomological characteristics were studied: the beginning of flowering, maturation, average yield/plant (g/plant), average fruit weight (g), total soluble solids, acidity and pH. The dates of the blooming of the 3-5 primary king flowers was recorded as beginning of flowering (Ağaoğlu, 1986). When the primary fruits have shown the characteristic ripe colour and aroma of the cultivar they are harvested. These were noted as first harvest dates of the cultivar. During the harvest periods the fruits were harvested 2-3 times a week. They were weighed in a balance sensitive to 0.1 g. The fruits of 3 replicates were gathered and in this manner monthly yields were determined. This yield was divided by the number of plants in the individual replicate and in this way yield/plant was determined (Average yield/plant (g/plant) was recorded). These harvests were accumulated to calculate the yield by the formulae of Yield/plant = Total fruits in all replicates/Number of plants. To calculate average fruit weight (g), total fruit weight divided by the number of fruits. Total Soluble Solid (TSS) (%) was measured by hand refractometer using the juice of 5 randomly chosen fruits. Acidity was

measured in the juices of 10 randomly chosen fruits. Five milliliter of the juice was taken by a pipette and it was added to 45 mL distilled water. In order to see the change in color 1 or 2 drops of phenolphthalein as indicator was added. It was titrated by the help of digital burette and the NaOH spend was read as mL. Similarly, 5 mL of the fruit juice was used to measure pH by pH-meter.

Statistical analyses were conducted by SAS program (1990) according to factorial design. ANOVA tables were conducted by GLM procedure and the means were separated by Tukey Test at 5% significance level.

## RESULTS AND DISCUSSION

The earliest flowering (11 Feb.) recorded in Earliglow on T + S media in 1999. Also in 1999 the latest flowering (26 Feb.) occurred in Douglas on P + S + FYM media. During the 2000 period the earliest flowering (16 Feb.) occurred in Camarosa on T + S + S and T + S media while the latest flowering (3rd March) was in Douglas on P+S FYM media (Table 1).

In 1999, the earliest first harvest was realized in Earliglow on 4 March while the latest first harvest occurred in Douglas on 25 March. The duration between flowering and first harvest varied between 20 to 29 days (Table 1). In 2000, the harvests were delayed in comparison to 1999. In this year the earliest first harvest started on 10 March in Camarosa while the latest harvest occurred on 28 March in Douglas and the duration between flowering and harvest varied between 23 to 30 days (Table 1).

Table 1: Phenological observations of the several strawberry cultivars included in the study conducted during 1999-2000

Cultivar	Media	Beginning of flowering	First harvest dates
1999			
Earliglow	P+S+FYM <sup>1</sup>	16/2	12/3
	T+S+S	12/2	4/3
	T+S	11/2	4/3
Cavendish	P+S+FYM	22/2	22/3
	T+S+S	20/2	18/3
	T+S	22/2	18/3
Douglas	P+S+FYM	26/2	22/3
	T+S+S	24/2	24/3
	T+S	24/2	25/3
2000			
Camarosa	P+S+FYM	21/2	22/3
	T+S+S	16/2	15/3
	T+S	16/2	10/3
Cavendish	P+S+FYM	25/2	22/3
	T+S+S	24/2	22/3
	T+S	26/2	22/3
Douglas	P+S+FYM	3/3	28/3
	T+S+S	28/2	24/3
	T+S	28/2	24/3

<sup>1</sup>The media tested were: 1) Perlite + Sand + FYM (P + S + FYM), 2) Turf + Sand + Orchard soil (T + S + S), 3) Turf + Sand (T + S)

Table 2: The effect of different applications on the total yield (g/plant) of the several strawberry cultivars included in the study conducted during 1999-2000

Cultivar	Media	Month			Total yield (g/plant)
		April	May	June	
1999					
Earliglow	P+S+FYM <sup>1</sup>	53.15	72.04	35.26	160.45
	T+S+S	56.39	82.99	28.29	167.67
	T+S	68.19	78.27	33.60	180.06
	D% 5	NS	NS	NS	NS
Cavendish	P+S+FYM	54.88a	65.38	30.82	151.08
	T+S+S	60.13ab	63.41	32.65	156.19
	T+S	77.96b	90.57	35.58	204.11
	D% 5	18.22	NS	NS	NS
Douglas	P+S+FYM	80.27	88.99	37.85b	207.11
	T+S+S	68.11	91.20	47.18ab	206.49
	T+S	97.63	100.53	50.49a	248.65
	D% 5	NS	NS	12.57	NS
2000					
Camarosa	P+S+FYM	51.42b	60.15	29.66	141.23
	T+S+S	62.24a	64.18	20.98	147.40
	T+S	62.27a	68.16	31.04	161.47
	D% 5	6.42	NS	NS	NS
Cavendish	P+S+FYM	52.06	53.87b	35.79	141.72
	T+S+S	50.69	60.16a	25.65	136.50
	T+S	50.90	55.24ab	30.91	137.05
	D% 5	NS	5.97	NS	NS
Douglas	P+S+FYM	52.82	57.69b	38.75	149.26
	T+S+S	60.57	65.71ab	41.45	167.73
	T+S	54.55	70.32b	47.11	171.98
	D% 5	NS	10.49	NS	NS

<sup>1</sup>The media tested were: 1) Perlite + Sand + FYM (P + S + FYM), 2) Turf + Sand + Orchard soil (T + S + S), 3) Turf + Sand (T + S)

Average yields/plants Table 2 were higher in 1999 than 2000. It may be that the low yield in 2000 was due to low temperatures in March. In both years average yields were highest in May and decreased toward to June. The highest yield in May 1999 was 93.57 g/plant and in May 2000 was 64.57 g/plant. The highest yielding cultivar was appeared to be Douglas which is known to be as a high yielding cultivar (Marfa *et al.*, 1984).

For total yields, the highest yield in 1999 (248.65 g/plant) was obtained from Douglas grown on T + S media. In the year 2000 the highest total yield (171.98 g/plant) was obtained from Douglas grown on again T + S media (Table 2).

The cultivar Douglas has been found a productive type in several studies (Marfa *et al.*, 1984; Paraskevopoulou-Paroussi *et al.*, 1990).

In several studies by Kaşka *et al.* (1988) the highest yields were obtained in April and May with summer plantings. In June, the yields were reduced markedly. These findings are parallel to those of ours.

For the average fruit weight, the heaviest fruits were obtained from Douglas (May, 12.51 g/fruit) in 1999. It was followed by Earliglow (May, 12.49 g/fruit). In the year 2000, Camarosa has given the heaviest fruits (April, 12.31 g/fruit). Camarosa was followed by Douglas (April, 10.59 g/fruit). In both years the lightest fruits were obtained from Cavendish (June, 1999; 6.68 g/fruit; June 2000; 6.77 g/fruit) (Table 3).

Effects of different growing media on the average fruit weights, in both years (1999-2000) it was seen that T+S+S media produced the biggest fruits. This was followed by T + S and P+S+ MY media (Table 3).

During the two growing seasons, fruit weights showed a stable decline from May to June. This result is similar to the findings of Paydaş *et al.* (1992), Özdemir and Kaşka (1995a, b) and Paydaş and Kaşka (1995).

Fruit size is affected by genetics, environmental and cultural factors (mulch, irrigation, fertilizers etc.). Among these genetic factors of the cultivars and ability to adapt are the most important (Hancock, 1999). In this study, the cultivars varied in their average fruit sizes. Ağaoğlu (1986) pointed out that the biggest fruits in the primary bunch are the king fruits and this are followed by secondary and tertiary and quarterly fruits in reducing orders. Fruits were getting smaller in this study as the harvest season progressed (Table 3).

Total soluble solids were increased from April to June in both years due to the increase of temperature and light intensity (Table 4). The highest TSS was obtained in 1999 from Earliglow (June, 9.5%) at T+S media while the lowest values were obtained from Cavendish (April, 6.5%). In the year 2000 the highest TSS content was obtained from Camarosa (June, 10.6%) at T+S media.

İlgin *et al.* (2002) tested the soluble solid contents of Camarosa, Earliglow and Douglas cultivars and saw that average percentage of soluble solids were 13.78, 12.29 and

Table 3: The effect of different applications on the average fruit weight (g/plant) of the several strawberry cultivars included in the study conducted during 1999-2000

Cultivar	Media	Month						Total yield (g/plant)
		April	May	June				
1999								
Earliglow	P+S+FYM <sup>1</sup>	8.99b		12.51		8.22		9.91
	T+S+S	9.46b	10.14	13.66	12.49a	7.77	7.92ab	10.29
	T+S	11.98a		11.32		7.78		10.36
Cavendish	D% 5	1.62		NS		NS		NS
	P+S+FYM	6.92b		8.82		6.52		7.42
	T+S+S	10.79a	8.21	10.32	9.53b	7.59	6.68b	9.57
	T+S	6.92b		9.46		5.94		7.44
Douglas	D% 5	2.19		NS		NS		NS
	P+S+FYM	10.84		11.34		8.53ab		10.24
	T+S+S	12.23	11.52	13.94	12.51a	9.96 a	8.79a	12.04
	T+S	11.48		12.25		7.89b		10.54
2000								
Camarosa	P+S+FYM	11.52		8.13b		7.20		8.95
	T+S+S	13.18	12.31	10.61a	9.52	8.42	8.24	10.74
	T+S	12.23		9.83ab		9.11		10.39
	D% 5	NS		2.27		NS		NS
Cavendish	P+S+FYM	8.67		7.61		6.81		7.69
	T+S+S	10.40	10.05	9.21	8.58	7.56	6.77	9.06
	T+S	11.09		8.92		5.93		8.65
	D% 5	NS		NS		NS		NS
Douglas	P+S+FYM	10.74		8.11		7.34b		8.73
	T+S+S	9.79	10.59	9.99	9.48	9.35a	8.38	9.71
	T+S	11.23		10.35		8.45ab		10.01
	D% 5	NS	NS	NS	NS	1.32	NS	NS

<sup>1</sup>The media tested were: 1) Perlite + Sand + FYM (P + S + FYM), 2) Turf + Sand + Orchard soil (T + S + S), 3) Turf + Sand (T + S)

Table 4: The effects of different applications on the TSS (%) of the several strawberry cultivars included in the study conducted during 1999-2000

Cultivar	Media	April	May	June	Mean
1999					
Earliglow	P+S+FYM <sup>1</sup>	7.2	7.6	9.4	8.1
	T+S+S	7.6	8.0	8.9	8.2
	T+S	7.1	8.3	9.5	8.3
Cavendish	P+S+FYM	7.1	7.7	8.7	7.8
	T+S+S	6.9	8.2	9.0	8.1
	T+S	6.5	7.5	8.6	7.5
Douglas	P+S+FYM	6.9	7.9	8.0	7.6
	T+S+S	7.4	7.8	8.6	7.9
	T+S	7.3	7.7	8.3	7.8
2000					
Camarosa	P+S+FYM	7.8	8.4	9.9	8.7
	T+S+S	7.2	8.8	10.3	8.8
	T+S	8.7	8.7	10.6	9.3
Cavendish	P+S+FYM	7.8	9.2	9.3	8.8
	T+S+S	7.9	9.2	9.4	8.8
	T+S	7.4	8.8	9.3	8.5
Douglas	P+S+FYM	8.6	8.7	8.7	8.7
	T+S+S	7.0	8.8	9.3	8.4
	T+S	7.4	7.9	8.9	8.1

<sup>1</sup>The media tested were: 1) Perlite + Sand + FYM (P + S + FYM), 2) Turf + Sand + Orchard soil (T + S + S), 3) Turf + Sand (T + S)

Table 5: The effects of different applications on the acid content (%) of the several strawberry cultivars included in the study conducted during 1999-2000

Cultivar	Media	April	May	June	Mean
1999					
Earliglow	P+S+FYM <sup>1</sup>	0.12	0.11	0.10	0.11
	T+S+S	0.13	0.10	0.10	0.11
	T+S	0.13	0.11	0.10	0.11
Cavendish	P+S+FYM	0.12	0.11	0.11	0.11
	T+S+S	0.12	0.10	0.09	0.11
	T+S	0.13	0.12	0.10	0.12
Douglas	P+S+FYM	0.12	0.12	0.11	0.12
	T+S+S	0.12	0.11	0.11	0.11
	T+S	0.13	0.12	0.10	0.12
2000					
Camarosa	P+S+FYM	0.12	0.10	0.08	0.10
	T+S+S	0.11	0.11	0.10	0.10
	T+S	0.12	0.11	0.08	0.10
Cavendish	P+S+FYM	0.11	0.11	0.10	0.11
	T+S+S	0.11	0.10	0.08	0.10
	T+S	0.13	0.11	0.10	0.12
Douglas	P+S+FYM	0.13	0.11	0.11	0.12
	T+S+S	0.13	0.11	0.11	0.12
	T+S	0.11	0.10	0.11	0.11

<sup>1</sup>The media tested were: 1) Perlite + Sand + FYM (P + S + FYM), 2) Turf + Sand + Orchard soil (T + S + S), 3) Turf + Sand (T + S)

12.78, respectively. These values are higher than those of the present study. However, the previous study was conducted on non-protected culture. Therefore, the harvest were done later in the season when soluble solid content usually increases (Hancock, 1999).

The acid content of the fruits were reduced from April to June in parallel with the increase in temperatures. The highest acid content was obtained from Douglas (Table 5). pH values of the juices of fruits of different cultivars on different media in both years were shown in

Table 6: The effects of different applications on the pH values (%) of the several strawberry cultivars included in the study conducted during 1999-2000

Cultivar	Media	April	May	June	Mean
1999					
Earliglow	P+S+FYM <sup>1</sup>	3.61	3.62	3.44	3.56
	T+S+S	3.51	3.54	3.35	3.47
	T+S	3.71	3.53	3.44	3.56
Cavendish	P+S+FYM	3.82	3.57	3.58	3.66
	T+S+S	3.62	3.59	3.40	3.54
	T+S	3.72	3.60	3.41	3.58
Douglas	P+S+FYM	3.87	3.66	3.56	3.70
	T+S+S	3.89	3.78	3.64	3.77
	T+S	3.67	3.70	3.44	3.60
2000					
Camarosa	P+S+FYM	3.87	3.70	3.63	3.73
	T+S+S	3.81	3.72	3.57	3.70
	T+S	4.02	3.80	3.61	3.81
Cavendish	P+S+FYM	4.08	3.73	3.64	3.82
	T+S+S	3.86	3.68	3.59	3.71
	T+S	3.88	3.77	3.62	3.76
Douglas	P+S+FYM	3.97	3.86	3.64	3.82
	T+S+S	4.05	3.77	3.69	3.84
	T+S	4.03	3.84	3.66	3.84

<sup>1</sup>The media tested were: 1) Perlite + Sand + FYM (P + S + FYM), 2) Turf + Sand + Orchard soil (T + S + S), 3) Turf + Sand (T + S)

Table 6. Acidity gradually decreased as the season progressed from April to June.

In the previous studies, cultivar differences, ecological conditions and ripeness stage of fruits have been found to affect the amount of citric acid and found that titratable acidity amount changes between 0.075-1.21% as citric acid (Robinson and Stotz, 1945; Sweeney *et al.*, 1962; Sistrunk and Moore, 1967).

The results obtained from this investigation have shown that the strawberry production in K. Maraş would be conducted successfully. Modern strawberry production will help the expansion of the acreage and will give good benefits to the farmers. In many countries the farmers have given emphasis on the out of season production of strawberries. As in the many other temperate zone fruits, out of season production could be more economical because of the high prices. Turkey's Mediterranean coastal areas are quite suitable for early strawberry production. The transitional climate of K. Maraş seems to be suitable for late production of strawberries. Although the yields per plant are not as high as in comparison to Mediterranean areas, production in July and August will be profitable due to high prices. Therefore the farmers should be directed to late production of strawberries. Sack culture is easy for the farmers but it should also be modernized. It seems T+S media will be useful and Camarosa should be recommended considering that the highest yield and soluble solids contents were recovered from T+S media.

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