

## Comparison of Rooting Capabilities of Turkish Tea Clones

Eyyüp ALTINDAL, Fikri BALTA

Yüzüncü Yıl University, Department of Horticulture Faculty of Agriculture, 65080 Van - TURKEY

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**Abstract:** In this study, single leaf cuttings of 10 Turkish tea (*Camellia sinensis*) clones Hamzabey-1, Ardeşen-1, Fener-3, Hayrat-1, Çiftekavak-1, Muradiye-10, Tuğlalı-10, Gündoğdu-3, Kömürçüler-1 and Derepazarı-7 were rooted under greenhouse conditions at seven different collection times without using any plant hormones. The cuttings were collected on 28 August, 4 September, 11 September, 19 September, 25 September, 4 October and 10 October. Rooted plants were removed from rooting medium in mid-May. Plant survival, root dry weight, shoot dry weight and shooting percentage were recorded depending on the tea clones and collection times. The highest survival percentage by mean values of collection times was obtained from cuttings planted on 25 September (92.3%), followed by 19 September (84.3%), 10 October (83.6%), 4 October (79.2%) and 11 September (78.9%). Çiftekavak-1 had a higher mean plant survival ratio (92.83%) than other clones, and this was followed by Hayrat-1 (90.93%), Muradiye-10 (88.54%), Gündoğdu-3 (87.59%), Tuğlalı-10 (79.97%) and Ardeşen-1 (79.00%). In addition, the survival percentage and shooting percentage were 100% for cuttings of Hayrat-1 planted on 11 September, Çiftekavak-1 and Hayrat-1 planted on 19 September, and Çiftekavak-1 and Muradiye-10 planted on 25 September. The clone Çiftekavak-1 had the highest root dry weight (1.99 g) and shoot dry weight (0.93 g) per cutting by mean values at all collection times, and is recommended to the tea farmers.

**Key Words:** Tea, clones, survival, shooting

### Türk Çay Klonlarının Köklenme Yeteneklerinin Karşılaştırılması

**Özet:** Araştırmada Hamzabey-1, Ardeşen-1, Fener-3, Hayrat-1, Çiftekavak-1, Muradiye-10, Tuğlalı-10, Gündoğdu-3, Kömürçüler-1 and Derepazarı-7 isimli on Türk çay klonundan yedi farklı zamanda alınan tek yapraklı çelikler hormon kullanmaksızın sera şartlarında köklendirildi. Çelikler sırasıyla 28 Ağustos, 4 Eylül, 11 Eylül, 19 Eylül, 25 Eylül, 4 Ekim ve 10 Ekim tarihlerinde alındı. Köklü çay bitkileri Mayıs ortasında köklendirme ortamından alındı. Çay klonlarına ve çelik alma zamanlarına bağlı olarak yaşama oranları, kuru kök ağırlıkları, kuru sürgün ağırlıkları ve sürme oranları kaydedildi. Ortalama değerlere göre en yüksek yaşama oranı 25 Eylülde (% 92.3) dikilen çeliklerden elde edildi, bunu sırasıyla 19 Eylül (% 84.3), 10 Ekim (% 83.6), 4 Ekim (% 79.2) ve 11 Eylülde (% 78.9) dikilen çelikler izledi. Çiftekavak-1 klonu diğer klonlardan ortalama değer olarak daha yüksek yaşama oranına (% 92.83) sahipti, bunu sırasıyla Hayrat-1 (% 90.93), Muradiye-10 (% 88.54), Gündoğdu-3 (% 87.59), Tuğlalı-10 (% 79.97) ve Ardeşen (% 79.00) takip etti. Bunun yanında, 11 Eylülde dikilen Hayrat-1, 19 Eylülde dikilen Çiftekavak-1 ve Hayrat-1 ile 25 Eylülde dikilen Çiftekavak-1 ve Muradiye-10 klonunun çeliklerinde yaşama ve sürme oranları % 100'dü. Klonlar arasında Çiftekavak-1, tüm çelik alım tarihlerinde çelik başına en yüksek ortalama kuru kök ağırlığına (1.99 g) ve en yüksek ortalama kuru sürgün ağırlığına (0.93 g) sahipti ve çay üreticilerine önerilebilecek en iyi klon olarak seçildi.

**Anahtar Sözcükler:** Çay, klon, yaşama, sürme.

### Introduction

Commercial tea culture in Turkey is carried out in an area of 76800 ha in the provinces of Rize, Artvin, Trabzon, Giresun and Ordu located in the Black Sea region. A large part of the tea production area as a percentage is concentrated in Rize province (65%), followed by Trabzon (21%), Artvin (11%) and Giresun-Ordu (3%). Tea is an economically valuable plant for the region and a means of subsistence for more than 200,000 farmers. In the provinces, 37%, 10%, 7% and

2% of the population of Rize, Artvin, Trabzon and Giresun respectively engage in tea growing. Therefore, tea plants cover a considerable part of the agricultural fields in these provinces. For example, 95% of the agricultural fields in Rize are allocated exclusively to tea cultivation (Anonymous, 1997).

Almost all tea gardens are established with plants from seed origin. Continuous seed propagation since 1920 has produced populations with different yield and quality properties reflecting a wide genetic variation.

Using this population, clonal selection studies by the Atatürk Tea and Horticultural Research Institute of Rize have been performed and many superior tea clones have been released (Vanlı, 1985).

Earlier vegetative propagation studies indicated that this method is practical, easy and rapid, but the results can be influenced by environmental factors, type of plant material, hormone use, collection times, use of shade, rooting mediums and materials, structural factors and some chemical treatments (Özbek et al., 1961; Ayfer et al., 1987a, b; Sarımehtmet, 1987; Şen et al., 1988; Günler, 1989; Chen et al., 1990; Şen et al., 1991). On the other hand, hormone use in the tea growing region is currently not common. Therefore, tea growers prefer to use the easiest methods for propagation. The aim of this research is to present practical results in terms of rooting 10 Turkish tea clones.

### Materials and Methods

The research was performed in the greenhouse of the Atatürk Tea and Horticultural Research Institute of Rize during 1997-1998. The stock plants of 10 tea clones were regarded to be well adapted to regional conditions. Plants were hard pruned in March so they developed healthy annual shoots. Cuttings were taken from the middle portions of shoots at seven different times and prepared 7-8 cm long as a single leaf and with one or two nodes. A mixture of perlite and forestry soil (1:1 in volume) was used as the rooting media in polyethylene tubes 20 x 15 mm in dimension with 7-8 drainage holes on the bottom. Cuttings were planted and rooted under jute cloth shading in a greenhouse. Rooted plants were removed from rooting medium in mid-May. Rooted plant survival (%), root dry weights (g), shoot dry weights (g) and shooting percentage (%) were recorded depending on tea clones and collection times. A completely randomized design using three replicates and 10 cuttings per replicate (in total 2100 cuttings) and Duncan's multiple range test ( $P = 0.05$ ) were used for mean separation. In addition, correlations between plant survival (PS), root dry weight (RDW), shoot dry weight (SDW) and shooting percentage (SP) were compared (Düzgüneş, 1963).

### Results

The best survival percentages were obtained from the clones Gündoğdu-3 (90%), Çiftekavak-1 (83.3%) and Muradiye-10 (83.3%) planted on 28 August; Çiftekavak-1 (86.6%) and Gündoğdu-3 (86.6%) planted on 04 September; Hayrat-1 (100%), Çiftekavak-1 (93.3%) and Gündoğdu-3 (93.3%) planted on 11 September; and Çiftekavak-1 (100%) and Hayrat-1 (100%) planted on 25 September. In addition, cuttings of Çiftekavak-1 and Muradiye-10 planted on 04 October and 10 October respectively showed the best survival ratio. Differences among the survival percentages from all collection dates except for 25 September were significant (Table 1). Although some clones rooted well at each collection time, survival percents from cuttings set on 25 September were higher than those of other times. The highest survival percentages by mean values of collection times were determined in the cuttings planted on 25 September (92.3%), followed by 19 September (84.3%), 10 October (83.6%), 04 October (79.2%) and 11 September (78.9%). In terms of survival percentages, statistical differences were found among the collection times of clones except for Hamzabey-1 and Gündoğdu-3. There also exist statistical differences among mean values of collection times (Table 2).

The results of root dry weight were 1.99 g, 0.90 g and 0.85 g for Çiftekavak-1, Gündoğdu-3 and Hamzabey-1, respectively (Table 1). There were also significant differences in root dry weight at all collection times. Cuttings set on 28 August and 11 September produced higher average root dry weights than those set at other times. In addition, dry root weight was markedly lower in cuttings set on 10 October (Table 2). In every period, Çiftekavak-1 produced the highest dry weight consistent with survival percentage data.

With respect to shoot dry weight per cutting, statistical differences were recorded among clones at each collection time. Shoot dry weight was the highest in Çiftekavak-1 at all collection times. In addition, Çiftekavak-1 had the highest mean shoot dry weight (0.93 g), and this was followed by Ardeşen-1 (0.37 g), Hamzabey-1 (0.35 g) and Gündoğdu-3 (0.33 g). Cuttings of Fener-3 had the lowest shoot dry weight. At all times except for 10 October, Çiftekavak-1, Gündoğdu-3, Hamzabey-1 and Ardeşen-1 clones exhibited better results than others (Table 1). In addition, although statistical differences were also recorded between

Table 1. Differences among clones at each cutting collection time regarding plant survival (%), root dry weight (g), shoot dry weight (g) and shooting percentage (%).

Tea Clones	Plant survival (%)							Mean
	28 Aug.	04 Sep.	11 Sep.	19 Sep.	25 Sep.	04 Oct.	10 Oct.	
Hamzabey-1	73.3 abc <sup>x</sup>	60.0 c	73.3 cd	80.0 bc	80.0 a	86.6 abc	73.3 ab	75.21 bcd
Ardeşen-1	60.0 bc	66.6 bc	83.3 bcd	83.3 bc	96.6 a	86.6 abc	76.6 ab	79.00 abc
Fener-3	60.0 bc	60.0 c	60.0 d	96.6 ab	90.0 a	36.6 d	66.6 b	67.11 de
Hayrat-1	80.0 ab	80.0 abc	100 a	100 a	96.6 a	93.3 ab	86.6 ab	90.93 a
Çiftekavak-1	83.3 ab	86.6 a	93.3 abc	100 a	100 a	90.0 abc	96.6 a	92.83 a
Muradiye-10	83.3 ab	80.0 abc	83.3 bcd	83.3 bc	100 a	96.6 a	93.3 ab	88.54 ab
Tuğlalı-10	70.0 abc	70.0 abc	73.3 cd	93.3 ab	96.6 a	70.0 bcd	86.6 ab	79.97 abc
Gündoğdu-3	90.0 a	86.6 a	93.3 ab	80.0 bc	86.6 a	86.6 abc	90.0 ab	87.59 ab
Kömürcüler-1	40.0 c	56.6 c	60.0 d	66.6 c	86.6 a	63.3 cd	86.6 ab	65.67 de
Derepazarı-7	66.6 abc	70.0 abc	70.0 cd	60.0 c	90.0 a	83.3 abc	80.0 ab	74.27 cd
Root dry weight per cutting (g)								
Hamzabey-1	1.81 b <sup>w</sup>	0.63 bc	0.71 c	0.86 b	0.86 b	0.81 a	0.28 b	0.85 b
Ardeşen-1	0.53 cd	0.47 bc	0.56 c	0.60 c	0.82 b	0.52 bc	0.23 b	0.53 bc
Fener-3	0.16 d	0.20 c	0.22 c	0.36 de	0.14 b	0.08 d	0.41 ab	0.22 c
Hayrat-1	0.56 cd	0.54 bc	0.83 c	0.41 d	0.46 b	0.30 cd	0.13 b	0.46 bc
Çiftekavak-1	3.11 a	2.46 a	3.56 a	1.10 a	2.15 a	0.92 a	0.66 a	1.99 a
Muradiye-10	0.86 c	0.28 bc	0.20 c	0.12 f	0.19 b	0.28 cd	0.06 b	0.28 c
Tuğlalı-10	0.54 cd	0.20 c	0.36 c	0.23 def	0.33 b	0.15 d	0.12 b	0.28 c
Gündoğdu-3	0.98 c	0.82 b	2.22 b	0.64 c	0.83 b	0.69 ab	0.09 b	0.90 b
Kömürcüler-1	0.32 d	0.29 bc	0.57 c	0.18 ef	0.23 b	0.13 d	0.19 b	0.27 c
Derepazarı-7	0.30 d	0.25 bc	0.53 c	0.25 def	0.33 b	0.21 d	0.13 b	0.29 c
Shoot dry weight per cutting (g)								
Hamzabey-1	0.37 b <sup>y</sup>	0.17 b	0.37 b	0.56 ab	0.32 bcd	0.51 b	0.16 b	0.35 bc
Ardeşen-1	0.37 b	0.29 b	0.35 b	0.57 ab	0.47 b	0.37 b	0.15 b	0.37 b
Fener-3	0.08 b	0.11 b	0.17 b	0.26 c	0.15 e	0.08 c	0.10 b	0.14 c
Hayrat-1	0.15 b	0.17 b	0.34 b	0.20 c	0.20 de	0.15 c	0.10 b	0.19 bc
Çiftekavak-1	1.85 a	0.93 a	1.27 a	0.67 a	0.64 a	0.64 a	0.49 a	0.93 a
Muradiye-10	0.19 b	0.17 b	0.31 b	0.18 c	0.27 cde	0.20 c	0.12 b	0.21 bc
Tuğlalı-10	0.09 b	0.13 b	0.27 b	0.20 c	0.16 de	0.18 c	0.15 b	0.17 bc
Gündoğdu-3	0.18 b	0.25 b	0.54 b	0.50 b	0.38 bc	0.38 b	0.09 b	0.33 bc
Kömürcüler-1	0.09 b	0.11 b	0.40 b	0.16 c	0.19 de	0.19 c	0.13 b	0.18 bc
Derepazarı-7	0.17 b	0.14 b	0.25 b	0.16 c	0.24 cde	0.18 c	0.14 b	0.18 bc
Shooting percentage (%)								
Hamzabey-1	73.3 a <sup>z</sup>	60.0 c	73.3 bc	80.0 abc	80.0 a	86.6 abc	73.3 ab	75.2 bc
Ardeşen-1	60.0 ab	66.6 bc	83.3 abc	83.3 abc	96.6 a	86.6 abc	76.6 ab	79.0 abc
Fener-3	60.0 ab	60.0 c	60.0 c	96.6 a	93.3 a	36.6 d	66.6 b	67.5 c
Hayrat-1	80.0 a	80.0 ab	100 a	100 a	96.6 a	96.6 a	86.6 ab	91.4 a
Çiftekavak-1	83.3 a	86.6 a	93.3 ab	100 a	100 a	90.0 ab	96.6 a	92.8 a
Muradiye-10	83.3 a	86.6 a	83.3 abc	90.0 ab	100 a	96.6 a	93.3 a	90.4 a
Tuğlalı-10	70.0 ab	73.3 abc	73.3 bc	93.3 ab	96.6 a	70.0 bc	86.6 ab	80.4 abc
Gündoğdu-3	90.0 a	90.0 a	93.3 ab	80.0 abc	86.6 a	86.6 abc	90.0 ab	88.1 ab
Kömürcüler-1	40.0 b	63.3 bc	63.3 c	66.6 bc	86.6 a	63.3 c	86.6 ab	67.1 c
Derepazarı-7	66.6 ab	76.6 abc	70.0 bc	60.0 c	90.0 a	83.3 abc	80.0 ab	75.2 bc

<sup>x, w, y, z</sup> Based on Duncan's multiple range test (P=0.05) for mean separation in column represented by each collection time.

Table 2. Differences among cutting collection times for each clone regarding plant survival (%), root dry weight (g), shoot dry weight (g) and shooting percentage (%).

Cutting collection times	Plant survival (%)										
	Hamzabey-1	Ardeşen-1	Fener-3	Hayrat-1	Çiftekavak-1	Muradiye-10	Tuğlalı-10	Gündoğdu-3	Kömürçüler-1	Derepazarı-7	Mea
28 Aug.	73.3 a <sup>x</sup>	60.0 b	60.0 b	80.0 c	83.3 b	83.3 bc	70.0 c	90.0 a	40.0 b	66.6 b	70.6 c
04 Sep.	60.0 a	66.6 b	60.0 b	80.0 c	86.6 b	80.0 c	70.0 c	86.6 a	56.6 ab	70.0 ab	71.6 bc
11 Sep.	73.3 a	83.3 ab	60.0 b	100 a	93.3 ab	83.3 bc	73.3 bc	93.3 a	60.0 ab	70.0 ab	78.9 bc
19 Sep.	80.0 a	83.3 ab	96.6 a	100 a	100 a	83.3 bc	93.3 ab	80.0 a	66.6 ab	60.0 b	84.3 ab
25 Sep.	80.0 a	96.6 a	90.0 a	96.6 ab	100 a	100 a	96.6 a	86.6 a	86.6 a	90.0 a	92.3 a
04 Oct.	86.6 a	86.6 ab	36.6 c	93.3 ab	90.0 ab	96.6 a	70.0 c	86.6 a	63.3 ab	83.3 ab	79.2 bc
10 Oct.	73.3 a	76.6 ab	66.6 b	86.6 bc	96.6 ab	93.3 ab	86.6 abc	90.0 a	86.6 a	80.0 ab	83.6 ab
	Root dry weight per cutting (g)										
28 Aug.	1.81 a <sup>w</sup>	0.53 ab	0.16 a	0.56 ab	3.11 a	0.86 a	0.54 a	0.98 b	0.32 ab	0.30 ab	0.92 a
04 Sep.	0.63 bc	0.47 ab	0.20 a	0.54 ab	2.46 ab	0.28 b	0.20 b	0.82 b	0.29 ab	0.25 b	0.61 ab
11 Sep.	0.71 bc	0.56 ab	0.22 a	0.83 a	3.56 a	0.20 b	0.36 ab	2.22 a	0.57 a	0.53 a	0.98 a
19 Sep.	0.86 b	0.60 ab	0.36 a	0.41 bc	1.10 bc	0.12 b	0.23 b	0.64 bc	0.18 b	0.25 b	0.48 ab
25 Sep.	0.86 b	0.82 a	0.14 a	0.46 bc	2.15 abc	0.19 b	0.33 ab	0.83 b	0.23 b	0.33 ab	0.63 ab
04 Oct.	0.81 b	0.52 ab	0.08 b	0.30 bc	0.92 bc	0.28 b	0.15 b	0.69 bc	0.13 b	0.21 b	0.41 ab
10 Oct.	0.28 c	0.23 b	0.41 a	0.13 c	0.66 c	0.06 b	0.12 b	0.09 c	0.19 b	0.13 b	0.23 b
	Shoot dry weight per cutting (g)										
28 Aug.	0.37 abc <sup>y</sup>	0.37 abc	0.08 c	0.15 b	1.85 a	0.19 b	0.09 c	0.18 de	0.09 b	0.17 a	0.35 a
04 Sep.	0.17 c	0.29 bc	0.11 bc	0.17 b	0.93 b	0.17 b	0.13 bc	0.25 cd	0.11 b	0.14 a	0.25 a
11 Sep.	0.37 abc	0.35 abc	0.17 b	0.34 a	1.27 ab	0.31 a	0.27 a	0.54 a	0.40 a	0.25 a	0.43 a
19 Sep.	0.56 a	0.57 a	0.26 a	0.20 b	0.67 b	0.18 b	0.20 ab	0.50 ab	0.16 b	0.16 a	0.35 a
25 Sep.	0.32 bc	0.47 ab	0.15 bc	0.20 b	0.64 b	0.27 a	0.16 bc	0.38 bc	0.19 b	0.24 a	0.30 a
04 Oct.	0.51 ab	0.37 abc	0.08 c	0.15 b	0.64 b	0.20 b	0.18 abc	0.38 bc	0.19 b	0.18 a	0.29 a
10 Oct.	0.16 c	0.15 c	0.10 bc	0.10 b	0.49 b	0.12 c	0.15 bc	0.09 e	0.13 b	0.14 a	0.16 a
	Shooting percentage (%)										
28 Aug.	73.3 a <sup>z</sup>	60.0 c	60.0 bc	80.0 b	83.3 b	83.3 c	70.0 b	90.0 a	40.0 b	66.6 bc	70.6 c
04 Sep.	60.0 a	66.6 bc	60.0 bc	80.0 b	86.6 ab	86.6 bc	73.3 ab	90.0 a	63.3 ab	76.6 abc	74.3 bc
11 Sep.	73.3 a	83.3 abc	60.0 bc	100 a	93.3 ab	83.3 c	73.3 ab	93.3 a	63.3 ab	70.0 abc	79.3 bc
19 Sep.	80.0 a	83.3 abc	96.6 a	100 a	100 a	90.0 abc	93.3 ab	80.0 a	66.6 ab	60.0 c	84.9 ab
25 Sep.	80.0 a	96.6 a	93.3 a	96.6 a	100 a	100 a	96.6 a	86.6 a	86.6 a	90.0 a	92.6 a
04 Oct.	86.6 a	86.6 ab	36.6 c	96.6 a	90.0 ab	96.6 ab	70.0 b	86.6 a	63.3 ab	83.3 ab	79.6 bc
10 Oct.	73.3 a	76.6 abc	66.6 b	86.6 ab	96.6 ab	93.3 abc	86.6 ab	90.0 a	86.6 a	80.0 abc	83.6 ab

<sup>x,w,y,z</sup> Based on Duncan's multiple range test (P = 0.05) for mean separation in column represented by each clone.

collection times for each clone except Derepazarı-7, these differences were insignificant among the mean values of collection times (Table 2).

Shooting percentage varied from 37% to 100%. With regard to shooting percentages, statistical differences between clones at each collection time except 25 September were found. Shooting percentage was

100% for cuttings of Hayrat-1 planted on 11 September and 19 September, Çiftekavak-1 planted on 19 September and 25 September, and Muradiye-10 planted on 25 September. Çiftekavak-1 (92.8%), Hayrat-1 (91.4%) and Muradiye-10 (90.4%) had the highest mean shooting percentage. Statistical differences were not significant among these clones (Table 1). Statistical differences regarding shooting percentages were also

found between the collection times of clones except for Hamzabey-1 and Gündoğdu-3 (Table 2). However, the highest mean shooting ratio was obtained from 25 September (92.6%), followed by 19 September (84.9%), 10 October (83.6%), 4 October (79.6%) and 11 September (79.3%).

On the other hand, correlations between plant survival (PS), root dry weight (RDW), shoot dry weight (SDW) and shooting percentage (SP) from all data were also found. The relations of PS-RDW, PS-SDW and SP-SDW were significant, and those of PS-SP and RDW-SDW were very significant. PS-RDW, PS-SDW, SP-SDW, PS-SP and RDW-SDW correlations were 0.265, 0.286, 0.268, 0.993 and 0.865, respectively (Table 3).

### Discussion

Survival percentages determined in this study varied from 37% to 100% depending on tea clones set to root at seven different times. The cuttings rooted successfully (Figures 1-4). The survival percentage and shooting percentage were 100% for cuttings of Hayrat-1 planted

on 11 September, Çiftekavak-1 and Hayrat-1 planted on 19 September, Çiftekavak-1 and Muradiye-10 planted on 25 September without any hormone application. Even when cuttings were set on 28 August and 04 September and mean survival was the lowest, Çiftekavak-1, Muradiye-10, Gündoğdu-3 and Hayrat-1 survived over 80%. In addition, cuttings of Çiftekavak-1, Gündoğdu-3 and Hayrat-1 on 11 September and Çiftekavak-1, Hayrat-1, Fener-3 and Tuğlalı-10 set on 19 September had survival percentages over 90%. Çiftekavak-1 consistently gave the best results in terms of survival percentages, root dry weights, shoot dry weights and shooting percentages.

Ayfer et al. (1987a) studied the effects of different cover types, rooting media, IBA treatments and mist propagation on the rooting of clones Pazar-20, Tuğlalı-10, Gündoğdu-3, Fener-3, Derepazarı-7 and Muradiye-10. With respect to rooting percentages and root dry weights, they obtained the most successful results in a rooting system that used a 'Plastic tunnel saturated to moist and shaded with coarse white calico' using cuttings with a single leaf and one bud of the clones in question. Ayfer et al. (1987a) also reported that rooting percentages for Fener-3 and Tuğlalı-10 were 98.3% and 92.6%, respectively, and a mixture of soil and perlite (1:1) exhibited the best results among media used. In this study, cuttings of Fener-3 and Tuğlalı-10 planted on 19 September and 25 September survived between 90.0% and 96.6% under greenhouse conditions, and cuttings of Muradiye-10, Gündoğdu-3 and Derepazarı-7 achieved high plant survival rates without using any hormone treatment, different plastic tunnels, cover types and mist propagation.

Table 3. Correlations (r) between plant survival (PS), root dry weight (RDW), shoot dry weight (SDW) and shooting percentage (SP).

	RDW	SDW	SP
PS	0.265*	0.286*	0.993**
RDW	--	0.865**	0.247*
SDW	--	--	0.268*

\*Significant. \*\* Very significant.



Figure 1. Rooted cuttings of Çiftekavak-1.



Figure 2. Rooted cuttings of Muradiye-10.



Figure 3. Rooted cuttings of Tuğlalı-10.



Figure 4. Rooted cuttings of Hayrat-1.

Ayfer et al. (1987b) examined the effects of different shading materials and rooting media on the rooting of Fener-3 cuttings planted in August, and obtained the highest rooting (75.8%) with jute cloth shading and a higher rooting (93.3%) with a combination of jute cloth shading and sand medium. Cuttings of Fener-3 in this study survived at rates between 90% and 96.6% under greenhouse conditions utilizing jute cloth shading material when they were planted on 19 September and 25 September. On the other hand, Ayfer et al. (1987b) also assessed effects of cutting collection times (24 March, 10 July, 13 August and 10 September), cutting types (semi-hardwood and hardwood) and IBA treatments in Derepazarı-7, Fener-3, Gündoğdu-3, Muradiye-10, Pazar-20 and Tuğlalı-10 clones. Reporting that the highest rooting percentages were usually obtained from cuttings planted in July, but that all clones did not achieve high rooting percentages in this month, they did not recommend cutting to collect after August. However, this research indicated that collection times after August can also be used to obtain high rooting percentages.

Günler (1986) reported the highest rooting percentages and the highest root dry weights per cutting for Gündoğdu-3 and Fener-3, to be 86.7% (93 mg) and 66.7% (63.7 mg), respectively. This study presented higher rooting percentages and root dry weights for Gündoğdu-3 and Fener-3 clones than those reported by Günler (1986). Şen et al. (1991) recorded rooting of 92.5% from cuttings of Fener-3 and 62.5% cuttings of

Derepazarı-7 planted in December. This research also noted higher rooting percentages for Fener-3 and Derepazarı-7 than Şen et al. (1991).

On the other hand, information related to the rooting capabilities of the clones Hamzabey-1, Ardeşen-1, Hayrat-1, Çiftkavak-1 and Kömürcüler-1 was not found among the references available.

In addition, it has been suggested that the rooting levels of tea clones are affected by many environmental and structural factors, such as collection times (Ayfer et al. 1997b), cutting forms (Şen et al. 1988; Şen et al. 1991; Cheng and Yang, 1995; Nyirenda, 1996), clonal and varietal differences (Ayfer et al. 1987a; Ayfer et al. 1987b), rooting media (Ayfer et al. 1987a; Ayfer et al. 1987b; Günler, 1989), growth regulators (Özbek et al., 1961; Ayfer et al. 1987a; Rajasekar and Sharma, 1990; Fong, 1992), chemicals (Barman and Manivel, 1989; Chen et al., 1990), and cultural applications (Kaşka and Yılmaz, 1974; Sarimehmet, 1987).

Consequently, the results of this study indicate that Turkish tea clones have good rooting abilities despite differences in rooting between clones.

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### References

- Anonymous, 1997. Çaykur İstatistikleri Bülteni, s.43. Rize.
- Ayfer, M., M. Çelik, H. Çelik, M. Erden, T. Tutgaç and H. Mahmutoğlu, H., 1987a. Farklı köklendirme yöntemleri ve ortamlarının çay çeliklerinin köklenmeleri üzerine etkileri. Uluslararası Çay Simpozyumu Bildirileri, s.16-25, 26-28 Haziran, Rize.
- Ayfer, M., M. Çelik, H. Çelik, H. Vanlı, T. Tutgaç, T. Tuma and H. Dumanoğlu, 1987b. Farklı gölgeleme materyalleri, çelik alma zamanları ve çelik tiplerinin çay çeliklerinin köklenmeleri üzerine etkileri. Uluslararası Çay Simp.Bildirileri, s. 26-34, 26-28 Haziran, Rize.
- Barman, T.S. and L. Manivel, 1989. Triaconal as an aid for rooting of cuttings. Hort. Abst., 59-7:6196.
- Chen, J.S., F.M. Thseng, and W.H., Ko, 1990. Improvement of survival and subsequent growth of tea cuttings. Hortscience, 25(3):305-306.
- Cheng, W. and W.Yang, 1995. Investigation on cuttings from upper mature shoots of tea. J. of Tea Sci.15(1):77-78.
- Düzgüneş, O., 1963. Bilimsel Araştırmalarda İstatistik Prensipler ve Metodları. Ege Üniversitesi Matbaası, İzmir.
- Fong, C.H., 1992. The effect of organic fertilizer and growth substances on rooting of tea cuttings. Hort. Abst., 62-6:5316.
- Günler, N., 1989. Budama artıklarından hazırlanan çay çeliklerinin gölgeli plastik tünel altında köklendirilmesinde tüp büyüklüğünün etkileri. A.Ü. Fen Bil. Enst., (Yüksek Lisans Tezi), 55s., Ankara.
- Kaşka, N. ve M. Yılmaz, 1974. Bahçe Bitkileri Yetiştirme Tekniği. Ç.Ü.Z.F. Yayınları, Ders Kitabı 2, 601s., Adana.
- Nyirenda, H.E., 1996. Vegetative propagation of tea using immature (apical shoots) and over-mature (brown stem) cuttings. Hort. Abst., 66-3:2752.

- Özbek, S., M. Özsan, and M. Yılmaz, 1961. Çay çeliklerinin köklenmeleri üzerine muhtelif hormonların tesiri. A.Ü.Z.F. Yıllığı, 11(2):175-224. Ankara.
- Rajasekar, R. and V.S. Sharma, 1989. Interaction between IBA, certain micro-nutrients and phenolic acids in relation to rooting of tea cuttings. Sri Lanka J. of Tea Sci., 58(1):25-39.
- Sarımeahmet, M., 1987. Türkiye'de seleksiyonla bulunan iki klon çaydan (Muradiye-10 ve Fener-3) üretilen çay fidanlarının büyümesi üzerine N, P ve K gübrelmesinin etkisi ile ilgili bir araştırma. Çay Enst.Başk., 114s., Rize.
- Şen, S.M., S. Uzun, Y. Boz, H. Vanlı, T. Tutgaç and T. Turna, 1988. Çay klonlarında değişik çelik tiplerinin köklenmeye etkileri üzerinde arařtırmalar. O.M.Ü. Ziraat Fakültesi Dergisi, 3(1):13-20.
- Şen, S.M., S. Uzun, Y. Özkan, H. Vanlı, T. Tutgaç ve T. Turna, 1991. Çal klonlarının aşı ve çelikle çoğaltılması üzerine arařtırmalar. Y.Y.Ü. Ziraat Fak.Dergisi, 1-3:67-88.
- Vanlı, H., 1985. Çay Arařtırma Enst. Çalışmaları ve Sonuçları. Çay İşlet. Gen. Müd., Rize.