BUDDING SUCCESS OF PISTACIA *INTEGERRIMA* ON DIFFERENT PISTACIA ROOTSTOCKS

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Additional Index Words: Budding, *Pistacia*, rootstock

Abstrac
Since pistachio trees are grown under extremely arid conditions in Turkey, the yield per tree is quite low. Pistachio culture in the coming years will be irrigated by water from the Southeast Anatolia Project. For that reason, suitable pistachio rootstocks for the area are needed. Seed orchards of *P. integerrima,* which has been proven to be tolerant to disease, cold and drought, are of great importance for the region. In this study, the suitable rootstocks and budding methods for propagation of *P. integerrima* nursery trees were investigated. *P. integerrima* had the best budding success rates, and gave more vigorous shoots than *P. atlantica* rootstocks. Chip budding was found to be the best budding method for propagation. At the nursery stage, it appeared that *P. integerrima* was more compatible with wild *Pistacia* rootstocks than with *P. vera* rootstocks. Also, it was concluded that by top budding wild pistachios grown in the region with *P. integerrima* scions, the seed production orchards could be established immediately.

1 Introduction

Traditional pistachio culture is carried out under arid conditions without irrigation in Turkey. This situation causes considerably low nut yield and nut quality, and thus decreases Turkey's market competition among other pistachio producing countries such as Iran, USA and Syria. Increases in yield and quality can be obtained with the selection of good cultivars and proper orchard management techniques, however irrigation plays a crucial role in obtaining these objectives, even in pistachio trees which are regarded as drought tolerant.

In the coming years, the pistachio culture in Turkey will be irrigated using water provided by the Southeast Anatolia Project. Although *P. vera* is preferred as a rootstock because of its fast growing habit for the budding process (Ayfer et al., 1990), its seedling is sensitive to *Verticillium* spp and *Phytophthora parasitica* (Garcia, 1980). For that reason, *P. vera* seedlings are not suitable for use as rootstocks for pistachio under irrigated conditions. It was reported that pistachio trees on *P. terebinthus* and *P. atlantica* rootstocks died from Verticillium in the USA, where pistachio trees are commonly irrigated (Crane

and Maranto, 1988). Currently in the USA, pistachio culture is based on the *P. integerrima* rootstock which has been proven to be tolerant to *Verticillium* (Ferguson et al., 1993). Also, *P. integerrima* was reported to be tolerant to low temperatures (Maranto, 1991).

P. integerrima is expected to be a valuable rootstock for future Turkish pistachio culture. Therefore, for seed production, seed orchards are strongly required. The objectives of this study were to determine the budding success and shoot development of *P. integerrima* on different *Pistacia* rootstocks which are widely grown in Turkey.

Table 1. Bud take percentage of *P. integerrima* on different rootstocks with two different budding methods.

	Budding Methods		
Rootstocks	Chip budding	T-budding	Mean
P. atlantica	99.9 (88.8)* a	99.8 (87.4) a	99.8 (88.1) a
P. terebinthus	99.0 (84.4) b	81.9 (64.8) d	90.4 (74.6) b
P. khinjuk	90.0 (71.5) c	71.3 (57.6) f	80.6 (64.5) c
Siirt (*P. vera)*	78.2 (61.9) e	60.2 (50.8) g	69.2 (56.4) e
Ohadi (*P. vera*)	81.0 (64.1) d	63.7 (52.9) g	72.3 (58.5) d
Kirmizi (*P. vera*)	82.5 (65.3) d	63.0 (52.5) g	72.7 (58.9) d
Mean	88.4 (72.7) a	72.0 (61.0) b	

*Transformed figures are in the brackets

$D_{\%5}$ (rootstock): 1.65; $D_{\%5}$ (budding method): 0.44, $D_{\%5}$ (rootstock x budding method): 2.72.

Table 2. The percentage of emergence from buds of *P. integerrima* on different rootstocks with two budding methods.

	Budding Methods		
Rootstocks	Chip budding	T-budding	Mean
P. atlantica	99.9 (88.8)* a	91.1 (72.6) b	95.5 (80.7) a
P. terebinthus	80.1 (63.5) c	63.0 (52.5) e	71.5 (58.0) b
P. khinjuk	69.8 (56.6) d	54.1 (47.3) f	61.9 (51.9) c
Siirt (*P. vera)*	60.9 (51.2) e	40.4 (39.4) h	50.6 (45.5) d
Ohadi (*P. vera*)	61.0 (51.3) e	42.9 (40.8) gh	51.9 (46.1) d
Kirmizi (*P. vera*)	60.7 (51.2) e	41.7 (1.0) g	51.2 (45.7) d
Mean	73.3 (61.0) a	55.5 (48.8) b	

*Transformed figures are in the brackets

$D_{\%5}$ (rootstock): 1.45; $D_{\%5}$ (budding method): 0.26, $D_{\%5}$ (rootstock x budding method): 1.69.

2. Materials and Methods

In this study, *P. integerrima* scions were budded on *P. atlantica*, *P. terebinthus*, *P. khinjuk* and *P. vera* (cv. Siirt, Ohadi and Kirmizi seedlings. Before sowing, *P. vera* seeds were soaked in tap water for 24 h. *P. atlantica* and *P. terebinthus* seeds were soaked in a solution of H2SO4 (98 %) for 1 h and *P. khinjuk* seeds for 1.5 h (Nikpeyma and Kaska, 1994). These seeds were then soaked in tap water for 24 h. The seeds were sown in small pots in a greenhouse in January, 1992. When resulting seedlings reached a height of 4 cm, they were

transplanted in plastic tubes with dimensions of 10 x14 cm. After that, the seedlings with a 20 cm height were again transplanted in plastic tubes with dimensions of 25 x 40 cm. The media in all tubes was a mixture of peat, sand, and soil with a ratio of 1:1:1. In June, these container grown seedlings were placed outdoors and were grown under normal growing conditions.

In this study, T- and chip budding methods were examined. T-budding is a traditional pistachio budding method in Turkey usually done in June or July, while chip budding is a new pistachio budding technique which allows budding to be done in the early spring with the use of dormant bud sticks (Nikpeyma, 1990; ,Caglar, 1996). In this study, Chip budding was performed in the first week of April, 1993 and T- budding was performed in the first week of July, 1993.

The experimental design was a completely randomized block with 3 replications (each had three beddings). The percentage of bud takes and the percentage of emergence from buds were determined 1 month after each budding. On the seventh of July, 1994 the shoot length and diameter of the shoots were measured. Data with percentages were subjected to transformation before statistical analysis and means were separated by Tukey's test.

Table 3. Shoot length (cm) of *P. integerrima* on different rootstocks with two budding methods.

Rootstocks	Budding Methods		Mean
	Chip budding	T-budding	
P. atlantica	90.7 a	78.8 ab	84.7 a
P. terebinthus	72.8 abc	61.0 bcd	67.0 ab
P. khinjuk	61.9 bcd	48.4 cde	55.1 bc
Siirt (*P. vera)*	44.3 de	33.5 e	38.9 c
Ohadi (*P. vera*)	46.9 cde	32.4 e	39.7 c
Kirmizi (*P. vera*)	42.1 de	31.9 e	37.0 c
Mean	59.8 a	47.6 b	

$D_{\%5}$ (rootstock): 23.3; $D_{\%5}$ (budding method): 4.45, $D_{\%5}$ (rootstock x budding method): 27.2.

3. Results

The highest bud take percentage with *P. integerrima* was obtained on *P. atlantica* rootstocks (99.8 %), followed by *P. terebinthus* (90.4 %) and *P. khinjuk* (80.6 %). Bud take percentages were between 69.2 and 72.7 on *P. vera* rootstocks. Chip budding was found to be more successful than T-budding (Table 1).

The percentage of emergence from buds manifested similar behaviour as seen in bud take percentages. The highest value was 99.5 % on *P. atlantica,* followed by *P. terebinthus* (71.5 %) and *P. atlantica* (61.9 %). The percentage of emergence from buds was as low as 50 % on *P. vera* rootstocks. Emergence from buds was better by chip budding than by T budding (Table 2).

As seen in Table 3 and Table 4, the shoot development (shoot length and diameter) from buds which were budded on *P. atlantica* and *P. terebinthus* were

the most vigorous. This shoot growth was almost double that on the *P. vera* rootstocks. Generally, the shoots from chip buds were more vigorous than those from T-buds.

Table 4. Shoot diameter of *P. integerrima* stems on different rootstocks with two budding methods.

Rootstocks	Budding Methods		Mean
	Chip budding	T-budding	
P. atlantica	10.8 a	10.2 ab	10.5 a
P. terebinthus	11.1 a	10.5 ab	10.8 a
P. khinjuk	8.2 bc	6.9 cd	7.5 b
Siirt (*P. vera*)	5.2 d	4.5 d	4.9 c
Ohadi (*P. vera*)	5.7 d	4.8 d	5.2 c
Kirmizi (*P. vera*)	6.5 cd	4.9 d	5.7 bc
Mean	7.9 a	7.0 b	

$D_{\%5}$ (rootstock): 2.11; $D_{\%5}$ (budding method): 0.38, $D_{\%5}$ (rootstock x budding method): 2.47.

4. Discussion

In the propagation of *P. integerrima* trees, the best budding success and vigorous shoot development can be obtained on *P. atlantica* rootstocks, followed by *P. terebinthus* and *P. khinjuk* rootstocks, while the seedlings from all *P. vera* cultivars tested gave the lowest values. At the nursery level, it seemed that *P. integerrima* scions were more compatible with wild pistachios than with the commonly used *P. vera* rootstocks in Turkey. However, this case should be tested with further interstock studies. In this study Chip budding was the most successful pistachio budding method, which confirmed the results of previous studies (Nikpeyma, 1990; Caglar, 1996). In Turkey, for the future pistachio culture under irrigated condition, large quantities of *P. integerrima* seeds are needed. Top budding of *P. terebinthus* or *P. khinjuk* trees, which can be abundantly found in the area, with *P. integerrima* scions can shorten the time for seed production and allow production of disease tolerant pistachio rootstocks.

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