

Effects of hot water treatments on dormant grapevine propagation materials used for grafted vine production

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Abstract. *Agrobacterium vitis* is responsible for the crown gall disease of grapevine which breaks the grapevine trunk vascular system. Nutrient flow is prevented by crown gall and it leads to weak growth and death of the plants. It can be destructive disease often encountered in vineyards and it can be spread in cuttings for propagation. Thermotherapy treatment is an alternative method for eradicating *A. vitis* from grapevine cuttings but effects of thermotherapy treatments on dormant vine tissue, bud vitality, rooting and shooting of the propagation materials are not yet fully understood. In this research, it is aimed to determine the effects of thermotherapy treatment (Hot water treatment) on callus formation (at the basal part and grafting point), grafted vine quality (shoot length, shoot width, root number, shooting and rooting development, fresh and dry weight of shoots and roots) and final take in the grafted vine production. Experiment was conducted in the nursery of Manisa Viticultural Research Institute. Rootstocks (Kober 5BB, Couderc 1613 and 41B) and scions (Sultan 7 and Manisa sultani) were hot-water treated at 50°C for 30 minutes which is the most common technique against *Agrobacterium vitis*. After thermotherapy treatment, all rootstocks were grafted with Sultan 7 and Manisa sultan varieties. They were kept for 22 days in callusing room for callus development and then they were planted in polyethylene bags for rooting. At the end of the study, significant treatment x rootstock interaction were observed for the final take of Sultan 7 variety. Thermotherapy treated of 1613C/Sultan 7 combinations had more final take than the control (untreated) group. For instance, hot water treated cuttings of 1613C/Sultan 7 combinations had 75% final take while the control group had the 70%. Also there were not observed any adverse effects of HWT on bud and tissue vitality.

1. Introduction

Viticulture constitutes an important part of agricultural production in the world and it is common between 20–52° latitudes in the Northern Hemisphere and 20–40° latitudes for Southern Hemisphere. Turkey, which has a strong viticultural potential, is one of the important gene centers of the vine. Today, 74 million tons of world grape yield (production) that is 4.1 million tons yielded in Turkey. In addition, Turkey ranks 5th in the world with 467.093 ha grape harvested area [1] and that the grape yield per hectare is about 8.9 tons. It can be observed that this value is considerably less than the advanced countries of viticulture. This situation is due to various negativities encountered during the period planting to the marketing. Especially, some of the pests and diseases can affect adversely the grape yield per unit area in our country.

Crown gall, caused by the soil-borne bacterium (*Agrobacterium vitis*), is also the most important disease in our country's vineyards. The most remarkable signs are galls and cracks that appear on grapevine trunks [2]. Galls are more common on the lower trunk but they can develop in canes and at graft unions. Crown gall can kill young vines, reduce growing potential and require establishment of new trunks [3].

There are not any effective chemical treatments for grape crown gall control yet [4]. Therefore its control

focuses on prevention of injuries and using of pathogen free propagation materials [5].

In our country, grafted vine producers may select the infected cuttings in the vineyard for grafting process without being aware of it. Therefore the possibility of using infected propagation materials with *Agrobacterium vitis* while establishment of the vineyards, is one of the enhancing dissemination and transmission of disease. Furthermore if *Agrobacterium vitis* identify in herbal products, it is among the organisms subject to quarantine which is prohibited to circulate in our country. Therefore it is determined that *A. vitis* has an extremely important precaution for our country, according to the Regulation on "Plant passport system and registration of operators" published in the official gazette dated 2nd January 2011, numbered 27813 [6].

Hot water treatment (Thermotherapy) is an efficient, environmentally safe and commercially viable method for sterilization of *Agrobacterium vitis* [7]. The most common hot water treatment for dormant propagation materials (rootstocks and vine cuttings) is submerging them in a water bath at 50° C for 30 min [3, 7, 8]. However the most common problems in HWT studies are generally related its affects on bud and tissue vitality, growth in the nursery and the effects on grafting of vines for different varieties [3, 9–13].

In this study, it was aimed to determine the effects of hot-water treatment (thermotherapy) on propagation

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materials used for grafted vine production. In this way, new registered grape varieties (Sultan 7 and Manisa sultanı) were used as plant materials and it was observed responses of these varieties to the thermotherapy treatments.

2. Materials and methods

2.1. Plant material

This research was carried out in the nursery of Viticultural Research Institute in Manisa province. Five rootstock cultivars Kober 5BB, Couderc 1613, 41B and two scion cultivars Sultan 7, Manisa Sultanı were used as plant material. Sultan 7 is a seedless variety and it is the most common raisin variety in Turkey. It matures in second half of the August. It has high drying efficiency and yield potential. Manisa Sultanı is a seedless variety growing for primarily table grape. Berries are elliptic, green-yellow color. It matures in second half of the August. All these propagation materials were collected in the dormant season (November and February) from the vineyards of the Institute. Then they were placed in cold storage at 2–4° C until grafting. Sultan 7 and Manisa Sultanı grape varieties are newly registered varieties. Therefore, in this research, it was observed responses of these varieties to the hot water treatment (HWT) first time.

2.2. Methods

In the research, all propagation materials (rootstocks and scions) were kept in the room temperature overnight before the HWT. Then they were immersed in hot-water at 50° C for 30 minutes which is the most common technique against *Agrobacterium vitis*. Hot water tank had 1000 L water capacity with a recirculation pump and temperature was monitored via probes during the treatment process. After HWT, all propagation materials were left to drying at room temperature. Also there were not any hot water treatments for control group.

One bud scions of the Sultan 7 and Manisa sultanı grape varieties were omega shaped bench-grafted onto three rootstocks [14,15]. Grafted cuttings were dipped into paraffin wax (55–60° C) to cover the grafting point and placed in plastic boxes filled up with sawdust and coarse chip (3:1). All boxes were kept in callusing room (25–27° C, 90–95% humidity) for three weeks and then transferred to the outdoor conditions for adaptation in two days. When the callus formation was completed in the callusing room, rooting rates (%) and sprouting rates (%) were determined. Then, callusing level at the grafting point and at the basal part were measured according to the 0–4 scale (0-no callus development, 1- weak callus development, 2- crescent shaped callus development, 3- partially interrupted callus development, 4- complete callus development).

After these measurements, grafted cuttings were planted in polyethylene bags for rooting over 6–7 weeks at 25–27° C, 70–75% humidity in greenhouse. At the end of the this growing period in greenhouse, following parameters were measured; Shooting and rooting development level (0-4 scale), shoot length (cm), shoot width (mm), root number, fresh and dry weight of shoots and roots (g) and final take (%) were measured. All parameters were examined to determine the effects

of thermotherapy treatments on propagation materials (rootstocks and scions) for grafted vine production.

The experimental design was randomized plots with three replications and there were 30 cuttings in each replication. Analysis of variance is implemented to research data by using SPSS statistical analysis software package on computer, and in order to determine the differences among averages, LSD test is implemented.

3. Results and discussion

According to the measurements of after callus formation in the callusing room, effect of hot water treatment on rooting and sprouting rates was found non-significant. However hot water treated cuttings of all rootstocks x Manisa Sultanı combinations had higher values than control group in terms of rooting rates. Also the highest values were obtained from the hot water treated (64.4%) and untreated (56.7%) 1613C x Manisa Sultanı combinations respectively (Table 1 and Table 2). Besides that [16] reported similar results in their study. For instance, they observed different sprouting ratios during the callusing development for the all rootstock x variety combinations. On the other hand the highest rooting ratio was obtained from the 1613C x variety combinations (54.6%) in their study.

The Table 3 and Table 4 show that effects of HWT on callusing level at the basal part and grafting point, respectively. Treatment x rootstocks interactions for the Sultan 7 variety were found statistically significant in terms of callusing level at the basal part. The highest value (2.65) was observed in hot water treated vines of 41B/Sultan 7 combination. Also [17] reported that thermotherapy treatments stimulated callus formation at the basal part in most cases.

When measuring the callus formation at the grafting point, the lowest level were observed in hot water treated vines of 5BB/Sultan 7 combination (2.30). On the other hand the highest values were observed in 1613C/Sultan7 combinations. As can be seen from the results, callus formation was affected adversely by hot water treatment on 5BB/Sultan 7 and 5BB/ Manisa Sultanı combinations. However other combinations were placed in the highest level group statistically (Table 4). When the callus formation was considered as one of the important criteria determining the success in the production of grafted vines [18], 41B and 1613C rootstocks come into prominence for the both varieties. Hot water treated cuttings of 41B/Manisa Sultanı combinations was found 6.5% more callus formation than untreated group. In a study hot water treated and grafted cuttings were found 5–10% better callus formation than the control cuttings [3].

Significant treatment x rootstock interactions were observed for the Sultan 7 variety in terms of shooting and rooting development levels (Table 5 and Table 6). Hot water treated vines of 1613C/Sultan7 and 41B/Sultan 7 combinations had higher values than each control groups for the both shooting and rooting development levels. As can be seen from the results of all rootstocks x Sultan 7 combinations, hot water treatments induced more shooting and rooting development except 5BB/Sultan 7 combination. These findings was found parallel with the previous studies [11,17,19].

Table 1. Effects of HWT on rooting rates (%).

<i>Manisa Sultani</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	32.400	33.333	32,867b	5BB	51.297	34.167	42.732
41B	43.380	49.417	46,398ab	41B	41.733	54.373	48.053
1613C	56.783	64.430	60,607a	1613C	61.03	52.943	56.987
<i>Treatment Mean</i>	44.188	49.060		<i>Treatment Mean</i>	51.353	47.161	
LSD Treatment: ns				LSD Treatment: ns			
LSD Rootstock: 15,219**				LSD Rootstock: ns			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: ns			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 2. Effects of HWT on sprouting rates (%).

<i>Manisa Sultani</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	30.070	30.640	30.355	5BB	40.977	36.113	38.545
41B	35.417	35.417	35.417	41B	31.25	41.667	36.458
1613C	37.693	37.190	37.442	1613C	37.447	28.677	33.062
<i>Treatment Mean</i>	34.393	34.416		<i>Treatment Mean</i>	36.558	35.486	
LSD Treatment: ns				LSD Treatment: ns			
LSD Rootstock: ns				LSD Rootstock: ns			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: ns			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 3. Callusing level at the basal part (0–4).

<i>Manisa Sultani</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	2.70	1.10	1,900a	5BB	2,393a	0,973b	1,683b
41B	2.97	1.84	2,407a	41B	2,580a	2,650a	2,615a
1613C	0.59	0.59	0,593b	1613C	0,647b	0,753b	0,700c
<i>Treatment Mean</i>	2,088a	1,179b		<i>Treatment Mean</i>	1,873a	1,459b	
LSD Treatment: 0,835**				LSD Treatment: 0,399*			
LSD Rootstock: 1,022**				LSD Rootstock: 0,685**			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: 0,969**			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 4. Callusing level at the grafting point (0–4).

<i>Manisa Sultani</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	3,777a	3,333b	3,555b	5BB	3,807a	2,303b	3,055c
41B	3,697a	3,940a	3,818a	41B	3,593a	3,623a	3,608b
1613C	3,867a	3,867a	3,867a	1613C	4,000a	3,960a	3,980a
<i>Treatment Mean</i>	3,780	3,713		<i>Treatment Mean</i>	3,800a	3,296b	
LSD Treatment: ns				LSD Treatment: 0,242**			
LSD Rootstock: 0,206*				LSD Rootstock: 0,296**			
LSD Treatment x Rootstock: 0,291*				LSD Treatment x Rootstock: 0,419**			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 5. Effects of HWT on shooting development level (0–4).

<i>Manisa Sultani</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	1.900	1.633	1.767b	5BB	2.657 ab	1.733 d	2.195b
41B	2.410	2.247	2.328ab	41B	1.913 cd	2.243 bcd	2.078b
1613C	2.330	3.020	2.677a	1613C	2.553 abc	3.007 a	2.780a
<i>Treatment Mean</i>	2.214	2.300		<i>Treatment Mean</i>	2.374	2.328	
LSD Treatment: ns				LSD Treatment: ns			
LSD Rootstock: 0.575*				LSD Rootstock: 0.496**			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: 0.702**			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 6. Effects of HWT on rooting development level (0–4).

<i>Manisa Sultanı</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	1.833	1.750	1,792b	5BB	2,500b	1,500c	2,000b
41B	2.833	2.333	2,583a	41B	1,500c	3,000ab	2,250b
1613C	2.500	2.500	2,500a	1613C	2,830b	3,830a	3,333a
<i>Treatment Mean</i>	2.389	2.194		<i>Treatment Mean</i>	2,278b	2,778a	
LSD Treatment: ns				LSD Treatment: 0,401*			
LSD Rootstock: 0.529*				LSD Rootstock: 0,689**			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: 0,975**			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 7. Effects of HWT on shoot length (cm).

<i>Manisa Sultanı</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	9.897	7.667	8,782b	5BB	14,783a	9,933b	12,358ab
41B	13.210	12.333	12,772ab	41B	9,440b	10,540b	9,990b
1613C	12.610	17.903	15,257a	1613C	13,200ab	15,887a	14,543a
<i>Treatment Mean</i>	11.906	12.634		<i>Treatment Mean</i>	12.474	12.120	
LSD Treatment: ns				LSD Treatment: ns			
LSD Rootstock: 4,550**				LSD Rootstock: 2,914**			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: 4,121**			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 8. Effects of HWT on shoot width (mm).

<i>Manisa Sultanı</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	1.830	1.507	1.668	5BB	1.973	1.620	1.797
41B	2.010	1.643	1.827	41B	2.143	5.330	3.737
1613C	1.950	2.187	2.068	1613C	1.847	1.920	1.883
<i>Treatment Mean</i>	1.930	1.779		<i>Treatment Mean</i>	1.988	2.957	
LSD Treatment: ns				LSD Treatment: ns			
LSD Rootstock: ns				LSD Rootstock: ns			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: ns			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 9. Effects of HWT on root number.

<i>Manisa Sultanı</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	12,083c	8,500c	10,292b	5BB	14,000cd	11,183cd	12,592b
41B	27,333ab	13,000bc	20,167b	41B	8,000d	18,667c	13,333b
1613C	27,333ab	41,667a	34,500a	1613C	36,000b	49,667a	42,833a
<i>Treatment Mean</i>	22.250	21.056		<i>Treatment Mean</i>	19,333b	26,506a	
LSD Treatment: ns				LSD Treatment: 5,099**			
LSD Rootstock: 10,209**				LSD Rootstock: 6,245**			
LSD Treatment x Rootstock: 14,438**				LSD Treatment x Rootstock: 8,832**			
*p < 0.05, **p < 0.01, ns: non-significant							

The Table 7 shows that effects of hot water treatments on shoot length while the Table 8 shows the effects of hot water treatments on shoot width. Significant treatment x rootstock interactions were observed for the shoot length of Sultan 7 variety. The highest values were observed in hot water treated vines of 1613C/Sultan 7 (15.89 cm) combinations. Also hot water treated cuttings was found 20.3% and 11.7% more shoot length than the untreated ones in 1613C/Sultan 7 and 41B/Sultan 7 combinations respectively. The effect of hot water treatment on shoot width was statistically non-significant for both varieties. However the highest value was observed

in hot water treated vines of 41B/Sultan 7 (5.33 mm) and 1613C/Manisa Sultanı(2.19 mm) combinations. Also in previous studies, it was observed that the effects of thermotherapy treatments were varied in terms of shoot length and shoot width on different rootstock x variety combinations [13,20]. In a study carried out by [3], hot water treated and grafted vines of K51-40/Zante Currant and Ramsey/Zante Currant combinations had longer shoots than the control group.

For both varieties, significant treatment x rootstock interaction were observed in terms of root number. Hot water treated vines of 1613C/Manisa sultanıand

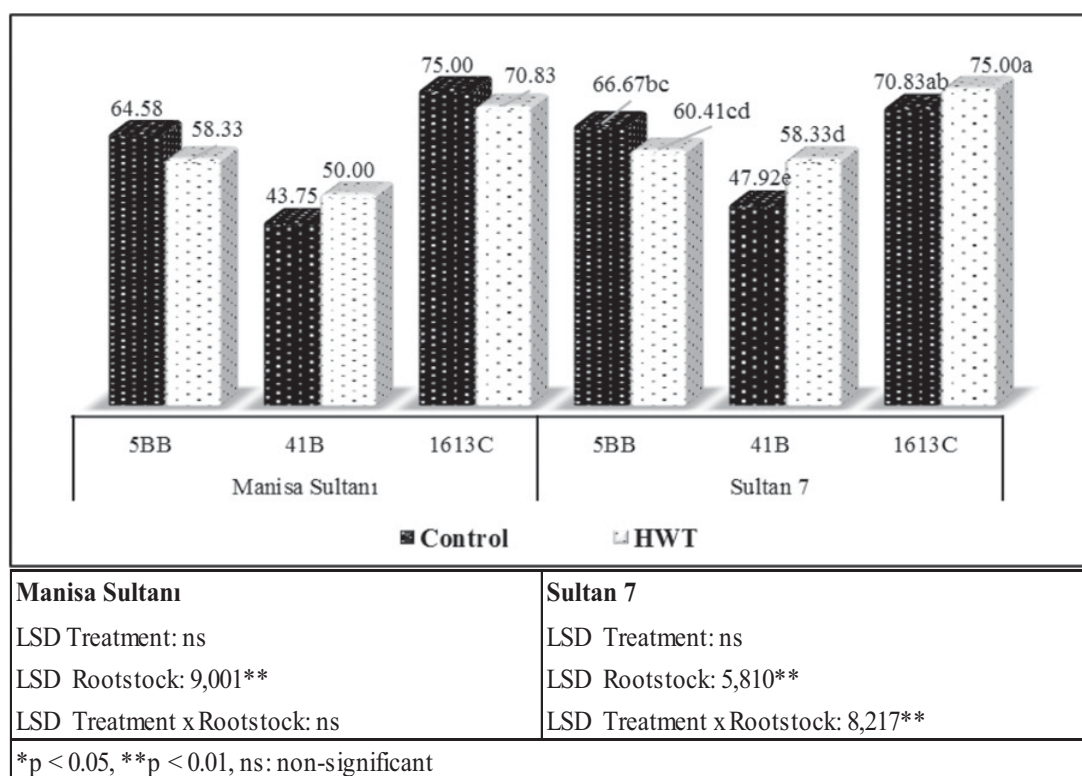


Figure 1. Effects of HWT on Final Take value (%).

Table 10. Effects of HWT on fresh weight of shoots (g).

Manisa Sultanı				Sultan 7			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	45,710c	44,253cd	44,982b	5BB	51,143b	37,330c	44,237b
41B	42,533d	46,363c	44,448b	41B	39,050c	45,143bc	42,097b
1613C	54,640b	57,590a	56,115a	1613C	51,877b	64,267a	58,072a
Treatment Mean	47,628b	49,402a		Treatment Mean	47.357	48.913	
LSD Treatment: 1,599 *				LSD Treatment: ns			
LSD Rootstock: 2,747**				LSD Rootstock: 6,132**			
LSD Treatment x Rootstock: 2,770*				LSD Treatment x Rootstock: 8,672**			

*p < 0.05, **p < 0.01, ns: non-significant

Table 11. Effects of HWT on dry weight of shoots (g).

Manisa Sultanı				Sultan 7			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	10.050	10.620	10,335b	5BB	11,077b	11,190b	11.133
41B	11.400	11.013	11,207b	41B	10,273b	12,870a	11.572
1613C	14.220	13.890	14,055a	1613C	11,630ab	11,797ab	11.713
Treatment Mean	11.890	11.841		Treatment Mean	10,993b	11,952a	
LSD Treatment: ns				LSD Treatment: 0.943**			
LSD Rootstock: 0,972**				LSD Rootstock: ns			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: 1.633**			

*p < 0.05, **p < 0.01, ns: non-significant

1613C/Sultan7 combinations had higher values compare to the control vines. Root number of grafted vines for the hot water treated 1613C/Manisa sultanı combination was 41.67 while 1613C/Sultan 7 combination was 49.67 (Table 9). Also it was observed more root numbers with the hot water treatments in 41B/Sultan7, 1613C/Sultan7 and 1613C/Manisa sultanı combinations. In a study conducted by [13], there was an increment in the root numbers with the hot water treatments.

According to the measurements of final take, it was found that significant treatment x rootstock interaction for the Sultan 7 variety (Fig. 1). Hot water treated group of 41B/Sultan 7 and 1613C/Sultan 7 combinations had 21.7% and 5.9% more final take than the control group. On the other hand hot water treated vines of 5BB/Sultan 7 combinations had 9.4% lower final take compare to the control group. Generally hot water treatment affected the final take positively in the rootstocks x Sultan 7

Table 12. Effects of HWT on fresh weight of roots (g).

<i>Manisa Sultanı</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	57.823	55.587	56,705b	5BB	70,187a	63,340ab	66,763a
41B	64.520	64.663	64,592a	41B	42,430e	50,710d	46,570c
1613C	67.047	62.157	64,602a	1613C	52,033cd	59,733bc	55,883b
<i>Treatment Mean</i>	63.130	60.802		<i>Treatment Mean</i>	54.883	57.928	
LSD Treatment: ns				LSD Treatment: ns			
LSD Rootstock: 4,172**				LSD Rootstock: 5,607**			
LSD Treatment x Rootstock: ns				LSD Treatment x Rootstock: 7,930**			
*p < 0.05, **p < 0.01, ns: non-significant							

Table 13. Effects of HWT on dry weight of roots (g).

<i>Manisa Sultanı</i>				<i>Sultan 7</i>			
Rootstocks	Control	HWT	Rootstock Mean	Rootstocks	Control	HWT	Rootstock Mean
5BB	6,587c	8,720bc	7,653c	5BB	8,237b	9,300ab	8,237a
41B	9,813b	10,247b	10,030b	41B	4,063d	10,927a	4,063c
1613C	13,140a	10,147b	11,643a	1613C	6,347c	9,697ab	6,347b
<i>Treatment Mean</i>	9.847	9.704		<i>Treatment Mean</i>	6,216b	9,974a	
LSD Treatment: ns				LSD Treatment: 1,089**			
LSD Rootstock: 1,568**				LSD Rootstock: 0,951*			
LSD Treatment x Rootstock: 2,218**				LSD Treatment x Rootstock: 1,885**			
*p < 0.05, **p < 0.01, ns: non-significant							

combinations. However it was observed that 5BB/variety combination was more sensitive than the others and this combination was affected adversely by thermotherapy treatment. Additionally it was observed that thermotherapy treatments effects can be changed by the varieties. These findings were similar to the previous studies [8, 11, 13, 19, 21].

According to the fresh shoot weight values, significant treatment x rootstock interaction were observed for the Manisa Sultanıand Sultan 7 varieties (Table 10). Hot water treated vines of all combinations, except 5BB/Manisa sultanıand 5BB/Sultan 7 combinations had higher fresh shoot weight values compare to the control group. Additionally hot water treated vines of 1613C/Manisa Sultanıand 1613C/Sultan 7 combinations had the highest fresh shoot weight values for each variety, 57.59 g and 64.27 g respectively. Also significant treatment x rootstock interaction was found for the Sultan 7 variety in terms of dry shoot weight (Table 11). The highest and lowest value was obtained from hot water treated (12.87 g) and untreated (10.27 g) vines of 41B/Sultan 7 combination respectively.

The Table 12 shows that effect of HWT on fresh weight of roots. In Sultan 7 variety, it was determined that significant treatment x rootstock interaction. The highest value was observed in hot water treated vine of 1613C/Sultan 7 combination while the lowest value was obtained from untreated vine of the 41B/Sultan 7 combination. Moreover there were significant treatment x rootstock interactions for the both Manisa Sultanıand Sultan 7 varieties in terms of dry root weight. The highest (10.93g) and lowest value (4.06g) was observed in hot water treated vines and untreated vines of 41B/Sultan 7 combination.

According to the fresh and dry weights of the shoots and roots, generally hot water treatments had positive effects except 5BB x variety combinations. It was observed

that 5BB rootstock x variety combination was the most sensitive combination in this experiment. On the other hand there were not determined any adverse effects of thermotherapy treatments on bud and tissue vitality. Also similar results were found in previous studies [3, 7, 17, 22, 23].

4. Conclusion

Thermotherapy treatment at 50°C for 30 minutes was found an effective method against *Agrobacterium vitis* in previous studies. Therefore this technique was applied to the dormant grapevine propagation materials before the grafting process in an attempt to examine the growing period of different rootstocks x variety combinations.

It is known that the tolerance of plant material to the hot water treatment is an important matter. Overall the findings reveal that in this study there were no any adverse effects on bud and tissue vitality in Sultan 7 and Manisa Sultanıgrafted onto 5BB, 41B and 1613C rootstocks. On the other hand it was observed that combination of 5BB rootstock with the varieties was more sensitive than the others against to the thermotherapy treatment. Therefore growers should pay attention to this relation between Kober 5BB rootstock and thermotherapy treatment.

Moreover hot water treated vines of 1613C/Sultan 7 and 41B/Sultan 7 combinations became prominent in terms of final take. As can be seen from the results hot water treated cuttings of Sultan 7, which is a raisin variety, has stood out with its high final take values for all rootstocks.

In addition, considering that 41B is a hard-rooted rootstock and final take values are generally low, it is so important that the thermotherapy has a positive effect on final take of 41B rootstock and variety combinations.

As a result, in order to grow healthy grafted vines and provide economic technique against *Agrobacterium vitis*

in Sultan 7 and Manisa sultan varieties - newly registered varieties which were obtained from the Sultani Çekirdeksiz - thermotherapy treatment needs to be widespread.

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