Comparisons of Methods and Time of Budding in Kiwifruit (*Actinidia deliciosa,* A. Chev)

[1]Hamdi ZENGİNBAL* [1]Muharrem ÖZCAN[2] Ayhan HAZNEDAR [1]Taki DEMİR
[1]*Faculty of Agriculture, Department of Horticulture, University of Ondokuz Mayıs, Samsun / TURKEY*
[2] *Atatürk Tea and Horticultural Plants Research Institute, Rize / TURKEY*

*Corresponding author:
E-mail: hzenginbal@omu.edu.tr

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Abstract:

This experiment was conducted to examine the method and time of budding in kiwifruit propagation. In this study, 'Hayward' seedlings were used as rootstock in the field conditions. The same cultivar was used for grafting scion. Chip and T budding were used as budding types. The buddings were performed 15th April, 1st May, 15th May, 1st June, 1st August, 15th August, 1st September and 15th September. Bud take rate, bud sprouting rate, graft shoot diameter and graft shoot length were determined as experimental parameters after grafting. All budding methods and budding times were found to be suitable for kiwifruit propagation. However, the highest mean percent of bud take and sprouting rate were obtained with chip budding performed on 1st May, 15th May, 1st September and 15th September. The highest mean shoot diameter and shoot length were obtained with chip budding performed on 15th August, 1st September and 15th September.

Keywords: Kiwifruit, propagation, grafting times, budding methods

INTRODUCTION

Kiwifruit is native of China but its full economic importance has only been highlighted in New Zealand. Owing to its resemblance of its brownish hairy fruit to kiwi, the native bird of New Zealand, it is termed as Kiwifruit [1]. The fruit has since then spread to other countries of the world.

Kiwifruit has gained worldwide popularity in the recent years because of its wider climatic adaptability, delicious fruits with unique blend of taste, precocity and high nutritive and medicinal values. Studies proved that kiwifruit cultivation has too high returns per unit area. For that reason, this fruit is has received considerable interest from the fruit growers. The biggest bottleneck in the expansion of growing area for this fruit is scarcity of its planting material.

Although the fruit is recently introduced to Turkey, it has gained substential popularity among the growers. Kiwifruit production has been carried out in twenty one provinces in the Mediterranean, Aegean, Black Sea and Marmara regions of Turkey. The Black Sea region has the biggest kiwifruit production. The Black Sea region, especially its eastern parts is searching to diverse its range of products and to find alternatives for them. In other words, there has been an increase in interest for new crops. In this connection, kiwifruit has considerable attached and gitred increasing interest from producer [2,3].

In order to meet the demand for the kiwifruit, it is important to obtain its shoots and to present them to the producer. Kiwifruit can be propagated by grafting and budding. Both methods can be used to produce vines and crops. Seedlings make good field nursery and container plants [4,5]. Chip and T budding are probably the most widely used grafting techniques. Most fruit trees, and many other woody plants are commercially propagated by this way. They are simplier, faster, and easier to learn than grafting and usually result in a higher percentage of success. In addition, budding makes using of scion wood more economic since every bud can result in a new tree. Budded kiwifruit vines grown in container has vigor and upper quality roots. The mortality rate is higher than rooted cuttings after planting [6]. Container raised plants are sold as medium to tall plants and can be transplanted to the field at any time of the year. Kiwifruit plants are easily grafted or budded.

The grafting success could be affected by several factors. These are temperature, humidity, grafting time, grafting type, pest and disease [7,8,9]. Therefore, the study was conducted to determine the success of budding types performed in the growing season and dormant season in kiwifruit propagation.

MATERIALS AND METHODS

The experiment was conducted at Rize province, Turkey during 2002-2003. The three years old kiwifruit (Hayward cultivars) seedlings having uniform diameter were used as rootstocks. For seedling production, sandy loam soil was used. Soil analysis results obtained from soil samples taken in 20 cm below of soil surface were as follow: pH 4.65-6.35; organic matter 0.14 - 3.96%; total nitrogen content 0.14 - 0.24%; available P_2O_5 13 -30 ppm; exchangeable K_2O 80 - 370 ppm.

The budding scions (Hayward cv.) were selected from the kiwifuit orchard of Atatürk Tea and Horticultural Plants Research Institute in Rize, Turkey. The scion woods grafting in the growing bud were selected in previous winter from vigorous plants in the kiwifruit orchard. The buds packed in dumpy sawdust and stored in cold storage at 0-1°C for the time to initiation of the study [10]. The scion woods grafting in the dormant bud were selected in summer pruning from vigorous ones in the kiwifruit orchard.

On the other hand, chip and T budding types were performed on 8 different dates. The buddings during in the growing season were done on 15th April, 1st May, 15th May and 1st June. The buddings during the dormant season were done on 1st August, 15th August, 1st and 15th September. White and soft plastic tapes were used for wrapping.

The experiment was designed in a randomized blocks with 3 replications and 20 grafts per replication. Cultural prectices such as irrigation, weeding and removal of sucker below graft bud union were followed with regular intervals. Data on sprouting were recorded after bud burst, while bud take success was recorded 3 months after graft budding. Observations on shoot length and shoot diameter were recor-

ded in December. Data as percentage were transformed using the arc-sin√x transformation, and statistical analyses were applied over these transformed data by using MSTAT-C pocket program (Russell D. Freed, Crop and Soil Sciences Department, Michigan State University). Duncan's Multiple Range Test was used to indicate the differences between the average data.

The maximum, minimum and mean temperature (°C) and relative humidity (%) were recorded during two months after budding in both years (Figure 1, 2). As shown in Figure 1, 2 mean daily temperatures varied from 9.4 to 28 °C in 2002 and from 7.7 to 26.8 °C in 2003. Mean daily relative humidity varied from 53.3 to 91% in 2002 and from 56.7 to 93.7% in 2003.

RESULTS

Climatic Data

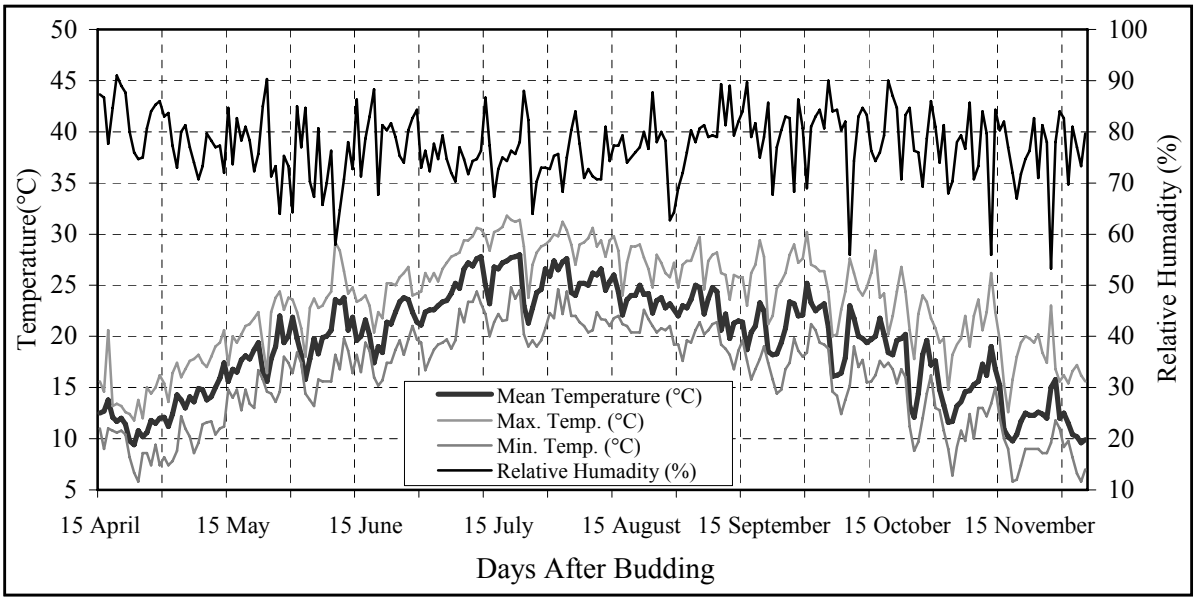

Figure 1. The temperature (°C) and relative humidity (%) changes during the days after budding in 2002**.**

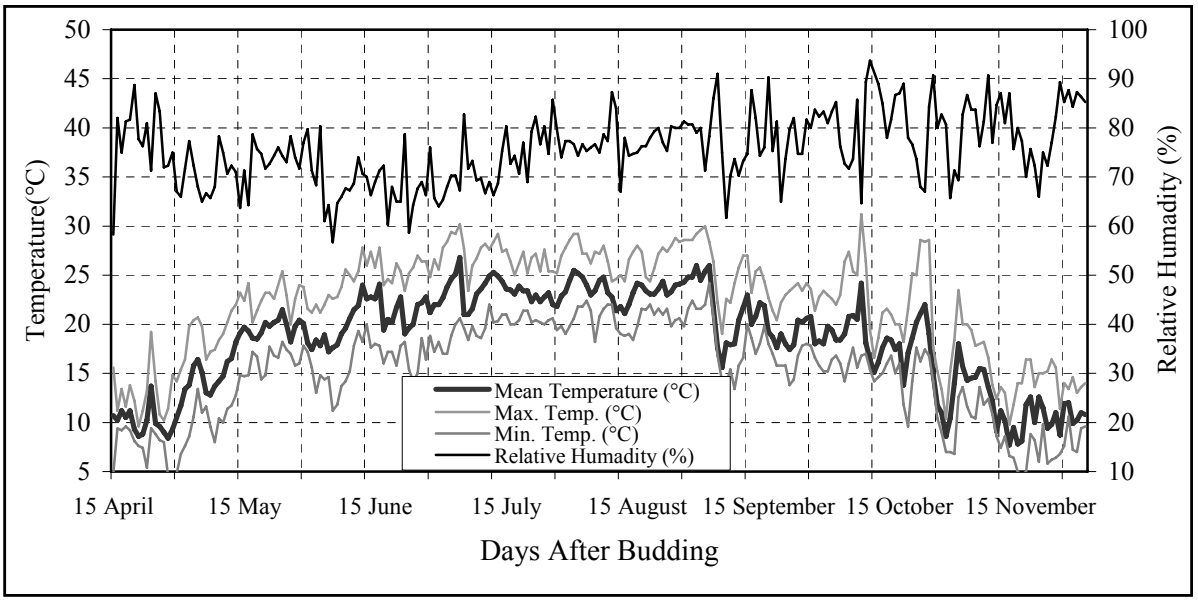

Figure 2. The temperature (°C) and relative humidity (%) changes during the days after budding in 2003.

Bud Take

As shown in Table 1, bud take was significantly influenced by budding methods x grafting times of propagation in both years. The highest mean bud take rate (100.0 %) was obtained from chip budding performed on 15th April, 1st May and 15th September in 2002; 1st May and 15th September in 2003.

Sprouting

The bud sprouting success was significantly influenced by budding methods x grafting times of propagation in both years. Chip budding performed on 15th April in 2002 and 15th September in 2003 had the highest bud sprouting rates (100.0 % and 95.0 % respectively) (Table 1).

Shoot Diameter

As shown in Table 2, the budding methods x budding times had insignificant effect on shoot diameter in 2002 and significant effect in 2003. The highest shoot diameter was recorded with chip budding performed on 15th September (9.5 mm) in 2002; 1st September and 15th September (9.5 mm) in 2003.

Shoot Length

The budding methods x grafting times had insignificant effect on shoot length in both years (Table 2).

DISCUSSION

Climatic Data

These temperature and relative humidity values were consistent with those reported by Anonymous [11].

Bud Take

Chip budding was superior to T budding in terms of bud take. The success of chip budding may be attributed to high level of callus formation around the grafting location. Likewise, Howard et al. [12] reported that callus formation was higher and faster for chip budding than those of inverted T and conventional local T budding. In addition, thick rootstock bark in kiwifruit could reduce the budding success as reported by Polat and Kaşka [13] indicating bud scion did not fit grafting location in T shape and it results in weak callus formation and drying of grafting location. These findings are in conformity with those of Lawes and Sim [14], Spirovska et al. [15], Zenginbal [16] and Chandel et al. [17] reporting that chip budding gave higger results in terms of bud take in kiwifruit. Bud take rate decreased for the graftings performed from 15th April to 1st June and increased from 1st August to 15th September which caused by high temperature and humidity. Hartmann et al. [7], reported that callus connection was observed in 15-20 days after grafting and in this period graftings should not be exposed to high and low temperatures. As shown in Figures 1-2, high temperatures in both years prevailing just after grafting caused lower success in budding performed on 1st June, 1st August and 15th August. In addition, Tuzcu et al. [18] reported that bud take rate could reach up to 90% at temperatures up 15 - 18 ^{o}C.

Sprouting

The fact that callus induction and connection for chip budding were higher than those of T budding resulted in cambial connectivity and high bud sprouting as reported by Polat and Kaşka [13]. In addition, preparation of bud scion also affected the bud sprouting [8]. So, bud scions were taken from graft scion with wood tissue in chip budding but without wood tissue in T budding. T budding done at all grafting times had the lowest bud sprouting rates. This is probably due to tissue damages from budding. Likewise, pith tissue is wide and stem tissues are friable in kiwifruit. Therefore, cortex is separated from wood tissue by pressure of grafting resulting in enormous damage around grafting area. These findings are in conformity with those of Lawes and Sim [14], Spirovska et al. [15] and Chandel et al. [17], who found that chip budding was in favor of bud sprouting in kiwifruit. Budding done on 1st May, 15th May and 15th Septemberproved to be the optimum time for budding in kiwifruit. The findings are in conformity with those of Spirovska et al. [15], Zenginbal [16] and Chandel et al. [17]. The higher success rate might be because of favorable temperature and relative humidity prevailing during the period following grafting and rapid sap flow in rootstock and scion which might have favored the healing process and established the continuity of cambial and vascular tissues for bud sprouting.

Shoot Diameter

Although both budding methods produced acceptable shoot diameter, in general, chip budding method was found to be superior to T budding. The shoot diameter was attained with chip budding performed by hand. While comparing various methods of grafting and budding Zenginbal [16], Chandel et al. [17] and Kim et al. [19] also obtained maximum growth of the plants with chip budding. The quick and strong union formation, greater uptake of water and nutrients and longer growing period may account for higher growth of chip budded plants. Similar results on different fruit species [13,20] and kiwifruit [15,16] were also reported. In terms of grafting times, grafting performed in the dormant bud evaluated the vegetation better and resulted in the highest shoot diameter. Grafting performed in the growing season also produced higher results.

Shoot Length

Although both budding methods produced acceptable shoot length, in general, chip budding method was found to be superior to T budding. Similar results were also reported by Polat and Kaşka [13], Spirovska et al. [15], Zenginbal [16], Chandel et al. [17], Kim et al. [19] and Küden [20]. In terms of grafting times, grafting performed in the dormant bud evaluated the vegetation better and resulted in the highest shoot length.

CONCLUSION

According to the results of this study, all budding methods and grafting times were found to be successful to kiwifruit nursery plant production. However, the highest mean bud take rate and sprouting rate were obtained from chip budding performed on 1st May, 15th May, 1st September and 15th September. The highest mean shoot diameter and shoot length were recorded with chip budding performed on 15th August, 1st September and 15th September. The T budding gave the lowest results in all the budding times. It is also possible to generalize the present results for a long period of times because climatic data for the years when the study was conducted are similar to those of prevalent years of Rize.

Table1. The effects of different methods and times of budding on bud take and sprouting rate in kiwifruit

Budding times	Budding methods	Bud take (%)		Sprouting (%)	
		2002	2003	2002	2003
15 April	Chip budding	100.0[1](90.0)[2]a	80.0 (63.9) bd	100.0[1](90.0)[2]a	73.3 (56.7) be
	T budding	93.3 (78.1) ab	73.3 (60.0) de	58.3 (49.9) fg	30.0 (32.2) g
1 May	Chip budding	100.0 (90.0) a	100.0 (90.0) a	85.0 (67.2) bc	91.7 (73.4) ac
	T budding	83.3 (68.3) bd	80.0 (63.9) bd	58.3 (49.8) fg	63.3 (53.1) df
15 May	Chip budding	86.7 (69.2) bd	90.0 (74.8) bc	85.0 (67.4) bc	90.0 (74.8) ab
	T budding	90.0 (74.8) ac	85.0 (67.2) bd	81.7 (64.7) bc	70.0 (57.0) ce
1 June	Chip budding	81.7 (64.7) bd	85.0 (67.2) bd	70.0 (57.2) cf	78.3 (62.3) ae
	T budding	78.3 (62.4) bd	76.7 (61.1) ce	63.3 (52.7) ef	60.0 (50.8) ef
1 August	Chip budding	83.3 (66.8) bd	85.0 (67.2) bd	65.0 (54.0) df	75.0 (60.0) ae
	T budding	60.0 (50.8) d	55.0 (47.9) e	45.0 (42.1) g	40.0 (39.2) fg
15 August	Chip budding	85.0 (67.2) bd	85.0 (67.2) bd	76.7 (61.1) be	80.0 (63.4) ae
	T budding	75.0 (60.0) bd	70.0 (56.8) de	60.0 (50.8) eg	55.0 (47.9) ef
1 September	Chip budding	90.0 (74.8) ac	95.0 (77.1) b	80.0 (63.4) bd	90.0 (71.6) ac
	T budding	75.0 (60.0) bd	75.0 (60.1) de	65.0 (53.8) df	70.0 (56.9) ae
15 September	Chip budding	100.0 (90.0) a	100.0 (90.0) a	90.0 (71.6) b	95.0 (77.1) a
	T budding	71.7 (57.9) cd	75.0 (60.1) de	61.7 (51.8) eg	70.0 (56.9) ae
Overall Mean	15 April	96.7 (84.0) a	76.7 (62.0) bc	79.2 (62.9) a	51.7 (46.0) b
	1 May	91.7 (79.2) ab	90.0 (77.0) a	71.7 (58.5) c	77.5 (63.2) a
	15 May	88.3 (72.0) ac	87.5 (71.0) a	83.3 (66.1) a	80.0 (65.9) a
	1 June	80.0 (63.6) cd	80.8 (64.2) bc	66.7 (55.0) c	69.2 (56.5) ab
	1 August	71.7 (58.8) d	70.0 (57.5) c	55.0 (48.1) d	57.5 (49.6) b
	15 August	80.0 (63.6) cd	77.5 (62.0) bc	68.3 (56.0) c	67.5 (55.7) ab
	1 September	82.5 (67.4) bd	85.0 (68.6) ab	72.5 (59.0) c	80.0 (64.2) a
	15 September	81.8 (73.9) ac	87.5 (71.0) a	75.8 (61.7) bc	82.5 (67.0) a
Overall Mean	Chip budding	90.8 a**	90.0 a**	81.5 a**	84.2 a**
	T budding	78.3 b**	73.8 b**	61.7 b**	57.3 b**
LSD (P<.001) Time		11.4	8.7	6.7	10.3
LSD (P<.001) Method x Time		16.1	12.3	9.4	14.8

[1] Original data
[2] Transformed data
** Values not associated with the same letter are significantly different (P<.001)

Table 2. The effects of different methods and times of budding on graft shoot diameter and shoot length in kiwifruit

Budding times	Budding Methods	Shoot Diameter (mm)		Shoot Length (cm)	
		2002	2003	2002	2003
15 April	Chip budding	6.7	8.0 bd	59.6	81.8
	T budding	6.9	5.0 e	60.9	53.3
1 May	Chip budding	6.5	8.1 bd	72.5	88.5
	T budding	5.8	7.5 cd	66.3	72.5
15 May	Chip budding	5.3	7.9 bd	35.7	89.3
	T budding	4.6	7.1 d	43.7	70.1
1 June	Chip budding	5.6	5.4 e	37.8	41.2
	T budding	4.9	4.9 e	34.5	38.2
1 August	Chip budding	8.1	7.7 bd	99.8	88.8
	T budding	7.6	7.2 cd	75.7	77.9
15 August	Chip budding	9.1	8.4 ac	117.6	116.9
	T budding	8.9	7.7 bd	115.9	87.6
1 September	Chip budding	9.2	9.5 a	112.0	114.2
	T budding	8.3	8.2 bd	92.9	90.3
15 September	Chip budding	9.5	9.5 a	117.2	114.2
	T budding	8.6	8.8 a	94.2	88.5
Overall Mean	15 April	6.8 bc	6.5 c	60.2 de	67.6 b
	1 May	6.1 cd	7.8 b	69.4 cd	80.5 b
	15 May	4.9 d	7.5 b	39.7 ef	79.7 b
	1 June	5.3 d	5.2 d	36.2 f	39.7 c
	1 August	7.9 ab	7.4 b	87.7 bc	83.4 b
	15 August	9.0 a	8.1 b	116.8 a	102.3 a
	1 September	8.7 a	8.8 a	102.4 ab	102.2 a
	15 September	9.1 a	9.1 a	105.7 ab	101.3 a
Overall Mean	Chip budding	7.5 a*	8.1 a**	81.5 a*	91.9 a**
	T budding	6.9 b*	7.1 b**	73.0 b*	72.3 b**
LSD (P<.001) Time		1.2	0.8	21.4	16.1
LSD (P<.001) Method x Time		NS	1.1	NS	NS

* Values not associated with the same letter are significantly different (P<.005)
** Values not associated with the same letter are significantly different (P<.001)
NS : Non significant

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