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An Investigation on the Propagation of Kiwifruit (*Actinidia deliciosa*, *A. Chev.*) by Grafting under Turkey Ecological Conditions

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Abstract: The experiment was conducted to standardize the methods and time of grafting in kiwi propagation. In this study, Hayward scion was used as grafting scion 4 years old seedling rootstock in the field conditions. Four grafting methods (cleft grafting by machine, cleft grafting by hand, whip and splice) were performed on three different dates (1st January, 1st February and 1st March). According to the results of this trial, all grafting methods and grafting times were successful to kiwi propagation. However, the highest mean bud-take rate, sprouting rate, shoot diameter and shoot length were recorded with whip and splice graftings performed on 1st February. The cleft grafting by machine gave the lowest results.

Key words: Kiwifruit cultivars, grafting methods, grafting time

Introduction

Due to the existence of suitable ecological conditions in the Eastern Black Sea Region, kiwifruit, which is a new fruit for most Turkish people, is widely cultivated in this region. Therefore, there is an increase in demand by farmers for seedlings. Imports have sometimes been used to meet this demand. However, this led to nematode related diseases and other diseases which are not seen in the future (Warrington and Weston, 1990; Ağı *et al*., 1999).

Eastern Black Sea region is unsuitable for cultivating various kinds of agricultural products because of its geographical conditions. Opportunities related to agricultural production are very limited (Turna, 1992) and so it is important to choose products which can best be adapted to the Black Sea environment to obtain maximum income per unit area.

In kiwifruit adaptatation studies, successful results have been achieved in the Eastern Black Sea region. It was thought that in agroforestry, the kiwifruit could be just as useful as such products as alder, hazelnut and tea which are economically important crops in the region today. The Black Sea region has the biggest kiwifruit production with 1582 tons of Turkey (Anonymous, 2002).

In order to meet the demand for the kiwifruit, it is important to procure its shoots and to present them to the producer. The kiwifruit can be propagated by using the generative and vegetative methods. In addition, vegetative methods are preferable like many other fruit species.

Kiwifruit can be propagated vegetatively either through cutting (softwood and hardwood) or grafting and budding (Sale, 1985; Lawes, 1992). Root quality of shoots propagated by cutting method is worse than that of shoots propagated by grafting and budding methods (Diaz Hernandez and Garcia Berrios, 1997). As a result, very less number of plants is produced which are relatively negligible against a very huge demand. Seedlings have also vigor and long roots than cuttings (Özcan, 2000).

The grafting success could be affected by several factors such as temperature, hygiene, pest and disease, humidity, developing capability of both scions (bud) and rootstock, grafting time

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and conservation of healing union against water loss and drying (Kaşka and Yilmaz, 1974; Hartman *et al.*, 1990; Tanimoto, 1994). Therefore, present studies were undertaken to standardize method and time of grafting in kiwifruit.

Materials and Methods

The four years old kiwifruit seedlings having uniform diameter were used as rootstock. They were grown in Rize ecological conditions located in North-East Turkey. For seedling production, sandy loam soil were used. Soil analysis results obtained from soil samples taken in 20 cm below of soil surface are 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

Scion woods (Hayward) were selected in previous winter from vigorous productive plants grown in the kiwi orchard of Atatürk, Tea and Horticultural Plants Research Institute in Rize. They were packed in dumpy sawdust and stored in cold storage at 0-1°C for days to initiation of study (Strik and Cahn, 1996).

On the other hand, cleft grafting by machine, cleft grafting by hand, whip and splice were used as grafting methods (Fig. 1). The graftings were done 1st January, 1st February and 1st March. The maximum, minimum and mean temperature (°C) and relative humidity (%) were recorded during two months after grafting (Fig. 2 and 3).

The experiment was laid out in a randomized block design with 3 replications and 20 plants per replication. Cultural operations 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 diameter were recorded in December. Data as percentage were transformed using the arc-sin$\sqrt{x}$ transformation and statistical analysis 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.

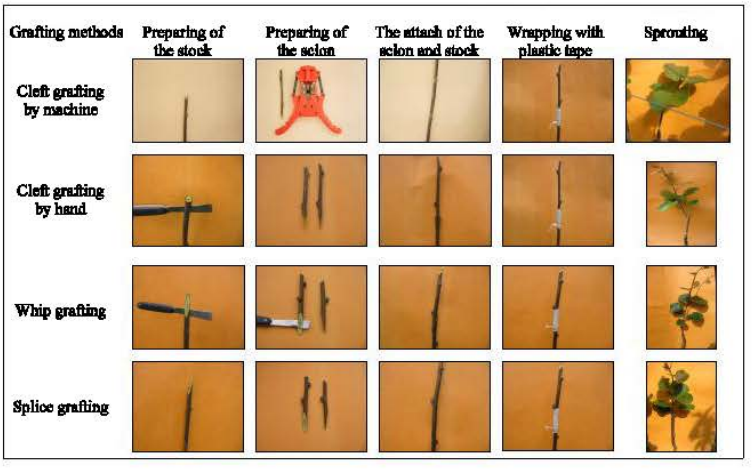

Fig. 1: Four grafting methods (cleft grafting by machine, cleft grafting by hand, whip and splice) were adopted in Hayward kiwifruit cultivars

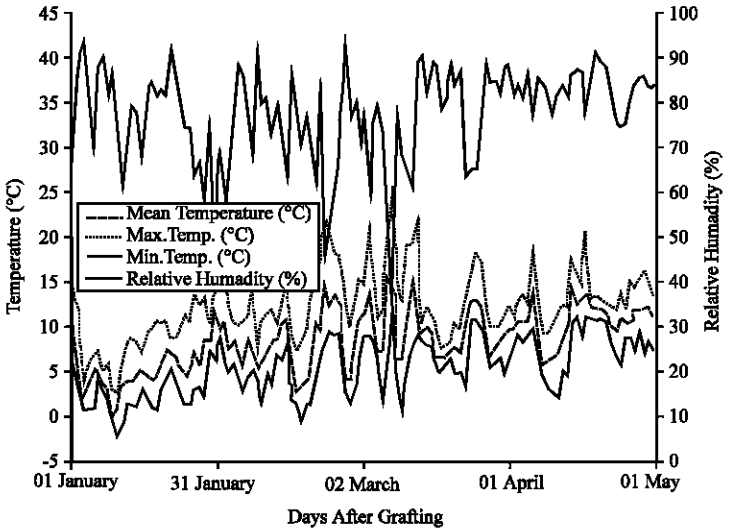

Fig. 2: Changing of mean, maximum and minimum daily temperature and relative humidity during the days after grafting (2002)

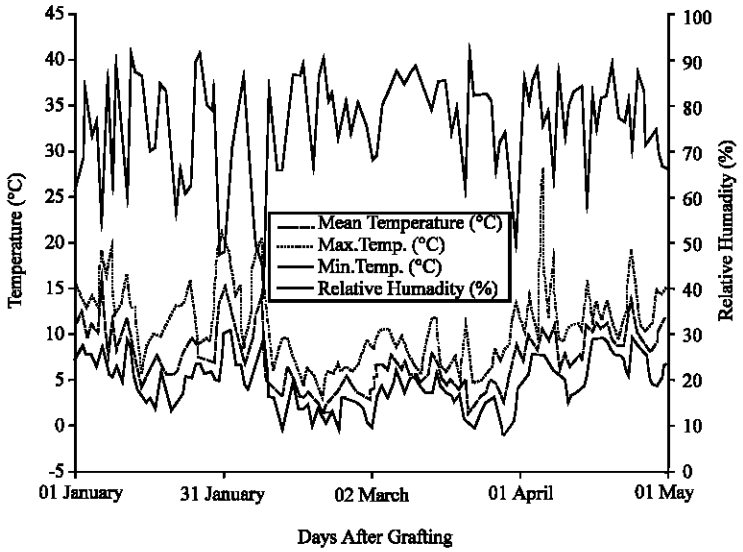

Fig. 3: Changing of mean, maximum and minimum daily temperature and relative humidity during the days after grafting (2003)

Results and Discussion

It was determined that the grafting time, grafting methods and grafting methods x grafting times had a significant effect on bud take and sprouting (Table 1). The whip and splice grafting gave the highest bud-take (whip grafting 91.67 and 93.89%; splice grafting 91.67 and 96.67%, respectively to years) and sprouting (whip grafting 86.67 and 90.00%; splice grafting 88.33 and 92.22%, respectively to years). Grafting time on 1st February gave the highest bud-take (93.33 and 91.25%, respectively to years) and sprouting (86.25 and 88.75%). Whip and splice graftings done at 1st February had highest bud take and sprouting (Table 1). Whip and splice graftings were also

Table 1: Effect of different grafting methods and time of grafting on bud-take, sprouting and growth of grafts in Hayward kiwifruit cultivars

Grafting methods	Grafting times	Bud-take(%)		Sprouting(%)		Shoot Diameter (mm)		Shoot Length (cm)	
		2002	2003	2002	2003	2002	2003	2002	2003
Cleft grafting by machine	1 January	70.00e[1] (56.79)[2]	71.67d (57.86)	60.00g (50.77)	55.00d (47.87)	7.09	6.31	62.50	58.58f
	1 February	80.0ce (63.43)	80.00cd (63.43)	65.00eg (53.72)	70.00bd (56.79)	8.67	7.88	90.0	82.00c
	1 March	73.33de (58.93)	86.67c (68.85)	61.67fg (51.75)	66.67cd (54.78)	7.24	7.66	78.0	76.33cd
	Mean	74.44c (59.72)	79.45b (63.38)	62.22c (52.08)	63.89c (53.15)	7.66b	7.28b	76.83b	72.30c
Cleft grafting by hand	1 January	83.33cd (65.95)	80.00cd (63.43)	73.33df (58.93)	73.33bc (58.93)	6.85	5.99	64.12	77.27cd
	1 February	93.33b (77.71)	85.00c (67.21)	86.67c (68.85)	85.00b (67.21)	9.17	8.12	131.67	92.00b
	1 March	85.00cd (67.21)	90.0bc (71.56)	75.00de (60.00)	80.00bc (63.43)	7.58	8.14	89.0	65.70ef
	Mean	87.22b (70.29)	85.00b (67.40)	78.33b (62.59)	79.44b (63.19)	7.87ab	7.42b	94.93a	78.32b
Whip grafting	1 January	86.67c (68.66)	88.33bc (70.11)	80.00cd (63.43)	76.67bc (61.14)	7.25	6.62	74.59	70.72de
	1 February	100.0a (90.00)	100.0a (90.00)	95.00b (77.08)	100.0a (90.00)	9.33	8.92	116.67	131.32a
	1 March	88.33bc (70.11)	93.33b (77.71)	85.00cd (63.43)	93.33a (81.14)	8.12	8.67	94.20	126.31a
	Mean	91.67a (76.26)	93.89a (79.27)	86.67a (67.98)	90.00a (77.43)	8.24a	8.07a	95.15a	109.45a
Splice grafting	1 January	85.00cd (67.21)	90.00bc (71.56)	80.00cd (63.43)	80.00bc (63.43)	7.41	6.48	76.12	71.12de
	1 February	100.0a (90.00)	100.0a (90.00)	98.33a (85.69)	100.0a (90.00)	9.50	8.78	134.17	133.34a
	1 March	90.00bc (71.56)	100.00a (90.00)	86.67cd (66.14)	96.67a (83.85)	8.32	8.51	98.32	130.96a
	Mean	91.67a (76.26)	96.67a (83.85)	88.33a (71.75)	92.22a (79.09)	8.41a	7.92a	102.87a	111.81a
Overall Mean	1 January	81.25b (64.65)	82.25b (65.74)	73.33b (59.14)	71.25b (57.84)	7.15c	6.35b	69.33c	66.53c
	1 February	93.33a (80.28)	91.25a (77.66)	86.25a (71.34)	88.75a (76.00)	9.17a	8.43a	118.13a	109.67a
	1 March	84.17b (66.95)	92.50a (77.03)	77.09b (60.33)	84.17a (70.80)	7.81b	8.24a	89.88b	102.72b
LSD (p<.001)	Method	4.59	4.65	4.04	7.59	0.54	0.33	17.50	5.16
LSD (p<.001)	Time	3.98	4.03	3.50	6.58	0.63	0.28	15.15	4.47
LSD	Method × Time	1% = 7.96	1% = 8.06	1% = 7.00	5% = 9.68	NS	NS	NS	1%=8.94

1 There are no significantly differences between data given in the column, 2 Transformed data

performed well on kiwi grafting works. Higher rate of success in whip and splice graftings might be due to the formation of better graft union owing to better contact of cambial layers of rootstock and scion. These findings are in agreement with those of Zucherelli (1979), Chandel *et al*. (1998) and Spirovska *et al*. (1993). In addition, these results are in close agreement with those of Awasthi *et al*. (1982). Higher rate of survival in whip and splice graftings might be due to stock and scion interlocked more securely, resulting in more intimate contact of cambial layers of the two components than other methods (Hartmann *et al*., 1990). Grafting done on 1st February proved to be the optimum time for grafting in kiwifruit. It was followed by 1st March. The findings are in conformity with those of Chandel *et al*. (1998) and Spirovska *et al*. (1993). The higher success rate might be because of favourable temperature and relative humidity prevailing during the period following grafting and rapid sap flow in rootstock and scion which might have favoured the healing process and established the continuity of cambial and vascular tissues for bud take.

Cleft grafting by machine done on all grafting times had lowest bud-take and sprouting rate. This is probably due to tissue damages from grafting by machine. Likewise, pith tissue is wide and stem tisues are friable in kiwifruit. Therefore, cortex is seperated from wood tissue by pressure of grafting machine resulting in enermous damage around grafting area.

In terms of grafting times, 1st February in 2002 and 1st February, 1st March in 2003 were found to be most suitable date for bud - take and sprouting. Grafting time on 1st January gave the lowest results. Hartman *et al*. (1990), 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 Fig. 2 and 3 the low temperatures in both years prevaling just after grafting caused the lower success in grafting performed at January. In addition, Tuzcu *et al*. (1987) reported that bud-take rate can reach up to 90% in case of the temperatures up 15-18°C in their study conducted out to determine the relationship between bud-take rate of grafting, budding and ambient temperature. As shown in Fig. 2 and 3, mean daily temperature varied with 0.3-11.5°C in January of 2002, but 4.0-16.2°C in January of 2003. These temperature values are not consistent with those reported by Tuzcu *et al*. (1987) and the difference can be reason for the decrense in bud-take rate.

It was determined that the grafting time and grafting methods had a non significant effect on shoot diameter and shoot length. The grafting methods × grafting times had a significant effect on shoot diameter and shoot length (Table 1). The whip and splice grafting gave the highest shoot diameter (whip grafting 8.24 and 8.07 mm; splice grafting 8.41 and 7.92 mm, respectively to years) and shoot length (whip grafting 95.15 and 109.45 cm; splice grafting 102.87 and 111.81 cm, respectively to years). Grafting time on 1st February gave the highest shoot diameter (9.17 and 8.43 mm, respectively to years) and shoot length (118.13 and 109.67, respectively to years). Whip and splice graftings done 1st February had highest shoot diameters and lengths (Table 1). These findings are in agreement with those of Chandel *et al*. (1998) and Spirovska *et al*. (1993). Grafting done on 1st February proved to be the optimum time for grafting in kiwifruit. It was followed by 1st March.

Conclusions

According the results of this trial, all grafting methods and grafting times were succesfull to kiwi propagation. However, the highest mean bud-take rate, sprouting rate, shoot diameter and shoot length were recorded with whip and splice graftings performed on 1st February. The cleft grafting by machine gave the lowest results. 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 those of prevalent years of Samsun.

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