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The Effect of Tying and Wrapping Materials and Their Color on Budding Success in Kiwifruit

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Abstract: We studied the effect of tying and wrapping materials and their color on budding success in kiwifruit. The work was done in the open field during 2002-2003. Three-year-old, gallon container grown Hayward seedlings were chip-budded with Hayward chip-bud sticks in the first quarter of May. Raffia (black), cannabis fiber, leathery polyethylene band (white), soft rubbery polyethylene tape (white), paper tape, cotton yarn and plastic string (white) were used as tying and wrapping material in the first experiment. Green, red, black and white raffia was used as wrapping material in the second experiment. In the first trial, the soft rubbery plastic tape gave the highest graft-take (100%), sprouting rate (96.67% and 100%, respectively to the years), graft shoot diameter (7.58 mm and 7.62 mm, respectively to the years) and length (70.43 cm and 78.01 cm, respectively to the years). Paper tape gave the lowest results. In the second trial, the white raffia gave the best results on graft success (96.67% and 93.33%, respectively to the years) and graft shoot length and diameter. In conclusion, the soft rubbery plastic tape could be effectively used for tying the kiwifruit bud-grafts and white wrapping material increased the bud success. The conventional wraps like cannabis fiber, plastic string, cotton yarn or paper tape are not suitable for kiwifruit budding.

Key Words: Kiwifruit, *Actinidia deliciosa*, chip-bud, wrap and tie types, color

Kivide Yapılan Göz Aşılarında Başarı Üzerine Aşı Bağı Tipi ve Renginin Etkileri

Özet: Bu çalışmada kivide yapılan göz aşılarında başarı üzerine aşı bağı tipi ve renginin etkileri araştırılmıştır. Deneme 2002 ve 2003 yıllarında Samsun ekolojik şartlarında ve açıkta yapılmıştır. Denemede dört litrelik kaplarda yetişmekte olan 3 yaşındaki Hayward çöğürleri anaç olarak kullanılmış ve Hayward çeşidinden alınan yongalı gözler kullanılarak Mayıs ayının ilk çeyreğinde aşılar yapılmıştır. Birinci denemede, aşılama sonrasında aşı bağı olarak rafya (siyah), kendir, sert plastik (beyaz), yumuşak plastik (beyaz), kağıt bant, pamuk ip ve plastik ip (beyaz) kullanılmıştır. İkinci denemede ise aşı bağı olarak yeşil, kırmızı, siyah ve beyaz renkli rafya kullanılmıştır. Aşı tutma oranı her iki yılda da yumuşak plastiğin kullanıldığı aşılarda en yüksek (% 100) olmuştur. Aynı aşı bağı, aşı sürme oranı (yıllara göre sırası ile, % 96.67 ve % 100), aşı sürgün uzunluğu (yıllara göre sırası ile 70.43 cm ve 78.01 cm) ve aşı sürgünü çapı (yıllara göre sırası ile 7.58 mm ve 7.62 mm) bakımından da en yüksek değerleri vermiştir. Kağıt bant ise en düşük değerde kalmıştır. Öte yandan beyaz renkli rafya aşı tutma, sürme ve aşı sürgünü gelişmesi bakımından en yüksek değerleri vermiştir. Bu sonuçlara göre, kivinin göz aşısı ile çoğaltılmasında kullanılabilecek en uygun aşı bağlama materyali yumuşak plastik olup bu materyalin renginin beyaz olması aşıda başarıyı yükseltebilmektedir. Yerel olarak kullanılmakta olan kendir lifleri, pamuk ip veya kağıt bant kivide aşıların bağlanması için uygun değildir.

Anahtar Sözcükler: Kivi, *Actinidia deliciosa*, yongalı-göz aşısı, aşı bağı tipi ve rengi

Introduction

Kiwifruit is a recent introduction in Turkey, becoming increasingly popular among growers in the Black Sea and Marmara regions. Kiwifruit vines can be propagated by grafting or by rooting of cuttings. Both methods can be used to produce vines and crops. Both seedlings and rooted cuttings make good field nursery and container plants (Sale, 1985; Lawes, 1992). However, budding or grafting the desired variety onto a seedling rootstock is the general commercial practice due to the fact that *Actinidia* cuttings root fairly readily from hardwood or softwood cuttings (Diaz Hernandez and Garcia Berrios, 1997; Beutel, 1981). Seedlings have also vigor and longer roots than cuttings (Özcan, 2000). T-budding is probably the most widely used grafting technique, since roses, most fruit trees, and many other woody plants are

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commercially propagated this way. It is simpler, faster, and easier to learn and usually results in a higher percentage of success (Howard et al., 1974; Howard, 1977; Beutel, 1981). In addition, budding makes more economical use of scion wood since every bud can result in a new tree. Container grown budded kiwifruit vines have vigor and uppermost quality roots, and the mortality rate is higher than that of rooted cuttings after planting (Meyer, 1988; Zenginbal and Özcan, 2003). Container raised plants are sold as medium for tall plants and can be transplanted to the field at any time of the year. On the other hand, field grown nursery stocks are transplanted to the kiwifruit vineyard barefoot in the winter (Beutel, 1981). Kiwifruit plants are easily grafted or budded. After budding or grafting, the graft union is tied up with different material and these materials can vary in color (Meyer, 1988). Grafting and budding require that the graft union be held together by tying until the parts unite. Tying is essential for promoting healing and preventing drying of buds and scion woods and it can be done in several ways (Hartman et al., 1990). According to Eriş (1989), soft plastic tape is the most appropriate wrap type in kiwifruit grafting or budding. Nursery adhesive works well to wrap the budding (Howard, 1977; Meyer, 1988). Plastic polyethylene, polyvinylchloride and parafilm tape have been used with successful results to wrap graft or bud unions rapidly. The last one is waterproof, flexible and stretchable thermoplastic film with a paper backing. Masking tape is also a satisfactory wrapping material (Beineke, 1978; Hartman et al., 1990). Rubber strips, electrician's tape, or adhesive tape can also be used to tie the bud. The tying can be done with strong ordinary rubber bands. However, it is best to use a special rubber or plastic budding strips. White or transparent plastic tape is more often used to cover the bud (Howard, 1977; Meyer, 1988). Wrapping and tying must be tight but not cover the bud. Besides wrap type and color, the grafting success may be affected by several factors, such as temperature, hygiene, pest and diseases, humidity, developing capability of both scions (bud) and rootstock, grafting time and grafting and/or budding type and conservation of healing union against water loss and drying (Kaşka and Yılmaz, 1974; Hartman et al., 1990; Tanimoto, 1994). Due to the high demand of budded kiwifruit vines, growers tried to produce their own kiwi vines under their conditions and used different tying and wrapping materials like rubber tape, raffia, cannabis-fiber, soft polyethylene tapes, paper tape, cotton yarn or plastic strips. There are no specific observations on how the wrapping materials and their color affect budding success in kiwifruit. Hence, the present study was undertaken to examine the effects of tying and wrapping materials and their color on the success of kiwifruit budding.

Materials and Methods

Three-year-old kiwifruit seedlings having uniform girth were used as the stock plant. They were grown in a gallon pot including an equal volume of soil, sand and farmyard manure. The sand had no organic material, while the farmyard manure contained 83.8% water, 0.29% nitrogen, 0.17% phosphorus, 0.10% potassium and 0.34% calcium. Scion woods were selected the previous winter from vigorous productive plants grown in the kiwi orchard of the Atatürk Tea and Horticultural Plants Research Institute in Rize, Turkey. They were packed in damp sawdust and stored in cold storage at 0-1 °C for 90 days until the initiation of the study as described by Strik and Cahn (1996). Three-year-old, gallon container grown Hayward seedlings were chip-budded with Hayward chip-bud sticks in the first quarter of May in 2002 and 2003, as recommended by Zenginbal and Özcan (2000). In the first work, raffia, cannabis fiber, leathery polyethylene band (white), soft rubbery polyethylene tape (white), paper tape, cotton yarn and plastic string (white) were used as tying and wrapping material, and green, red, black and white raffia were used as wrapping material in the second work. The work was done in the open field with gallon pot grown kiwifruit seedlings. The maximum, minimum and mean temperature (°C) and relative humidity (%) were also recorded for 2 months after grafting (Figures 1 and 2).

The experiment was laid out in a randomized block design with 3 replications and 10 plants used for a replication. Cultural operations like irrigation, weeding and removal of suckers below graft bud union were done at regular intervals. Data on sprouting were recorded after bud burst, while bud-take success was recorded 3 months after budding. Observations on shoot length and diameter were recorded in December. Data as percentages were transformed using the arc-sin$\sqrt{x}$ transformation, and statistical analyses were applied to these transformed data by using the MSTAT-C software package (Russell D. Freed, Crop and Soil Sciences

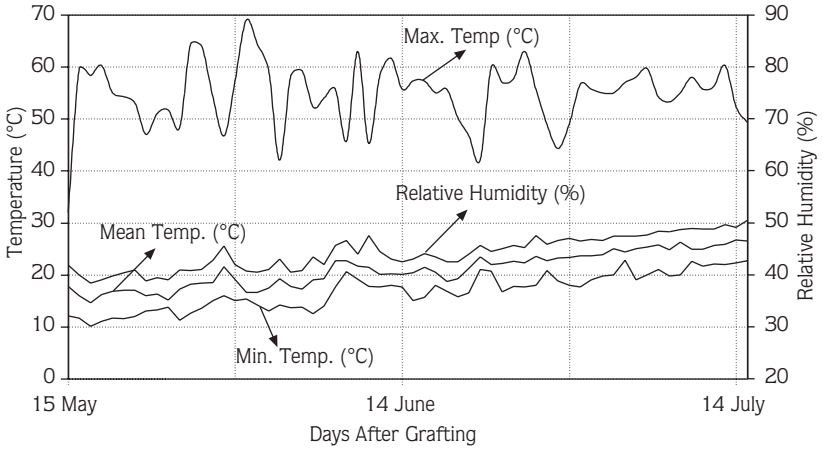

Figure 1. The mean, maximum and minimum temperatures (°C) and relative humidity (%) changes after budding in 2003.

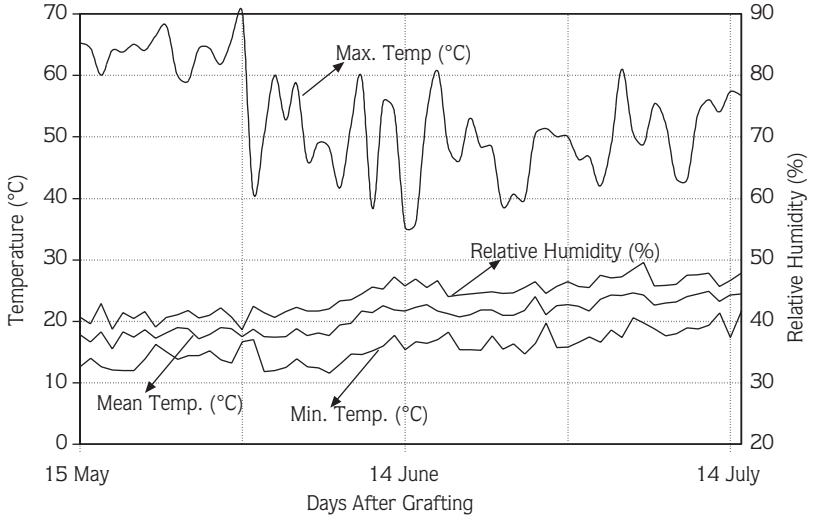

Figure 2. The mean, maximum and minimum temperatures (°C) and relative humidity (%) changes after budding in 2004.

Department, Michigan State University). Duncan's multiple range test was used to indicate the differences between the average data.

Results and Discussion

The tying and wrapping materials had a significant effect on bud take, sprouting and bud shoot growth (Table 1). The soft rubbery polyethylene tape gave the highest bud-take (100%), sprouting (96.67% and 100%, respectively to years) and graft shoot development. Leathery polyethylene band and raffia also performed well on kiwi budding. As the elastic tying and wrapping materials prevent humidity loss and drying of bud sticks, wound tissue over the cut surfaces could be produced more easily for healing. Elastic materials will also allow for some diameter growth of the grafts. On the other hand, soft tying materials are easy to wrap and make more effective contact between stock and bud sticks (Kaşka and Yılmaz, 1974; Skene et al., 1983;

Table 1. The effect of wrapping material on bud-take, sprouting, shoot diameter and length in kiwifruit budding.

Tying & Wrapping Material	Bud-take (%)		Sprouting (%)		Shoot Diameter (mm)		Shoot Length (cm)	
	2002	2003	2002	2003	2002	2003	2002	2003
Raffia (Black)	86.67^{a*}	70.00^{b}	76.67^{abc}	66.67^{bc}	5.09^{ab}	5.23^{c}	46.00^{abc}	46.41^{c}
	(68.86)**	(57.00)	(61.22)	(55.08)				
Cannabis Fiber	70.00^{ab}	50.00^{b}	40.00^{bc}	23.33^{d}	5.12^{ab}	4.89^{cd}	33.83^{c}	33.87^{d}
	(57.00)	(45.00)	(39.15)	(28.78)				
Leathery Polyethylene Band	96.67^{a}	93.33^{a}	90.00^{ab}	86.67^{b}	6.36^{a}	6.44^{b}	65.95^{ab}	68.56^{b}
	(83.86)	(77.71)	(71.57)	(68.86)				
Soft Rubbery Polyethylene Tape	100.00^{a}	100.00^{a}	96.67^{a}	100.00^{a}	7.58^{a}	7.62^{a}	70.43^{a}	78.01^{a}
	(90.00)	(90.00)	(83.86)	(90.00)				
Paper Tape	26.67^{b}	36.67^{b}	26.67^{c}	23.33^{d}	1.59^{b}	4.46^{d}	15.33^{c}	32.41^{d}
	(21.15)	(37.22)	(21.15)	(28.78)				
Cotton Yarn	50.00^{ab}	50.00^{b}	40.00^{bc}	46.67^{cd}	5.09^{ab}	5.04^{cd}	34.33^{c}	36.17^{d}
	(45.00)	(45.00)	(38.85)	(42.99)				
Plastic String	60.00^{ab}	66.67^{b}	46.67^{bc}	60.00^{c}	5.16^{ab}	5.16^{c}	38.85^{bc}	38.00^{d}
	(50.85)	(55.08)	(43.08)	(51.15)				
LSD ($P < 0.001$)	41.5	19.69	37.28	16.96	3.47	0.59	28.39	6.93

*There are no significant differences between data given in the column.
**Transformed data

Kacar, 1989; Hartmann et al., 1990; Soylu et al., 1995). According to Tuzcu et al. (1987), temperature must be between 15 and 18 °C for good callus formation and graft success. On the other hand, graft union must be protected from high temperatures for a month after grafting (Beutel, 1981; Hartman et al., 1990). Therefore, soft plastic tying materials maintained good circumstances for healing and increased the rate of bud take. Increased callus formation affected the bud shoot growth and development positively. Budding wrapped with soft rubbery polyethylene tapes gave the highest shoot length (70.43 cm and 78.01 cm, respectively to years) and diameter (7.58 mm and 7.62 mm, respectively to years) (Table 1). Because of the earliest and good wound tissue formation on cut surfaces, cambial connectivity between stock and scion set rapidly. Enabling water and mineral nutrients could be supplied easily via rootstocks (Skene et al., 1983; Hartmann et al., 1990). Cambial connectivity is related to callus formation and is mostly affected by temperature and humidity around graft union. In the present study, soft rubbery plastic material prevented desiccation of cut surfaces and increased callus formation that had a positive effect on graft take and growth of grafted kiwifruit shoots. These findings also showed similarity to the results reported by Zenginbal and Özcan (2000). Paper tape deteriorated rapidly, did not conserve humidity in the graft union and decreased bud take, sprouting and graft shoot diameter and length. Cotton yarn and plastic string also decreased graft success (Table 1). These findings suggest that the soft rubbery polyethylene tape is the most suitable wrapping material for kiwifruit budding. Howard et al.

(1974) and Howard (1977) also stated that white or transparent plastic tape is more often used for covering the bud.

Graft union could be protecting against high temperature using different colors of wrapping material that reflect the sun's rays. In the present study, the color of the wrapping material affected graft success significantly (Table 2). The white raffia gave the highest bud take (96.67% and 93.33%, respectively to years), sprouting and bud shoot growth and development followed by black, red and green raffia. The temperature around budded kiwifruit plants was higher. This could affect the bud-take. As shown in Figures 1 and 2, mean daily temperature after budding was 11.8-22.5 °C and 15.3-25.5 °C, respectively to years. According to Tuzcu et al. (1987), temperature must be 15-18°C during graft healing. However, the kiwifruit buds are bigger and have more water content (Connor, 1982) and they could be affected more easily by high temperature than other temperate fruits (Tuzcu et al., 1987). Increasing the environmental temperature may decrease the bud-take due to high absorbance capacity of darker raffia. Therefore, the lighter color of raffia gave the highest bud-take. The sprouting rate may increase with the increasing bud-take. Graft shoot length and diameter are related to connectivity between stock and scion (Skene et al., 1983).

In conclusion, the highest bud-take was obtained with soft plastic wrapping materials and white raffia. Paper tape decreased the graft success. Therefore, soft rubbery or leathery polyethylene tapes could be used effectively in kiwifruit budding works in spring. The conventional wraps like cannabis fiber, plastic string, cotton yarn or paper tape are not suitable for kiwifruit budding.

Table 2. The effect of color of raffia on bud take, sprouting, shoot diameter and length in kiwifruit budding.

Wrapping Material Color	Bud-take (%)		Sprouting (%)		Shoot Diameter (mm)		Shoot Length (cm)	
	2002	2003	2002	2003	2002	2003	2002	2003
Green	60.00^{b*}	56.67^{b}	53.33^{b}	56.67^{b}	5.14	4.97^{c}	36.45^{b}	39.24^{c}
	(50.77)**	(48.93)	(46.92)	(48.93)				
Red	80.00^{ab}	63.33^{b}	76.67^{ab}	60.00^{b}	5.79	5.49^{b}	46.42^{b}	43.24^{bc}
	(64.64)	(52.86)	(62.71)	(50.94)				
Black	86.67^{ab}	70.00^{b}	76.67^{ab}	66.67^{ab}	5.09	5.23^{bc}	46.00^{b}	46.41^{b}
	(68.86)	(57.00)	(61.22)	(55.08)				
White	96.67^{a}	93.33^{a}	90.00^{a}	86.67^{a}	6.36	6.44^{a}	65.95^{a}	68.56^{a}
	(83.86)	(77.71)	(71.57)	(68.86)				
LSD	18.89[1]	17.80[1]	16.09[1]	14.53[1]	N.S	0.44[2]	14.82[1]	6.58[2]

*There are no significantly differences between data given in the column,
**Transformed data
[1] $P < 0.005$
[2] $P < 0.001$
NS: Non-significant.

References

Beineke, W.F. 1978. Parafilm: A new way to wrap grafts. HortScience 13: 284.

Beutel, J. 1981. Kiwifruit Propagation. U.C. Davis Extension Service, p. 12.

Connor, D.M. 1982. Cutting Propagation of *Actinidia chinensis* (Kiwifruit). Combined Proceedings of the International Plant Propagators Society, 32: 329-333. Monrovia Nursery Co., Azusa, California, USA.

Diaz Hernandez, M.B. and J. Garcia Berrios. 1997. Performance of kiwifruit plant material propagated by different methods. Acta Horticult. 444: 155-169.

Eriş, A. 1989. Türkiye İçin Yeni Bir Meyve Türü Kivi (*Actinidia chinensis* Planch.). T.C. Ziraat Bankası Kültür Yayınları No: 22, Ankara.

Hartmann, H.T., D. Kester and F.T. Davies. 1990. Plant Propagation Principles and Practices. Fifth Edition. Regents/Prentice Hall, Englewood Cliffs, New Jersey.

Howard, B.H. 1977. Chip budding fruit and ornamental trees. Proc. Inter. Plant. Prop. Soc. 27: 357-364.

Howard, B.H., D.S. Skene and J.S. Coles. 1974. The effect of different grafting methods upon the development of one-year-old nursery apple trees. J. Hort. Sci. 49: 287-295.

Kacar, B. 1989. Bitki Fizyolojisi. Ankara Üniversitesi Ziraat Fakültesi Yayınları No: 1153, Ders Kitabı 323. Ankara.

Kaşka, N. and M. Yılmaz. 1974. Bahçe Bitkileri Yetiştirme Tekniği. Çukurova Üniversitesi Ziraat Fakültesi Yay.: 79, Ders Kitabı 2.

Lawes, G.S. 1992. Propagation of kiwifruit. MAF Ecology, Soil and Plant Research Group. Ruakura Agriculture Centre, Hamilton, New Zealand.

Meyer R., 1988. Backyard growing of kiwifruit and related Actinidia. J. Calif. Agric. 3: 11-13

Özcan, M. 2000. Değişik uygulamaların kivi tohumlarının çimlenmesi üzerine etkileri. OMÜ, Ziraat Fakültesi Dergisi, 15: 48-52.

Sale, P.R. 1985. Kiwifruit Culture. Government Printer, Wellington, New Zealand.

Skene, D.S., H.R. Shepart and B.H. Howard. 1983. Characteristic anatomy of union formation in T- and chip-budded fruit and ornamental trees. J. Hort. Sci. 58: 295-299

Soylu, A., A. Eriş, R. Türk, E. Barut and C. Türkben. 1995. Meyvecilik. T.C. Anadolu Üniversitesi, Yay. No: 859, AÖF Yay.: 455, Eskişehir. p. 421.

Strik, B. and H. Cahn. 1996. Growing Kiwifruit. EC 1464. Oregon State University. Corvallis.

Tanimoto, G. 1994. Propagation In: "Kiwifruit Growing and Handling" (Ed. J.K. Hasey, R.S. Johnson, J.A. Grant, W.O. Reil). Univ. of California, Division of Agriculture and Natural Resources, Publication 3344, pp. 21-24.

Tuzcu, Ö., A. Doğrular, A. Demirkol, M. Kaplankıran and T. Yeşiloğlu. 1987. Antalya Ekolojik Koşullarında Bazı Önemli Avakado Çeşitlerinde En Uygun Aşılama Yöntem ve Zamanının Belirlenmesi. Derim 4: 110-125.

Zenginbal, H. and M. Özcan. 2000. Samsun Ekolojik Şartlarında Kivilerin Sürgün Göz Aşılarıyla Çoğaltılmaları Üzerine Bir Araştırma. OMÜ Ziraat Fakültesi Dergisi, 15: 27-35.

Zenginbal, H. and M. Özcan. 2003. Kivilerin Aşıyla Çoğaltılma Teknikleri. Ulusal Kivi ve Üzümsü Meyveler Sempozyumu. 23-25 Ekim, p. 120-125. Ordu-Türkiye.