A Research on the affinity coefficients of Red Globe grape variety with 140 R, 41 B rootstocks

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Abstract. This research has been performed in order to evaluate four different affinity coefficients with formulas, with the purpose to determine achievement ratios related to the omega grafting applied onto the 41 B, 140R rootstock of the Red Globe grape variety which is commercially important grape variety in Lakes Region of Turkey. The study was done in Egirdir Fruit Research Station in Isparta city of Turkey. When the affinity values were statistically analyzed according to rootstocks and year, combinations was significantly evaluated and by evaluating 2012 and 2013 year's data consecutively, hopeful combinations were determined. It has been determined that 2013 years affinity coefficients and 140 R rootstock combination were slightly better than 2012 year and 41B combination. It has been determined that evaluating only with the formulations is not sufficient to get an exact result by the determination of a good affinity. Therefore it is needed to continue studies in future for a long time growing. The results which were evaluated in this study and next years' studies results must be evaluated together when a stable affinity occurs, a final result and suggestion can be made about combinations. Rootstock proposals regarding to the varieties and regions can be made paying special attention to these features will be beneficial for successful viticulture in the future.

1. Introduction

Successful grafting depends on the formation of a union between rootstock and scion. The inability of the two different plants parts, when grafted together to produce such union and the difficulties of the resulting single plant to develop satisfactorily is termed "incompatibility". The different characteristics in growth between rootstock and scion are one of the causes of bad affinity; especially when active callus formation in scion and rootstock occurs during different growing periods. Additionally, fast development of wound tissue in scion or rootstock causes insufficient vascular tissue which results in insufficient anatomical connection. In both cases, basipetal and acropetal transport is reduced or prevented. This causes the emergence of physiological disorders and symptoms.

Among Euvitis sub-species of genus Vitis do not display absolute incompatibility. However, the anatomical structure differences, as well as grafting compatibility in later stages resulting biochemical in compatibility may affect negatively the performance of grafted vines significantly.

Determination of affinity coefficients between the scion and rootstock is one of the most widely used method, the assessments made in the vineyard are the evaluations for affinity for the rootstock and scion (12). In practice, usually growth differences above and below the point of grafting is regarded as a sign of incompatability. On the other hand, normal development and yield performances above and below the graft may not be always an indicator for incompatability (2).

A graft union is considered to be successful when several functional phloem and xylem connections cross the graft surface (23). However, incompatible grafts can grow several years without any external symptom of incompatibility (9, 15), indicating the presence of functional vascular connections (5). Different levels of compatibility between grapevine rootstock and *Vitis vinifera* cultivars were found to exist (8, 13, 11, 15, and 22) and these cases were mostly noted during the adaptation experiments conducted in different ecologies on scion–rootstock combinations. An early and accurate prediction of graft incompatibility has great importance because it may allow avoiding incompatible combinations while selecting compatible ones (6).

Rootstocks play an important role in production due to their physiological properties. Grafting maintains integration through anatomical fusion. Physiological difference in the thickness of the scion is of major concern. In case the weakness of affinity, low life expectancy is expected.

Damage from Phylloxera can be avoided by using proper rootstocks under different ecologies and soil types, different grape varieties. Thus, there is need to test adaptation and affinity under different soil and environmental conditions. Especially in recent years, some compatibility problems appeared in grapevines due to the different climatic and soil features of Turkey in different regions. It is necessary to determine the soil properties

Figure 1. Turkey Map and Isparta City.

Figure 2. Lakes Region and Egirdir town.

in order to select the American grapevine rootstocks compatable with the grape variety to be grown. Therefore, affinity coefficients must be calculated and evaluated for future planning in viticulture (1, 3).

The objective of this study that is performed in two vegetation periods is to determine the level of affinity between Red Globe grape variety grafted onto 41 B and 140 R rootstocks at the same age. Measuring the rootstock thickness is the principle on which measurements are based in all four formulas used in comparisons.

2. Material and method

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This experiment was conducted during the 2011–2012 and 2012–2013 growing season using 2 year-old grapevines. This study was carried out in Egirdir Fruit Research Station farmlands. Egirdir is a district of Isparta. Its altitude is 920 m high and it represents passing zone climate and ecological conditions. Geographical coordinates of Egirdir district; are 37° 50′ 41″, 38° 16′ 55″ N latitude, 30°57′ 43′′, 30°44′ 39″ E latitude (19, 20). Isparta is known to have ideal ecological conditions for viticulture in Lakes Region where Isparta is located (Figs. 1 and 2). Average rainfall is between 445–764 mm, and temperature varies between −14 °C and + 37 °C (Table 1).

Soil analyses were done in Egirdir Fruit Research Station Soil analyses laboratories. Soil analyses report is on Table 2. According to soil analyses 41 B rootstock was chosen for high lime and 140 R rootstock was chosen for its good performance and vigorous development for Red Globe grape variety.

2.1. Plant material

Vineyard was established in 2011 year winter period with in row with spacing 2 m × 3 m with drip irrigation and on Red Globe variety grafted 41 B and 140 R rootstocks. Soil is in clayish loam texture with 7, 78 pH and contains high lime. Vines were trained to rational pergola system and spur pruning system.
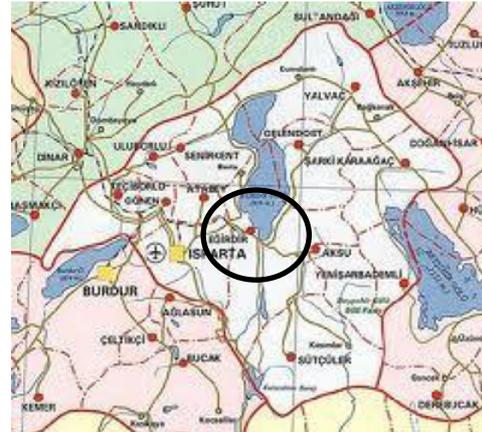
41B American grapevine rootstock (*Chasselas x V. berlandieri 41B Millardet et de Grasset*) has a short vegetation period (early), therefore transfers this feature onto grafted varieties providing early maturation. It is resistant to 40% active lime. Roots go deep and are very resistant to phylloxera.

140 R is a very hardy rootstock suitable for the most challenging drought conditions. It is also able to tolerate active lime up to 20% and is adapted to acid soils. 140 R has a high resistance to root-knot nematode but low resistance to root-lesion and citrus nematode. 140 R has good tolerance to saline conditions and is able to exclude grape juice chloride and sodium in saline conditions to a significantly greater extent than *Vitis vinifera* as well as most other rootstocks. This rootstock is moderately susceptible to spring waterlogging particularly in its formative years. A rootstock suitable for hot climates where moderate to high yields are required for the production of commercial wine, however, it is also suitable for sites susceptible to drought as well as those with high salinity. 140 R has a long vegetative cycle which may delay ripening or cause excessive vigor on high growth potential sites in cooler regions.

2.2. Experimental methods

The measurements were taken randomly from 40 grapevines. Each plot comprised 10 grapevines distributed in 4 rows. For this study, the following measurements were taken; rootstock diameter (mm) (C), graft union diameter (mm) (B), scion diameter (mm) (A) in 2011–2012 and 2012–2013 vegetation periods.

2.2.1. Affinity analysis

Graft affinity between scion and rootstock can be determined using different methods. Getting affinity criteria demands an evaluation of at least the first harvest of each variety; therefore many researchers are looking for alternative methods to determine affinity (7, 24). Four different formulas developed by Branas (1974), Perraudine (1962), Laveé and Spiegel-Roy (1971) and Onaran (Kara, 1995) methods were used to calculate the affinity coefficient. AC means the affinity coefficient in

Table 1. Some Climatic data of the experiment area.

Year	Avg. Temperature (°C)	Min. Temperature (°C)	Max. Temperature (°C)	Avg. Precipitation (mm)	Avg. Humidity (%)
Average	12.2	−14.9	38.6	764	66.5
2011	11.9	−8.2	37.4	669	66.3
2012	12.9	−12.7	38.6	622	68.9
2013	13.1	−7.9	34.1	654	63.7

Table 2. Soil analyses of the experiment area.

Physical Analyses		
	Texture	Clayish Loam
	pH	7.78
	Lime (%)	9.8
	Saturation (%)	49
Chemical Analyses		
	Organic matter (%)	2.8
	N (ppm)	1617
	P (ppm)	4.52
	K (ppm)	221.1
	Ca (ppm)	4679
	Mg (ppm)	492
	Na (ppm)	13.48
	Fe (ppm)	13.64
	Cu (ppm)	4.23
	Mn (ppm)	6.25
	Zn (ppm)	1.04
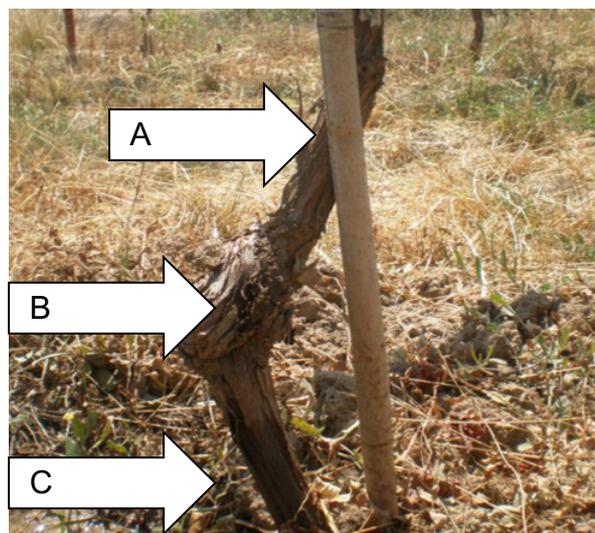
Figure 3. A grapevine in the vineyard and measuring points.

all formulas. The affinity coefficient was formulated by Branas (1974) as:

$$AC = [(C/A) \times (C + A)/2B] \times 10$$

A scion diameter was measured 10 cm above the graft union (cm);

B Graft union diameter (cm);

C Rootstock diameter was measured 10 cm below graft union (cm).

AC = 10: There is an affinity deal when the value is 10 or near 10,

AC > 10: When it is greater than 10, the rootstock is thicker than the scion,

AC < 10: When it is lower than 10, the scion is thicker than the rootstock).

The formulae developed by Perraudine (18) formulae;
$$AC = [(C/A) + (C + A)/2B] + 10 \quad AC = 12;$$

AC = 12 There is an affinity deal when the value is 12 or near 12

AC > 12 When it is greater than 12, the rootstock is thicker than the scion

AC < 12 When it is lower than 12, the scion is thicker than the rootstock.

Spiegel-Roy and Lavee (17) formulae is an another formulae for evaluating affinity coefficients;

$$AC = (C/A) – 1 \text{ (bad affinity when it is away than 0 value).}$$

According to Onaran (14, 20) formulae;

$$AC = (C \times 100)/A = \% \text{ (good affinity when it is nearer to 100 value).}$$

Results obtained by each formulas is evaluated under their names.

Trial is designed as randomized blocks with 4 replications, and each replication comprised 10 vines. Results are evaluated by Jump 7.0 JMP statistical software package. Data were subjected to analysis of variance and differences among averages were evaluated by LSD test.

3. Results and discussion

Trial is designed as randomized blocks with 4 replications, and each replication comprised 10 vines. Results are evaluated by Jump 7.0 JMP statistical software package. Data were subjected to analysis of variance and differences among averages were evaluated by LSD test.

Compatibility of the grafted rootstock and scion of the components depends on their anatomical and physiological capacity. Callus development at the junction point in rootstocks grafted with the scion determines the diameter at grafting interface.

Rootstock diameters in Red Globe/140R graft combination in 2012 year varied between 10.45–19.09 mm with an average value of 14.64 mm. Scion diameters varied between 4.59–9.71 mm, with an average value of 7.25 mm, graft union diameters varied from 20.98 to 37.06 mm with an average value of 28.22 mm.

Table 3. Average values of scion, grafting union and rootstock diameters.

Rootstock/year	Average Scion Diameter (A) mm	Average Graft Union Diameter (B) mm	Average Rootstock Diameter (C) mm
2012 41 B	4.95	27.21	14.83
2012 140 R	7.25	28.22	14.64
2013 41 B	11.38	27.45	16.90
2013 140 R	14.02	39.34	17.03

Table 4. Affinity coefficients of rootstocks for Branas formulae.

Year-Rootstock	Least Sq Mean*	
2012 - 41 B	10.927 ± 0.033	a
2013 - 41 B	10.805 ± 0.033	b
2012 - 140 R	10.769 ± 0.033	b
2013 - 140 R	10.619 ± 0.043	c

Grouping with same letter are not significantly different.

Rootstock diameters in Red Globe/140R graft combination in 2013 year varied between 12.49–23.02 mm with an average value of 17.03 mm. Scion diameters varied between 9.09–15.22 mm with an average value of 14.02 mm and graft union diameter varied from 25.88 to 44.41 mm with an average value of 39.34 mm.

Rootstock diameters in Red Globe/41B graft combination in 2012 year varied between 11.08–18.90 mm with an average value of 14.83 mm scion diameters varied between 3.21–7.84 mm with an average value of 4.95 mm and graft union diameter varied from 21.12 to 33.81 mm with an average value of 27.21 mm.

Rootstock diameters in Red Globe/41B graft combination in 2013 year varied between 13.85–19.74 mm with an average value of 16.90 mm. Scion diameters varied between 7.34–19.04 mm with an average value of 11.38 mm and graft union diameter varied from 20.98 to 35.74 mm with an average value of 27.45 mm.

Performance of Red Globe grape variety on 41 B and 140 R rootstocks and data related to the effects of rootstocks are shown in (Table 3).

Average scion diameters in two years period doubled from 2012 to 2013 year vegetation period in both rootstocks. There was no significant differences between rootstock diameters and between the years. A significant increase of average graft union diameter has been noticed in 2013 for 140 R rootstock.

Spiegel-Roy and Lavee and Onaran formulas make calculations only for the ideal scion and rootstock affinity and they gave close or more common results in terms of affinity coefficients.

When rootstocks were evaluated according to Branas formulae, in 2012, 41 B combination was evaluated the best with (10.92 a) value, other groups 2013 41 B, 2013 140 R, 2013 41 B followed it respectively with values 10.80, 10.76 and 10.61 (Table 4). But the differences with other combinations are not very high. All combinations were nearly same by Branas formulae. In all groups rootstocks were thicker than the scion. 2013-140R combination had the nearest value with 10.61 to 10 value which could be accepted best group but all groups were

Table 5. Affinity coefficients of rootstocks for Perraduine formulae.

Year-Rootstock	Least Sq Mean*	
2012 - 41 B	11.161 ± 0.551	a
2013 - 41 B	8.010 ± 0.551	b
2012 - 140 R	7.950 ± 0.551	b
2013 - 140 R	6.950 ± 0.711	b

Grouping with same letter are not significantly different.

Table 6. Affinity coefficients of rootstocks for Spiegel-Roy and Lavee formulae.

Year-Rootstock	Least Sq Mean*	
2012 - 41 B	2.022 ± 0.118	a
2012 - 140 R	1.126 ± 0.118	b
2013 - 41 B	0.701 ± 0.118	c
2013 - 140 R	0.555 ± 0.118	c

Grouping with same letter are not significantly different.

Table 7. Affinity coefficients of rootstocks for Onaran formula.

Year-Rootstock	Least Sq Mean*	
2012 - 41 B	300.321 ± 12.599	a
2012 - 140 R	212.571 ± 12.599	b
2013 - 41 B	171.893 ± 12.599	c
2013 - 140 R	143.643 ± 12.599	c

Grouping with same letter are not significantly different.

nearer to each other so evaluations for Branas formulae must be continued.

When rootstocks were evaluated according to Perraudine formulae 2012 41 B combination was evaluated the best with (11.16 a) value, other groups 2013 41 B, 2012 140 R, 2013 140 R followed it respectively with values 8.01, 7.95 and 6.95 (Table 5). The difference with other combinations that were grouped together is very high. Perraudine formulae results were not close to the 12 value except 2012 140 R group so Perraudine results gave less sensitive compared to Branas formula.

When rootstocks were evaluated according to Spiegel-Royce and Lavee formulae 2013 41 B, 2013 140 R combinations were evaluated better with (0.70c, 0.55c) values, other groups 2012 140 R, 2012 41 B followed it respectively with values 1.12, 2.05 (Table 6) 2013 41B and 2013 140 R groups had higher values in this formulae than other formulas results differ than other formulas in Spiegel Royce formulae. 2013 year results had showed good affinity for this formula.

When rootstocks were evaluated according to Onaran formulae 2012 41 B combination was evaluated the best with (300.3 a) value, other groups 2012 140 R, 2013 140 R, 2013 41 B followed it respectively with values 212.5, 171.8 and 143.6 (Table 7). In this formulae 2013 140 R combination looks better but is not enough to say it has a good affinity according to the second year's result.

Coefficients calculated for two rootstocks and two years were evaluated according to 4 different formulas, in 2013 rootstocks showed better affinity than the first year and 140 R rootstock showed slightly better affinity than 41 B by field observations. When 4 different formulas were evaluated together, 140 R rootstock year combinations were slightly better than 41 B rootstocks. It is still very

early to declare as displaying a very good affinity with only two years' results.

Grafting incompatibility problems in the variety/rootstock combinations, depend on climatic conditions expect rootstock and variety sometimes. Differences in growth rates between scion and rootstock can be regarded as the first sign of graft incompatibility. Although, vineyards, well maintained in terms of yield and quality under favourable climatic conditions, are known to exist without a problem.

Branas formula gave closer results to ideal value 10 than other formulas ideal values. There were differences in affinity coefficient values between years. 2013 140R combination had slightly more compatible affinity coefficient values than 41B and other year combinations except Perraudine formula. But this case does not mean 140R has a good affinity with Red Globe grape variety. It is very early to say combinations of 140R or 41B rootstocks with two years results that they have a good or bad affinity. These results are the pre results of the research and also they must be evaluated with Egirdir/Isparta ecological conditions. Study must be continued in following years. The results which were evaluated in this study and the results which will be get in next years must be evaluated together when a stable affinity occurs a final result and suggestion can be made about combinations.

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