HortScience 23(2):316–317. 1988.

Influence of Strain of 'Delicious' Apple on Root Development of 1-year-old Trees

Bruce H. Barritt
Tree Fruit Research Center, Washington State University, Wenatchee, WA 98801

Additional index words. rootstock shank rooting, spur-type trees, nonspur trees, *Malus domestica*

Abstract. **First-year root development on the M.7A rootstock shank was evaluated with four nonspur and seven spur-type strains of 'Delicious' apple (*Malus domestica borkh.*) The rootstock shank was the portion of the rootstock that was above the soil line in the nursery and was buried at the time of planting in the orchard. First-year total shoot length and trunk diameter increase of the scion were generally greater for nonspur than for spur-type strains. Dry weight of new roots per centimeter of rootstock shank length was correlated with shoot length and with trunk diameter increase (r = 0.53 *** and r = 0.68 ***, respectively). Although the more vigorous nonspur strains generally had more rooting on the rootstock shank than spur-type strains, there appear to be other factors, including the nursery environment, that influence shank rooting.**

When producing an apple tree, the scion cultivar is budded onto the rootstock up to 30 cm above the soil line; this portion of the rootstock (the rootstock shank) may be buried when the tree is planted in the orchard (2, 5–7). Root development on the buried rootstock shank is critical to the early establishment and anchorage of the young tree (5, 6). Rom and Motichek (9) recently found that the growth habit of the scion cultivar can influence the development of adventitious roots on the buried rootstock shank. On spur-type and standard strains of 'Granny Smith' and 'Delicious', they observed less adventitious root development on MM.111 and MM.106 rootstock shanks for spur than standard strains. In view of these findings, the current trend for nurseries to bud higher than 20 cm for deep orchard planting and the virtual replacement of standard strains of 'Delicious' by spur types (3), an investigation was undertaken to study a range of spur and nonspur strains of 'Delicious' for their influence on shank rooting.

Trees of 11 'Delicious' strains on M.7A rootstock of uniform grade (16 mm scion diameter) were obtained from three commercial nurseries. Four strains had standard (nonspur) growth habit, 'Imperial Red', 'Sharp Red', 'Ryanred', and 'Columbia'; and seven strains had spur growth habit, 'Oregon Spur II', 'Dana Red', 'Ryanred Spur', 'Redchief', 'Hardi-Brite Spur', 'Cascade Spur', and 'Scarlet Spur'. Ten trees of each strain, arranged as single-tree replicates in a randomized complete block design, were planted in May with in-row spacing of 50 cm and 2-m spacing between rows. The rootstock shank, the portion of the rootstock above the soil line in the nursery, varied in length from 22 to 28 cm and was buried at planting. At planting, the unbranched whips were pruned at 70 cm. Shoot growth below a height of 45 cm was removed. Trees were dug in November with a commercial nursery digger in order to retain as much of the complete root system as possible. Trunk diameter 15 cm above the bud union was measured at time of planting and at digging. Length of branches, number of nodes [>90% of root emergency occurs at nodal areas (1)] where new roots occurred on the rootstock shank, and dry weight of new roots on the rootstock shank were determined.

As expected (3), the nonspur strains were generally more vigorous than spur strains, although not all nonspur strains had greater growth than all spur strains (Table 1). Two nonspur strains, 'Imperial Red' and 'Ryanred', had significantly greater shoot growth and trunk diameter increase than all spur strains. Differences among strains occurred in the number of rooting nodes and in new root dry weight on the buried rootstock shank. 'Redchief', a spur strain, had fewer rooting nodes and less root dry weight than 'Imperial Red', a nonspur strain, confirming observations with these same strains by Rom and Motichek (9). However, not all spur strains had less rooting than nonspur strains. Root weight per centimeter of shank length was correlated with scion vigor measurements of shoot length and trunk diameter increase (r = 0.53 *** and r = 0.68***, respectively), suggesting that more vigorous strains have greater shank rooting than those less vigorous. However, the coefficients of determination are low, indicating that factors other than scion vigor contribute to shank rooting.

One factor contributing to variation in shank rooting may be a nursery environment favorable for the development of root initials. Low light intensity and high relative humidity in the stool bed and propagation row, where tree density is very high, are conducive to formation of root initials (1, 8). Climate at the nursery site also may influence the development of root initials. With trees grown at one nursery, 'Sharp Red', a nonspur strain, had a greater number of rooting nodes than three spur strains, 'Oregon Spur II', 'Dana Red', and 'Scarlet Spur'. Of the trees from a second nursery, 'Imperial Red', a nonspur, had a greater number of rooting nodes than 'Redchief', a spur strain. However, from a third nursery, two nonspur strains, 'Ryanred' and 'Columbia', did not differ in the number of rooting nodes from three spur strains, 'Ryanred Spur', 'Hardi-Brite Spur', and 'Cascade Spur'. Trees from this third nursery were grown in the Willamette Valley of Oregon, which has a cool, moist climate in comparison with the hot, dry environment of the Columbia Basin of central Washington where the other trees were grown. Studies of the influence of nursery practices and the nursery environment on subsequent development of shank rooting seem warranted, since spur strains are widely grown and since tree support and early tree

Table 1. Influence of strain of 'Delicious' apple on scion growth and on root development on the M.7A rootstock shank.

	Scion growth		Root development	
Delicious strain	Total shoot length/tree (cm)	Trunk diam increase (mm)	No. rooting nodes/cm shank length	Root dry wt/cm shank length ($g\cdot cm^{-1}$)
Imperial Red[y]	557 a[z]	7.9 ab	0.29 a	1.78 a
Ryanred[y]	485 ab	8.3 a	0.25 a	0.93 bc
Columbia[y]	436 bc	6.3 abc	0.20 abcd	0.87 bc
Sharp Red[y]	418 bc	5.4 bcd	0.25 a	0.82 bc
Oregon Spur II	359 cd	4.9 cd	0.15 bcd	0.32 c
Ryanred Spur	295 de	4.7 cd	0.26 a	0.94 bc
Dana Red	267 de	4.3 cd	0.14 cd	0.50 bc
Redchief	227 ef	4.2 cd	0.15 cd	0.73 bc
Hardi-Brite Spur	199 ef	4.8 cd	0.24 ab	0.83 bc
Scarlet Spur	232 ef	3.6 d	0.12 d	0.34 c
Cascade Spur	164 f	4.5 cd	0.21 abc	1.09 b

[z]Mean separation within columns by LSD, P = 5%.
[y]Nonspur strain.

Received for publication 30 Mar. 1987. Scientific Paper no. 7728, College of Agriculture and Home Economics Research Center, Washington State Univ., Pullman. The donation of trees by Carlton Plants, Hilltop Orchards and Nurseries, and Van Well Nursery, and the cooperation of the Van Well Nursery in digging the trees are gratefully acknowledged. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

growth are critical factors in the establishment of new orchards (4, 5).

Literature Cited

1. Doud, S.L. and R.F. Carlson. 1977. Effects of etiolation, stem anatomy, and starch reserves on root initiation of layered *Malus* clones. J. Amer. Soc. Hort. Sci. 102:487–491.
2. Ferree, D.C. and R.F. Carlson. 1987. Apple rootstocks, p. 107–143. In: R.C. Rom and R.F. Carlson (eds.). Rootstocks for fruit crops. Wiley, New York.
3. Ferree, D.C., J.C. Schmid, and C.A. Morrison. 1982. An evaluation of over 16 years of Delicious strains and other cultivars on several rootstocks and hardy interstems. Fruit Var. J. 36:37–45.
4. Harrison-Murray, R.S. and J.E. Jackson. 1984. Pre-treatment of nursery apple trees for deep planting. Rpt. E. Malling Res. Sta. 1983. p. 79.
5. Jackson, J.E., R.S. Harrison-Murray, and S. Hicks. 1984. Reducing staking costs and improving tree establishment. Rpt. E. Malling Res. Sta. 1983. p. 31–32.
6. Rogers, W.S. and M.S. Parry. 1968. Effects of deep planting on anchorage and performance of apple trees. J. Hort. Sci. 43:103–106.
7. Rom, R.C. and S.A. Brown. 1973. Burr-knot characteristics of six clonal apple rootstocks. Fruit Var. J. 27:84–86.
8. Rom, R.C. and S.A. Brown. 1979. Factors affecting burr-knot formation on clonal *Malus* rootstocks. HortScience 14:231–232.
9. Rom, R.C. and G.R. Motichek. 1987. Cultivar effects on adventitious root development of clonal apple rootstocks. HortScience 22:57–58.

HORTSCIENCE 23(2):317–321. 1988.

Effects of Rootstocks on Wine Grape Scion Vigor, Yield, and Juice Quality

William N. Lipe[1] and Ron L. Perry[2]
Texas Agricultural Experiment Station, Rt. 3, Box 219, Lubbock, TX 79401

Additional index words. Juice pH, °Brix, total acids, hardiness, *Vitis*

Abstract. **Forty cultivars of wine grapes (*Vitis spp.*) grafted on 'Dogridge' and 'Couderc 1613' rootstock and self-rooted vines were planted in 1974 at the Texas Agricultural Experiment Station near Lubbock. From fourth to 13th leaf vines were evaluated for vigor, winter hardiness, yield, and juice quality (°Brix, pH, and acids). Although each cultivar responded differently to rootstock, some general observations are made regarding acceptance or rejection of stocks. Compared to self-rooted cultivars, 'Dogridge' significantly increased vigor on 37% of cultivars while reducing vigor on 7%, reduced winter hardiness on 22% while increasing hardiness of 7%, and reduced yields on 32% while increasing yields on 17%. The most detrimental effect of the 'Dogridge' rootstock was on pH, which was increased on 50% of cultivars while reduced on none. In comparison, 'Couderc 1613' expressed more moderate effects on most scion cultivar parameters tested.**

Rootstocks are commonly used in grape production to provide resistance or tolerance to various production problems, including phylloxera, rootknot nematode, and cotton rootrot. Phylloxera resistance has been researched extensively over the past 100 years, with the general conclusion that *Vitis vinifera* L. cultivars grown in phylloxera-infested areas require resistant stocks to sustain adequate growth and production (11, 14, 19). Considerable research also is available relating to the importance of root-knot nematode resistance for vines grown in nematode-infested soils (8, 17, 19). Although limited, some research is available concerning rootstock resistance to cotton rootrot (18, 20–22). Most conclude that the increase in growth and yields from vines propagated on resistant stocks grown in infested soils is because these stocks overcome the losses attributed to pest pressure. The intrinsic value of these stocks on other parameters (vigor, winter hardiness, yield, quality), in the absence of pest pressure, has not been well-established.

Shaulis (23) attributed the "apparent" positive vigor response of 'Concord' on 'Couderc 3309' rootstock to lack of fruitfulness induced by the 'Couderc 3309' rootstock, and stated that it was the lack of fruit load that caused the increased vigor and not the rootstock per se. He stated that American and hybrid cultivars are less likely to respond to rootstock induced vigor than are *V. vinifera* cultivars, presumably because they are less susceptible to pest pressures. Harmon and Synder (8) found that, in root-knot nematode-infested soil, the scion cultivar Sultanina (*V. vinifera*) was significantly more vigorous on 'Dogridge' rootstock than on 'St. George' or self-rooted. Both vigor and yield were higher on 'Dogridge'. Vigor and yield on 'St. George' were lower than for self-rooted vines. There was some doubt expressed about the nematode infestation. Lider et al. (13, 14) found that scions on 'St. George' were low-yielding but excessively vigorous. Cook and Lider (4) found that scion petiole nitrate was increased by 'St. George' rootstock and they correlated increased petiole nitrate levels with increased vigor of the scion on 'St. George' rootstock. No reference was made to pest pressure. Randolph (22) found that 'Dogridge' rootstock increased the vigor of 'Carmen', 'Virginia', and 'Delaware' grapes by 49% to 81%. Again, no reference was made to pest pressures. These inconsistencies in rootstock contributions to vigor may be attributed to several factors, including scion/rootstock graft union compatability (11); vigor balance of stock to scion under unique environments (11); vine spacings (10); soils, cultivation, nitrogen, and crop load (23); water availability (7); and the presence or absence of pest pressure (19).

Effects of rootstocks on yield (without pest pressures) are likewise not well-established. The vigorous 'St. George' decreased yields (8, 14), whereas the vigorous 'Dogridge' in the same trial increased both yield and vigor (8).

Another parameter of primary concern where *V. vinifera* are produced in harsh winter environments is the effect of rootstock on winter survival. No literature was found on this topic, although Howell and Shaulis (9) found that those factors that contributed to

Table 1. Grape cultivars included in the 1974 cultivar rootstock planting at Texas Agricultural Experiment Station, Lubbock.

Vinifera	Hybrid
Aligote	Baco Noir
Barbera	BS 2862
Burger	Marechal Foch
Carignane	Chambourcin
Chenin Blanc	Landal
Flora	Landot 4511
French Colombard	Ravat 51
Grenache	Aurore
Gray Riesling	Planet
Helena	Chancellor
Petite Sirah	Colobel
Peverella	Verdelet
Royalty	Chelois
Rubired	Seyval Blanc
Red Veltline	Roucaneuf
Souzao	Villard Blanc
Turiga	Vidal Blanc
White Riesling	American
Zinfandel	Canada Muscat
	Missouri Riesling
	Wine King

Received for publication 15 Jan. 1987. Technical article no. 22320, Texas Agricultural Experiment Station. Mention of a trademark, proprietary product, or vendor does not imply endorsement by Texas A&M Univ. We acknowledge the assistance of David Davenport in conducting statistical analysis of the data. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

[1]Professor, Texas Agricultural Experiment Station, Lubbock.

[2]Presently Assistant Professor, Michigan State Univ., East Lansing.