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Rootstock and Scion Interact to Affect Apple Tree Performance

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NC-140 1990 Cultivar/Rootstock Trial Cooperators

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For about 20 years, the NC-140 Regional Research Committee has been studying the effects of rootstock on the performance of various tree fruit crops. The first and second cooperative plantings of NC-140 included Delicious apple on a variety of rootstocks from subdwarf to vigorous. Much useful information was generated from these trials, particularly because of the rigorous, systematic evaluation of performance and the large number of sites and conditions to which trees were exposed. A total of 25 to 30 sites was included, ranging from Mexico and the southern United States to several Canadian provinces.

Delicious was the cultivar of choice for these early plantings because it was important for all growing regions; however, little information was generated on how rootstocks may affect different cultivars. In fact, no large-scale trial had looked at the interaction of rootstock and scion in a systematic way. Therefore, planning began in 1987 to establish such a trial.

Trees for the 1990 NC-140 Cultivar/Rootstock Trial were propagated by Stark Bro's Nurseries during the winter of 1989 and were grown in Selma, CA, during the 1989 growing season. Trees were dug in the fall and shipped to cooperative sites (see tables for a list of locations) in the late winter and early spring of 1990. Each site included six replications of four cultivars (Smoothie Golden Delicious, Nicobel Jonagold, Empire and Law Rome) on five rootstocks (Mark, B.9, M.9 EMLA, O.3 and M.26 EMLA). The four cultivars were chosen with different growth habits, ranging from the basitonic (spur-type) Empire to the acrotonic (tip-bearing) Rome. The rootstocks were the most promising from the first two NC-140 cooperative trials.

Trees were individually staked and managed as slender spindles with a standard protocol. Pest management, irrigation and fertigation were per local recommendations. Yield and tree size were measured annually. Data reported here are through the seventh growing season (1996).

Using trunk cross-sectional area as a measure of tree size (Table 1), it is clear that rootstock affected tree size differently, depending on cultivar. M.26 EMLA, however, resulted in the largest tree, regardless of cultivar. Golden Delicious and Empire trees on M.9 EMLA were significantly smaller than those on O.3, but Rome trees on the two rootstocks were similar in size, and Jonagold trees on M.9 EMLA were significantly larger than those on O.3. Jonagold, Empire and Rome trees on B.9 were similar in size to those on Mark; however, Golden Delicious trees on B.9 were larger than comparable trees on Mark. The cultivars also differed overall. Specifically, Jonagold trees were the largest and Empire trees were the smallest. Site differences were very dramatic. Trees in Wichita, Kansas, were the largest, and those in Maine were the smallest, less than one-third the size of the Kansas trees. Massachusetts trees were not significantly larger than those in Maine.

The effects of rootstock on cumulative yield per tree also varied with cultivar (Table 2). The general trends were similar to those with tree size, with trees on O.3 and M.26 EMLA yielding the most, those on B.9 and Mark yielding the least, and trees on M.9 EMLA yielding intermediately. Over all rootstocks, Rome trees produced the highest yield and Empire trees produced the lowest. Regarding the effects of site, trees in Virginia and Ohio produced the highest yields, and those in Arkansas produced the lowest.

More important than yield per tree, the effects of rootstock on cumulative yield efficiency (relating yield to tree size) varied with cultivar (Table 3). The most efficient Golden Delicious, Jonagold and Empire trees were on B.9 and Mark, and the least efficient were on M.26 EMLA. Trees on M.9 EMLA and O.3 were intermediate. Rome trees on B.9 were the most efficient, those on M.26 EMLA were the least efficient, and those on Mark, M.9 EMLA and O.3 were intermediate. Rome trees, overall, were the most yield efficient, and Jonagold trees were the least efficient. Ohio and Massachusetts produced the most yield-efficient trees, and Arkansas trees were the least efficient.

This study, which will continue through the tenth growing season, has demonstrated variation in the effects of rootstock with different cultivars. To date, however, the importance of the variation is minimal. The reduced size of Jonagold trees on O.3 is an important deviation from the response with other cultivars. The tree is smaller than expected, but it is as yield efficient as it should be. Unless this observation is a reflection of some level of incompatibility between scion and rootstock, the only change that a grower needs to make to use this combination is adjustment of planting distances.

The rootstock that stands out in this trial is B.9. It performed well with all scions. Yield efficiency was as high or higher than Mark, without many of the problems associated with Mark. In this study, rootstock did not affect fruit size, but in other trials B.9 has resulted in larger-than-average fruit. It certainly is a rootstock worthy of significant grower trial, and it is available commercially in significant quantities.

Table 1. Trunk cross-sectional area at the end of the 1996 growing season.

Rootstock	Trunk cross-sectional area (cm ²) ^z				
	Jonagold	Golden Delicious	Rome	Empire	Average
Mark	31.6 d	30.0 e	30.1 c	28.3 d	30.0 D
B.9	34.7 d	35.3 d	32.4 c	32.1 d	33.6 C
M.9 EMLA	59.8 b	49.7 c	54.7 b	45.5 c	52.8 B
O.3	51.7 c	57.4 b	55.6 b	51.2 b	54.0 B
M.26 EMLA	74.9 a	67.8 a	64.8 a	64.1 a	68.0 A
Average	50.6 A	48.5 AB	47.4 B	44.3 C	
Site	Trunk cross-sectional area (cm ²) ^z				
Arkansas	42.2 ef				
Colorado	34.1 g				
Iowa	42.0 ef				
Indiana	45.5 def				
Kansas—Manhattan	68.5 b				
Kansas—Wichita	89.3 a				
Kentucky	49.6 cd				
Massachusetts	30.8 gh				
Maine	28.1 h				
Ohio	46.5 de				
Pennsylvania	30.9 gh				
Tennessee	39.7 f				
Utah	53.4 c				
Virginia	66.9 b				

^zRootstock means within columns, average rootstock means, average cultivar means, or average site means are significantly different at odds of 19:1 if not followed by the same letter.

Table 2. Cumulative yield per tree (1992-96) at the end of the 1996 growing season.

Cumulative yield (kg/tree) ^z					
Rootstock	Jonagold	Golden Delicious	Rome	Empire	Average
Mark	54 c	61 c	62 c	43 d	55 D
B.9	60 c	69 bc	79 b	53 c	65 C
M.9 EMLA	74 b	74 b	96 a	71 b	80 B
O.3	81 ab	94 a	102 a	83 a	90 A
M.26 EMLA	85 a	89 a	95 a	77 ab	87 A
Average	71 C	78 B	87 A	66 D	

Site	Cumulative yield (kg/tree) ^z
Arkansas	21 i
Colorado	32 h
Iowa	33 h
Indiana	48 fg
Kansas—Manhattan	139 b
Kansas—Wichita	126 c
Kentucky	80 d
Massachusetts	86 d
Maine	54 f
Ohio	149 a
Pennsylvania	49 gh
Tennessee	35 h
Utah	65 e
Virginia	150 a

^zRootstock means within columns, average rootstock means, average cultivar means, or average site means are significantly different at odds of 19:1 if not followed by the same letter.

Table 3. Cumulative yield efficiency (1992-96) at the end of the 1996 growing season.

Cumulative yield efficiency (kg/cm² trunk cross-sectional area)^z

Rootstock	Jonagold	Golden Delicious	Rome	Empire	Average
Mark	1.80 a	2.09 a	1.95 b	1.88 a	1.93 B
B.9	1.91 a	1.97 a	2.37 a	1.91 a	2.05 A
M.9 EMLA	1.37 bc	1.61 b	1.74 b	1.61 b	1.59 C
O.3	1.48 b	1.71 b	1.83 b	1.72 ab	1.69 C
M.26 EMLA	1.19 c	1.35 c	1.51 c	1.16 c	1.30 D
Average	1.55 C	1.75 B	1.89 A	1.65 BC	

Site	Cumulative yield efficiency (kg/cm ²) ^z
Arkansas	0.51 h
Colorado	1.01 fg
Iowa	0.90 gh
Indiana	1.13 ef
Kansas—Manhattan	2.34 c
Kansas—Wichita	1.78 d
Kentucky	1.85 d
Massachusetts	2.94 b
Maine	1.96 d
Ohio	3.48 a
Pennsylvania	1.32 e
Tennessee	1.04 fg
Utah	1.32 e
Virginia	2.37 c

^zRootstock means within columns, average rootstock means, average cultivar means, or average site means are significantly different at odds of 19:1 if not followed by the same letter.