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Apple Cultivar by Rootstock Trial

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Abstract
In addition to production potential and tree size control, tolerance to environmental stress is an important consideration in selecting an apple rootstock. In Iowa, rootstocks need to exhibit good winter cold tolerance to be considered for use in orchards. In 1992, a cultivar by rootstock study was established at the Western Research and Demonstration (R&D) Farm to evaluate how rootstocks performed on loess soils that are unique to the area. The trial evaluated the performance of three apple cultivars (Smoothee Golden Delicious, Empire, and Nured Jonathan) on seven commercially available rootstocks (seedling, MM.111, MM.106, M.7 EMLA, M.26 EMLA, M.9 EMLA, and Mark) trained to a central leader system. The study was conducted for 10 growing seasons, and the results on growth and production characteristics of the trees were summarized in the 2001 Annual Fruit and Vegetable Progress Report (FG-601) and the 2001 Annual Progress Report for the Western R&D Farm (ISRF01-10). This report summarizes the relative cold tolerance of the cultivars on the seven rootstocks.

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Horticulture

Disciplines
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Introduction

In addition to production potential and tree size control, tolerance to environmental stress is an important consideration in selecting an apple rootstock. In Iowa, rootstocks need to exhibit good winter cold tolerance to be considered for use in orchards. In 1992, a cultivar by rootstock study was established at the Western Research and Demonstration (R&D) Farm to evaluate how rootstocks performed on loess soils that are unique to the area. The trial evaluated the performance of three apple cultivars (Smoothee Golden Delicious, Empire, and Nured Jonathan) on seven commercially available rootstocks (seedling, MM.111, MM.106, M.7 EMLA, M.26 EMLA, M.9 EMLA, and Mark) trained to a central leader system. The study was conducted for 10 growing seasons, and the results on growth and production characteristics of the trees were summarized in the 2001 Annual Fruit and Vegetable Progress Report (FG-601) and the 2001 Annual Progress Report for the Western R&D Farm (ISRF01-10). This report summarizes the relative cold tolerance of the cultivars on the seven rootstocks.

Materials and Methods

During the 2002 growing season, the trees were cut down and evaluated for winter injury to the xylem (woody) tissue in the cultivar portion of the trunks. Symptoms of this type of injury, often referred to as blackheart, are expressed as darkened xylem tissue that might be mistaken for heartwood. Trees were cut off 8 inches (20 cm) above the scion/rootstock graft union. The diameter of the xylem tissue was measured at its widest point, and a second measurement was taken perpendicular to the first measurement at its midpoint. The same procedure was then used to measure the blackheart portion of the trunk. These measurements were used to calculate the total and injured surface area using the formula for the area of a circle, and from that the percentage of blackheart present in the trunks was determined and analyzed. Weather records from the Western R&D Farm were gathered and summarized as the minimum monthly temperature, and the date recorded from October through April during the course of the study (Table 1).

Results and Discussion

By main effect, 'Golden Delicious' and 'Empire' trees sustained greater blackheart injury that 'Jonathan' trees, but no differences existed between rootstocks (Table 2). A significant cultivar by rootstock interaction existed that showed differences between cultivars on MM.106, M.7 EMLA, and M.26 EMLA rootstocks, with no difference existing between cultivars on the other rootstocks. Overall, the extent of blackheart injury observed in the study was not considered severe.

Winter injury of deciduous woody plants, such as apples, does not usually occur in midwinter when the coldest temperatures are often recorded. Most often, injury occurs when a stressful event occurs in the fall during acclimation, or in late winter during de-acclimation. Potential stressful freezes occurred during acclimation on November 6, 1993 (11º F, not shown), and on October 8, 2001 (22º F); and in late winter following a thaw on February 17, 1993 (-14º F), March 8, 1995 (-8º F), April 8, 1997 (13º F), March 12, 1998 (-10º F), March 26, 2001 (12º F), and March 3, 2002 (-4º F) (Table 1). The coldest temperature recorded was -26º F (February 2, 1996); however, temperatures prior to that event were favorable for maintaining good cold tolerance. No tree loss was attributed to winter injury during this study.

'Golden Delicious' trees are slow to acclimate in the fall, and are considered somewhat tender throughout dormancy. In plantings at the ISU Horticulture Station, 'Empire' trees have frequently exhibited visual symptoms of decline following stressful freezes, whereas 'Jonathan' trees usually exhibit few symptoms. Cultivar differences in blackheart injury found in this study support these reports and observations.

Both MM.106 and M.26 EMLA rootstocks have been reported to acclimate slowly in the fall, but exhibit good tolerance of fluctuating temperatures in late winter. The high incidence

of injury of 'Golden Delicious' trees on MM.106 and M.26 EMLA rootstocks tends to suggest that much of the injury occurred in the fall during acclimation. M.9 EMLA has been reported to induce early acclimation, and the relatively low incidence of injury in trees on this rootstock would tend to support the suggestion. Mark rootstock has also been reported to induce early acclimation, but previous research at ISU has shown it to be susceptible to late-winter freezes associated with fluctuating temperatures. Although not significant, the slightly higher incidence of blackheart associated with this rootstock would suggest that some injury probably occurred in late winter.

Conclusion

The rootstocks evaluated in this study exhibited adequate cold hardiness for planting in western Iowa orchards.

Table 1. Minimum monthly winter temperature (T in F°) and day (D) of month recorded at the Western Iowa Research and Demonstration Farm during the course of the 1992 apple cultivar by rootstock trial.

Winter	October		November		December		January		February		March		April	
	T	D	T	D	T	D	T	D	T	D	T	D	T	D
1992/93	24	18	15	28	-7	31	-7	1	-14	17	-1	19	19	2
1993/94	16	31	-4	26	-3	28	-18	18	-19	9	15	9	18	6
1994/95	26	14	14	29	-9	11	-10	4	-6	11	-8	8	17	4
1995-96	31	31	10	4	-6	10	-18	31	-26	2	-8	7	23	5
1996/97	23	30	1	26	-10	24	-15	10	-2	13	6	5	13	8
1997/98	26	26	10	16	12	31	-8	13	21	12	-10	12	30	4
1998/99	37	1	23	6	-6	22	-15	4	13	19	16	9	30	16
1999/00	26	20	21	20	-6	21	-4	26	7	11	14	16	24	8
2000/01	22	8	8	20	-14	25	-9	20	-15	2	12	26	26	17
2001/02	22	27	21	29	1	31	1	1	-6	4	-4	3	16	4

Table 2. Percentage of blackheart found in the trunks of apple trees in the 1992 western Iowa apple cultivar by rootstock trial during the 2002 growing season.

Rootstock	Golden Delicious	Empire	Jonathan	Mean[z]
Seedling	21.9	25.3	22.8	23.3 a
MM.111	21.1	23.8	21.3	22.1 a
MM.106	24.2	21.1	14.0	19.7 a
M.7 EMLA	21.6	24.1	14.2	20.0 a
M.26 EMLA	32.8	19.8	16.1	22.9 a
M.9 EMLA	22.0	22.7	18.9	21.2 a
Mark	24.7	28.5	23.0	25.4 a
Mean[z]	24.0 a	23.6 a	18.6 b	

[z]Means followed by the same letter are not different at the 0.05 level of Tukey's HSD.