Rootstocks Influence Mineral Nutrition of 'Montmorency' Sour Cherry

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Additional index words. Prunus mahaleb, Prunus avium

Abstract. The influence of two rootstocks on leaf nutrient concentrations of 'Montmorency' sour cherry (Prunus cerasus L.) was studied at two locations for 4 years. Trees on Mazzard (Prunus avium L.) rootstocks were generally higher in leaf K, Ca, B, N, and Mn concentrations, but lower in leaf Mg than trees on Mahaleb (Prunus mahaleb L.) rootstocks. Differences due to rootstocks did not appear to be related to crop load or tree vigor.

The major rootstocks used in sour cherry production are seedlings of Prunus avium L. (Mazzard) and P. mahaleb L. (Mahaleb) (Perry, 1987). Mazzard rootstocks typically produce a more highly branched root system and vigorous tree than Mahaleb. Fruit yields are often higher on Mahaleb (Perry, 1987).

There is limited information comparing the effects of these rootstocks on the nutrient status of sour cherry. In the field, 'Montmorency' sour cherry trees on Mazzard rootstocks have been observed to accumulate higher foliar K concentrations than trees grafted on Mahaleb (Jadczuk and Sadowski, 1986; Kirkpatrick, 1960). Christenson (1968) observed that, in sand culture, 'Schmidt' sweet cherry trees on Mazzard had higher K, Ca, B, and Zn, but lower Mg and Fe concentrations in leaves than trees rooted on Mahaleb.

Rootstocks that differ in ability to absorb nutrients may influence the fertilization requirements of trees. Leaf N, K, B, Mn, and Zn levels below those considered normal by Shear and Faust (1980) have been observed in Michigan cherry orchards (Christenson, 1968), and these elements are applied in many orchards. Deficiencies of N, K, B, Fe, Mn, and Zn have also been reported in cherry elsewhere (Westwood and Wann, 1966). Our field study compared the effects of Mazzard and Mahaleb rootstocks on the nutrient status of sour cherry trees.

Plantings of 'Montmorency' sour cherry on both Mazzard and Mahaleb seedling rootstocks were established in Michigan at Clarksville (CHES) and Traverse City (NWES) in 1980. The rootstock seed sources are believed to be Mahaleb 900 and N.Y. Mazzard No. 570 (Perry, 1987). Plots consisted of two trees and were replicated three times in a completely randomized design at each site. Soil at the CHES site is classified as a Kalamazoo sandy loam, with a friable loam A horizon (0 to 25 cm), a clay loam to gravel B horizon (25 to 83 cm), and a sand and gravel C horizon. Soil at the NWES site is an Emmet-Leelanau sandy loam, with a sandy loam texture to a depth of 55 cm, sandy clay loam from 55 to 80 cm, and sandy loam to gravel below 80 cm.

Trees at both sites were fertilized with NH₄NO₃ at recommended rates (Hanson and Kesner, 1987). Potassium chloride was also applied to trees at the NWES site in 1982 (390 kg·ha⁻¹), 1985 (330 kg·ha⁻¹), and 1987 (110 kg·ha⁻¹). Trees at the NWES site received trickle irrigation from the year of planting. Trickle irrigation was provided at the CHES site from 1985 on.

To characterize each site, soil samples were collected at 0- to 20-cm and 20- to 40-cm depths from each plot on Aug. 1985 and analyzed by standard procedures. Soil K, Ca, and Mg concentrations were determined colorimetrically with a Technicon AutoAnalyzer II following extraction with 1 soil:water mixture. Following the Bray P-I extraction (Knudsen, 1980), soil P was determined with a colorimeter. Soil pH was determined in a 1 soil:1 water mixture. Pertinent soil chemical properties are summarized in Table 1.

Leaf samples (20 to 30 leaves per plot) were collected for nutrient analyses from the middle of current-season shoot growth between mid-July and early August in 1984, 1985, 1987, and 1988. Leaves were dried and ground in a Wiley mill to pass through a 40-mesh screen. Samples were ashed in a muffle furnace at 500°C for 6 hr. Leaf P, K, Ca, Mg, B, Cu, Fe, Mn, and Zn concentrations were measured with a directly coupled plasma emission spectrophotometer. Total leaf N was determined with a flow injection analyzer model Quickchem (Lachat Instruments, Mequon, Wis.) using Kjeldahl digestion followed by NH₄⁺ analysis (Lachat method 13-107-06-2-B).

Fruit yield was determined from 1984 to 1988. Trunk diameter was measured 30 cm above ground level in Fall 1982 and 1988. The increase in trunk cross-sectional area (TCSA) was used as an estimate of tree vigor.

Data for leaf nutrient concentrations and yield were analyzed as a completely randomized split-split-plot design with location as main plots, rootstock as subplots, and year as sub-subplots. An LSD test was used to separate means.

Leaf N, K, Ca, Mg, B, and Mn levels were significantly influenced by rootstocks, either alone or in their interaction with location (Table 2), whereas leaf P, Cu, Fe, and Zn levels were not. Over 4 years at both locations, leaves averaged 0.188 P, 12.4 ppm Cu, 72.6 ppm Fe, and 35.2 ppm Zn. Foliar concentrations of all nutrients were within the normal ranges proposed for cherry (Shear and Faust, 1980) and no symptoms of deficiencies were observed.

Trees on Mazzard rootstocks contained 16%, 26%, and 55% higher leaf Ca, B, and Mn concentrations, respectively, than trees

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Table 1. Mean soil pH and P, K, Ca, and Mg levels at 0- to 20- and 20- to 40-cm depths at CHES and NWES sites in 1984.*

<table>
<thead>
<tr>
<th>Site</th>
<th>Sampling depth (cm)</th>
<th>pH</th>
<th>P (kg·ha⁻¹)</th>
<th>K (kg·ha⁻¹)</th>
<th>Ca (kg·ha⁻¹)</th>
<th>Mg (kg·ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHES</td>
<td>0-20</td>
<td>5.2</td>
<td>195</td>
<td>331</td>
<td>1673</td>
<td>267</td>
</tr>
<tr>
<td></td>
<td>20-40</td>
<td>5.8</td>
<td>155</td>
<td>205</td>
<td>1943</td>
<td>151</td>
</tr>
<tr>
<td>NWES</td>
<td>0-20</td>
<td>4.8</td>
<td>101</td>
<td>251</td>
<td>780</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>20-40</td>
<td>5.9</td>
<td>31</td>
<td>81</td>
<td>630</td>
<td>49</td>
</tr>
</tbody>
</table>

*Means of three observations.

¹CHES, Clarksville; NWES, Traverse City.
on Mahaleb rootstocks over the 4 years at both locations (Table 2). The rootstock effect was not influenced by the year of sampling or the trial location. Using young sweet cherry trees in sand culture, Christenson (1968) also observed that Mazzard-rooted trees had higher leaf Ca and B levels than Mahaleb-rooted trees, but observed no effect of rootstocks on leaf Mn levels.

Rootstocks influenced leaf K and Mg levels; however, the effect varied with location (Table 2). At CHES, trees on Mazzard rootstocks contained 47% higher leaf K concentrations than trees on Mahaleb, whereas leaf K levels were not influenced by rootstocks at the NWES site. Trees on Mazzard rootstocks were also significantly lower in leaf Mn than Mahaleb-rooted trees at both locations across years (Table 3). Although Mazzard rootstocks typically produce a larger, more vigorous tree than Mahaleb (Perry, 1987), vegetative vigor was not affected by rootstocks at these sites (Table 3).

The differential effects of some citrus rootstocks on nutrient absorption may be related to the distribution of roots and nutrients in the soil profile (Castle and Krezdon, 1975). Although root distribution was not studied at these sites, Mazzard often produces more roots than Mahaleb in the upper soil horizons (Perry, 1987). When Mazzard and Mahaleb were compared in sand culture studies where nutrients were likely distributed uniformly in the media, effects on leaf K, B, and Mg were similar to those reported here under field conditions (Christenson, 1968). Therefore, root distribution patterns do not explain fully the effects of these rootstocks. Leaf samples collected in 1988 from a rootstock trial in Logan, Utah indicated that these rootstocks may have similar effects on leaf nutrient levels of sour cherry trees elsewhere. Trees on Mazzard rootstocks contained significantly higher leaf K and B concentrations, but lower Mg levels, than trees on Mahaleb (L. Anderson, unpublished data). Under the conditions of this study, Ma-
Abstract. Chemicals deposited on foliage varied by a factor of three to five times when tree-row-volume, sprayer calibration and other factors varied. Additional index words, tree-row-volume, sprayer calibration.

The deposition of spray chemicals on apple leaves depends on many factors, such as type of equipment, winds, sprayer travel speed, distance from the sprayer to the target, match of the sprayer nozzle to the tree, droplet size, rate of water use per unit volume of tree, tree size, canopy density, and tree shape. Recommended chemical rates per hectare have not been lowered in trellis and small tree training systems using the tree-row-volume (TRV) concept, in spite of smaller trees, closer row widths, and shorter tree heights. Deposition of spray chemicals on apple leaves collected from trees sprayed with a 0.01% copper solution at 1870 liters-ha-1 (y = 1.168 - 0.0154x, r2 = 0.73, P = 0.01) for three-wire trellis (non-spur) (O); typical globular system (non-spur) (■); Dutch spindle (spur) (△); three-wire trellis (non-spur) (■); and the Lincoln canopy (non-spur) (○) plants. Recommended chemical soil test procedures for the North Central region. North Central Reg. Publ. 221: 14-16.

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Spray Chemical Deposits in High-density and Trellis Apple Orchards

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Additional index words. tree-row-volume, sprayer calibration

Abstract. Chemicals deposited on foliage varied by a factor of three to five times when sprays were applied with an airblast sprayer to apple (Malus domestica Borkh.) trees in various training systems. Deposits were higher with vertical than horizontal training systems, smaller tree sizes, and less-dense tree canopies of spur-type trees. The Lincoln canopy tree training system prevented good spray penetration because the airblast spray pattern was split by the horizontal nature of the canopy.

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Deposition of spray chemicals on apple leaves depends on many factors, such as type of equipment, winds, sprayer travel speed, distance from the sprayer to the target, match of the sprayer nozzle to the tree, droplet size, rate of water use per unit volume of tree, tree size, canopy density, and tree shape. Recommended chemical rates per hectare have not been lowered in trellis and small tree training systems using the tree-row-volume (TRV) concept, in spite of smaller trees, closer row widths, lower tree heights, and shorter distances from sprayer nozzles to trees. Recommended dilute applications of most chemicals to apple orchards are based on 3740 liters-ha-1 for "standard" trees 6.1 m high, 7.0 m wide, and spaced 10.6 m between rows (Byers et al., 1971; Lewis and Hickey, 1972). Most orchards today do not conform to this standard tree size, and many pesticides are applied at concentrations other than dilute (Byers et al., 1984; Hall, 1979; Herrera-Aguirre and Unrath, 1980). Byers et al. (1971) proposed that smaller-than-standard trees be sprayed at chemical rates proportional to the TRV space of standard trees as defined above (Byers et al., 1984, 1971). TRV rates were calculated based on the assumption that each row was a rectangular box (row length/ha x tree height/row width) (Byers, 1987). For a "standard orchard", TRV was calculated to be 39,907