Mechanical Thinning of Peaches is Effective Postbloom

D. Michael Glenn, Donald L. Peterson, and Daniela Giovannini
U.S. Department of Agriculture, Agricultural Research Service, Appalachian Fruit Research Station, 45 Wiltshire Road, Kearneysville, WV 25430

Miklos Faust
U.S. Department of Agriculture, Agricultural Research Service, Fruit Laboratory, Building 004, Room 119, Beltsville Agricultural Research Center–West, Beltsville, MD 20705

Additional index words. spiked-drum shaker, impact shaker, Prunus persica

Abstract. Hand-thinning (Prunus persica L. Batsch) “Y”-trained peach trees at bloom and 51 days after full bloom (DAFB) was compared to mechanical fruit thinning 51 DAFB using a spiked-drum and an impact shaker. The spiked-drum shaker removed more fruit from horizontal branches than from vertical branches, yet did not selectively remove either large or small fruit. Bloom thinning by hand increased fruit size compared to postbloom thinning 51 DAFB, and both postbloom mechanical thinning techniques were as effective as postbloom hand thinning. The spiked-drum shaker may be a better thinning technique than the impact shaker because it transfers less shaking energy to the fruit, can be used in high-density plantings, and does not contact the trunk, lessening the potential for tree damage.

Thinning peaches is necessary to ensure marketable fruit size. Blossom thinning generally increases fruit size more than thinning at 40 to 60 days after full bloom (DAFB) (Baugher et al., 1988, 1991; Byers and Lyons, 1984, 1985; Havis, 1962; Johnson and Handley, 1989; Weinberger, 1941). However, the frequent occurrence of frost following bloom thinning may further reduce the crop load, and this risk discourages peach growers from using bloom thinning. Therefore, fruit thinning 40 to 60 DAFB is a common practice in areas with a frost risk, although it produces smaller fruit than bloom thinning. Fruit thinning by hand, the most common thinning practice, is labor-intensive and costly.

There have been many reports of chemical thinning in peaches but only a few reports of mechanical thinning of fruit trees. Chemical thinning in apple (Malus domestica Borkh.) production is effective; however, in peach production this approach has been disappointing (Cobianchi, 1971; Martin, 1988). Mechanical thinning of deciduous fruit trees has focused on the inertia shaker for fruit removal. Grausland (1980) used a cherry shaker to thin plums (Prunus domestica L.) and found that fruit size was increased, but fruit removal on the perimeter of the tree was insufficient and required hand thinning. Fitch (1980) recommended the use of tree shaking to thin plum trees in heavy crop years but cautioned about the potential for tree trunk damage. Menzies (1985; Havis, 1962; Johnson and Handley, 1989) found that inertial shakers could thin fruit as or more effectively than hand thinning, and the shakers did not selectively remove larger or smaller fruit. The objective of our work was to compare hand thinning of peach with mechanical fruit removal by the spiked-drum canopy shaker and impact trunk shaker systems.

Materials and Methods

In 1991, fifteen 7-year-old ‘Loring’ peach trees were used. Trees were trained to a free-standing “Y” (Horton, 1973) and were pruned by hand, removing four to eight large, misdirected shoots within the tree following mechanical shearing to reestablish the arms of the “Y” form. At the beginning of the experiment, four to seven 2-year-old branches in the central portion of the canopy on a major scaffold were tagged, and the orientation of the branch was categorized as horizontal (315° to 0° to 45° and 135° to 225°), vertical (45° to 90° to 135°), or downward (225° to 270° to 315°). The number of fruit per branch and the diameter of the branch at the origin were measured. Fruit diameter was measured across the suture. The shoot and fruit measurements were made on 21 May (47 DAFB), and fruit were thinned on 22 May using a vibrating spiked-drum shaker (Peterson et al., 1989) moving at 0.5 km/h (Fig. 1). Each 1-m-diameter drum (spike tip to tip) was made up of nine rod panels spaced 160 mm apart. Each rod panel consisted of 24 16-mm-diameter nylon rods radially spaced at equal angles. The spikes...
were uniformly accelerated along their length with a potential displacement of 100 mm at the tips. The axis of the spiked-drum was positioned under and parallel to one arm of the "Y" trellis.

The canopy arm of the "Y"-trained trees was 30 to 45 cm thick. Shaking frequency was 6 Hz. Each tree received two passes of the spiked-drum, one for each arm. On 22 May, after mechanical thinning, the number of fruit per branch was counted and their diameters were measured.

Data were analyzed using a randomized block design with 15 replications (trees). The treatments were the different branch orientations relative to the thinning action of the spiked-drum shaker.

In 1992, a randomized block design with four replicates was established with 10-tree plots of 8-year-old 'Loring' peach. The treatments were 1) hand thinning at full bloom; 2) hand thinning 51 DAFB; 3) tree-trunk impactor (Peterson and Miller, 1989) (Fig. 2) thinning 51 DAFB; and 4) spiked-drum shaker thinning 51 DAFB. Hand thinning spaced fruit 10 to 15 cm on the shoot. The trunk diameter was measured 30 cm above the soil, and the trunk cross-sectional area (XSA) was calculated. A scaffold limb in three trees per plot was tagged, and the number of fruit was counted before and after mechanical thinning to calculate removal percentage. Fruit were harvested in the 10-tree plots in two pickings and graded by weight on a Durand Wayland (LaGrange, Ga.) sorting line.

An accelerometer was attached to a 25-mm branch (spiked-drum shaker) and 37-mm branch (impact shaker) that was oriented perpendicular to the tree row at a 2-m height and 1.2 m from the center of the tree to measure tree vibration during thinning. Data acquisition was by a computerized system developed at the Appalachian Fruit Research Station (Peterson et al., 1993).

In 1993, a randomized block design with eight replicates was established with five-tree plots of 9-year-old 'Loring' peach. The treatments were 1) no thinning; 2) hand thinning 53 DAFB; 3) thinning 53 DAFB using the spiked-drum shaker at a 0.5-km/h ground speed and 6-Hz shaking frequency; 4) thinning 53 DAFB using the spiked-drum shaker at 2.0-km/h ground speed and 6-Hz shaking frequency. The hand-thinning treatment spaced fruit 10 to 15 cm on the shoot. The trunk diameter was measured 30 cm above the soil, and the XSA was calculated. Six fruit-bearing shoots in each of three trees per plot were tagged, and the number of fruit was counted before and after mechanical thinning to calculate removal percentage. Three shoots were selected on the outer perimeter of the Y-arm and on the inside of the Y-arm. In each group of three shoots, two were horizontally oriented and one vertically. Following thinning, 30 fruit per plot were collected from the ground and their diameters measured. Fruit were harvested in the five-tree plots in three pickings and graded by weight on a Durand Wayland sorting line. The number of broken branches per tree was counted 3 days after mechanical thinning.

Fruit size data in 1992 and 1993 were tested using analysis of covariance with total number of fruit per XSA as the covariant. This covariant reflected the tree size and potential crop load capacity. Removal data expressed as percentages were square root-transformed before analysis of variance.

**Results and Discussion**

The orientation of shoots in canopies of Y-trained peach trees significantly affected mechanical peach-thinning efficiency in 1991 and 1993 when the spiked-drum shaker was used (Tables 1 and 2). Shoots oriented vertically, either up or down, had fewer fruit removed than did horizontal shoots based on linear contrasts, presumably because of the long contact period between the horizontal shoot and the rolling spiked-drum. The spiked-drum shaker did not selectively remove either large or small fruit since the change in fruit diameter following thinning was nonsignificant in 1991 (Table 1), nor the size of fruit removed in 1992 (hand-thinned; spiked-drum

Table 1. Effect of limb orientation [vertical (vert.) vs. horizontal (horz.) vs. downward (down.)] on fruit size and mechanical thinning efficiency using a spiked-drum shaker 47 DAFB in 1991.

<table>
<thead>
<tr>
<th>Limb orientation</th>
<th>Fruit size (mm)</th>
<th>Removal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Vert.</td>
<td>27.1</td>
<td>28.3</td>
</tr>
<tr>
<td>Horz.</td>
<td>26.2</td>
<td>26.9</td>
</tr>
<tr>
<td>Down.</td>
<td>25.8**</td>
<td>6.9*</td>
</tr>
</tbody>
</table>

*Mean separation using Duncan's multiple range test (P ≤ 0.05).
**Nonsignificant.

Table 2. Effect of limb orientation [vertical (vert.) vs. horizontal (horz.)] and canopy position on thinning efficiency using a spiked-drum shaker 53 DAFB in 1993. Data are averaged over the 0.5- and 2-km/h ground speeds.

<table>
<thead>
<tr>
<th>Limb position orientation</th>
<th>Removal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside perimeter</td>
<td>Vert. 81 A</td>
</tr>
<tr>
<td>Inside perimeter</td>
<td>Horz. 89 A</td>
</tr>
<tr>
<td>Linear contrast</td>
<td>Horz. 19 B</td>
</tr>
</tbody>
</table>

*Mean separation using Duncan's multiple range test (P ≤ 0.05).
**Significant at P ≤ 0.05.
CROP PRODUCTION

Table 3. Effect on fruit size and limb breakage of bloom thinning and postbloom thinning using hand and mechanical techniques.

<table>
<thead>
<tr>
<th>Thinning method</th>
<th>Fruit wt (kg/tree)</th>
<th>Fruit diam</th>
<th>Limb breakage (no./tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Adjusted&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Mean</td>
</tr>
<tr>
<td>Hand, bloom</td>
<td>24.8</td>
<td>22.0</td>
<td>14.4</td>
</tr>
<tr>
<td>Hand, 51 DAFB</td>
<td>21.5</td>
<td>22.7</td>
<td>18.4</td>
</tr>
<tr>
<td>Impact shaker, 51 DAFB</td>
<td>21.4</td>
<td>22.7</td>
<td>16.4</td>
</tr>
<tr>
<td>Spiked-drum shaker, 51 DAFB</td>
<td>23.0</td>
<td>23.4&lt;sup&gt;ns&lt;/sup&gt;</td>
<td>15.8</td>
</tr>
<tr>
<td>None (control)</td>
<td>13.1</td>
<td>8.7 A</td>
<td>57.2</td>
</tr>
<tr>
<td>Hand 53 DAFB</td>
<td>2.7</td>
<td>2.0 B</td>
<td>55.0</td>
</tr>
<tr>
<td>Spiked-drum shaker, at 0.5 km/h 53 DAFB</td>
<td>4.6</td>
<td>6.2 AB</td>
<td>34.2</td>
</tr>
<tr>
<td>Spiked-drum shaker, at 2.0 km/h 53 DAFB</td>
<td>1.7</td>
<td>5.3 AB</td>
<td>35.1</td>
</tr>
</tbody>
</table>

<sup>1</sup> Adjusted means based on analysis of covariance using number of fruit per tree per trunk cross-sectional area; <sup>y</sup>P ≤ 0.10 for 1992, <sup>x</sup>P ≤ 0.05 for 1993.<br>
<sup>ns</sup>Nonsignificant.

In summary, bloom thinning increased fruit size compared to postbloom thinning, and postbloom mechanical thinning techniques

---

<sup>Fig. 3. Typical limb response using impact shaker (A) acceleration and (B) displacement (showing one of three impacts).</sup>
were as effective as postbloom hand thinning in 1 year but not in a second year of study. The spiked-drum shaker is a potentially useful postbloom mechanical thinner if trees are trained to accommodate the equipment. This method is applicable on any training system with a relatively flat production surface, such as the Italian palmetta or vertical hedge. Applying the spiked-drum shaker to a narrow canopy system will require thinning on both sides of the canopy and refinement of the optimal shaking frequency and ground speed for local conditions.

**Literature Cited**


