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Mechanical Bloom Thinning of Peach

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Abstract. **A mechanical bloom-thinning technique, using suspended flexible strands of rubber belting or rope moved through trees on a frame mounted on a forklift, was tested on 'Early Loring' peach [*Prunus persica* (L.) Batsch]. Heaviest thinning occurred in the upper two-thirds of the tree canopy. Shoot orientation and flower position did not affect bloom removal. Maximum bloom removal occurred at full bloom when the thinning machine passed through a tree at least four times. Operating at an increased tractor speed increased thinning. The most effective treatments removed 45% to 59% of the blossoms, reduced number of fruit from 18 to around 10/cm² limb cross-sectional area (CSA) and reduced hand thinning time by 30%.**

Thinning peaches by hand is labor intensive and expensive. Research on chemical and mechanical means of fruit removal began as early as the 1950s (7), but due to variable and unsatisfactory responses, neither method has been widely accepted commercially.

Inconsistent results and phytotoxicity have limited success with chemical thinning agents (3–5, 9, 11). Recent research on bloom thinning with desiccating chemicals (3, 4) and on fruit thinning with photosynthetic inhibitors (5) show promise; whether they can be successfully used under commercial conditions is as yet unknown. Limited adoption of mechanical fruit thinning has been attributed to the preferential removal of larger fruit, damage to trees by the shaker, and grower unwillingness to raise tree height to improve access to the trunk (1, 2, 6).

Satisfactory thinning by either chemicals or machines would reduce labor costs and increase the opportunity to complete thinning early enough for maximum effect on fruit size. The greatest influence on these characteristics occurs in heavy setting, early maturing cultivars (7). Recent bloom thinning work reinforces the importance of early thinning for maximum fruit size (3). Early thinning also increases flower bud formation for the following season (8).

Hand thinning during bloom is becoming a more common practice in peach orchards (8, 10). Growers partially thin at bloom to obtain beneficial effects on fruit size and complete the process after danger of frost has past. During the pink to full bloom stage, blossoms are easily removed by hand or by using various types of brushes. The major drawback, as with later hand thinning of fruits, is the labor requirement.

A few growers have mechanized bloom thinning by dragging ropes or some other flexible material through the trees. Two of these grower-initiated designs and modifications thereof were evaluated in this study. The objectives were to evaluate mechanisms for bud removal, the shoot and tree positions where optimum removal occurred, the reduction in hand-thinning time, and the influence on ultimate fruit size.

The mechanical thinner designs were tested in 1987 in a block of 6-year-old 'Early Loring' peach trees at an orchard in Martinsburg, W.Va. Trees were of uniform vigor and had received similar annual fertilizer, pesticide, pruning, and hand thinning treatments. Tree training was open center (standard) with four primary scaffolds. Trees were 2.3 m high and 3.6 m wide with a 1.2 m high bearing surface. Tree spacing was 5.4 m × 7.2 m.

Mechanical thinner designs tested included a rope removal system and a rubber belting system (Fig. 1). Hemp rope (25 mm diameter) was cut into 1.5 m lengths and stapled to a wooden frame at 25-mm intervals. Rubber conveyor belting was cut in continuous 25-mm-wide strips, 1.5 m in length, and was attached to the same wooden frame. Half-moon notches were cut on the sides of each strip with a 13-mm-diameter hole punch. The wooden frame was supported by a steel frame with a crank mechanism driven by a hydraulic motor, which oscillated the strands up and down as they were dragged through the tree (165 mm stroke).

The two bloom thinner designs were tested simultaneously and separately (by tying up respective strands not in use). The test unit was attached to a conventional front-mounted bulk bin forklift on a 53 kW farm tractor. The fork rotator hydraulic circuit was used to operate the rotation motor.

Since percent thinning could be determined immediately following use of the mechanical thinner, an initial trial was conducted to determine location within the tree and position on a shoot where maximum thinning occurred. Shoots were tagged in each half of six trees at the pink stage of bloom (10 Apr. 1987) in the following canopy positions: lower 0.5 m, mid 0.5 m, and upper 0.5 m. Each limb unit contained three to six shoots having a total of 50 to 75 blossoms; within this unit, one vertical and one horizontal shoot were tagged. Blossoms were counted immediately before and after four passes at 1.6 km·hr^{-1} through the trees with both belting and ropes. Total number of blossoms on the limb unit, number of blossoms on the vertical shoot, and number of blossoms and location of each (top, underside) on the horizontal shoot were recorded. The experimental design was completely random, and data were subjected to analysis of variance. Mean separation was carried out using the least-significant differences (LSD) method.

Information from the initial test was used to develop the best procedure for collecting data from the main experiment, in which time of treatment and machine characteristics were evaluated. Tests were conducted with and without oscillation, at three stages of development (pink, full bloom, post-bloom), with various numbers of passes over the trees (2, 4, and 8), and at two speeds (1.6 and 3.2 km·hr^{-1}). All possible factorial combinations of the above could not be included in the experiment, so 13 mechanical thinning treatments (see Table 1) and one hand fruit thinning treatment were selected for evaluation. The four passes with belting and ropes treatment was included in all combinations except travel speed. Mechanical treatments performed only partial thinning; therefore, follow-up hand thinning was also conducted. The treatments were applied to six whole-tree replicates in a randomized complete block design, with the exception that the tractor-speed treatments were applied to row replicates.

Two limbs, each containing a total of 50 to 75 flowers, were tagged in the mid 0.5-m section of each tree canopy. Percentage flower removal was determined the day of treatment (pink, 10 Apr.; full bloom, 15 Apr.; post-bloom, 14 May 1987). Limb diameter was measured with a vernier caliper and the cross-sectional area (CSA) was calculated. Treatments were compared on the basis of number of fruit/cm² limb CSA following the physiological June drop (5 June).

Follow-up hand thinning was conducted by the orchardist on 8 June, and the time required to hand thin each tree was recorded. Two days before the second picking, 29 July, 10 fruit of equal maturity were sampled from all sides of each tree at a height of 1.5 to 2.0 m in the outer 1 m periphery. Diameter of each fruit was measured with a vernier caliper. The data were subjected to analysis of variance. Mean separation was carried out using the LSD test.

The initial test determined that maximum mechanical thinning occurred on limbs in the top and middle portions of the tree (Table

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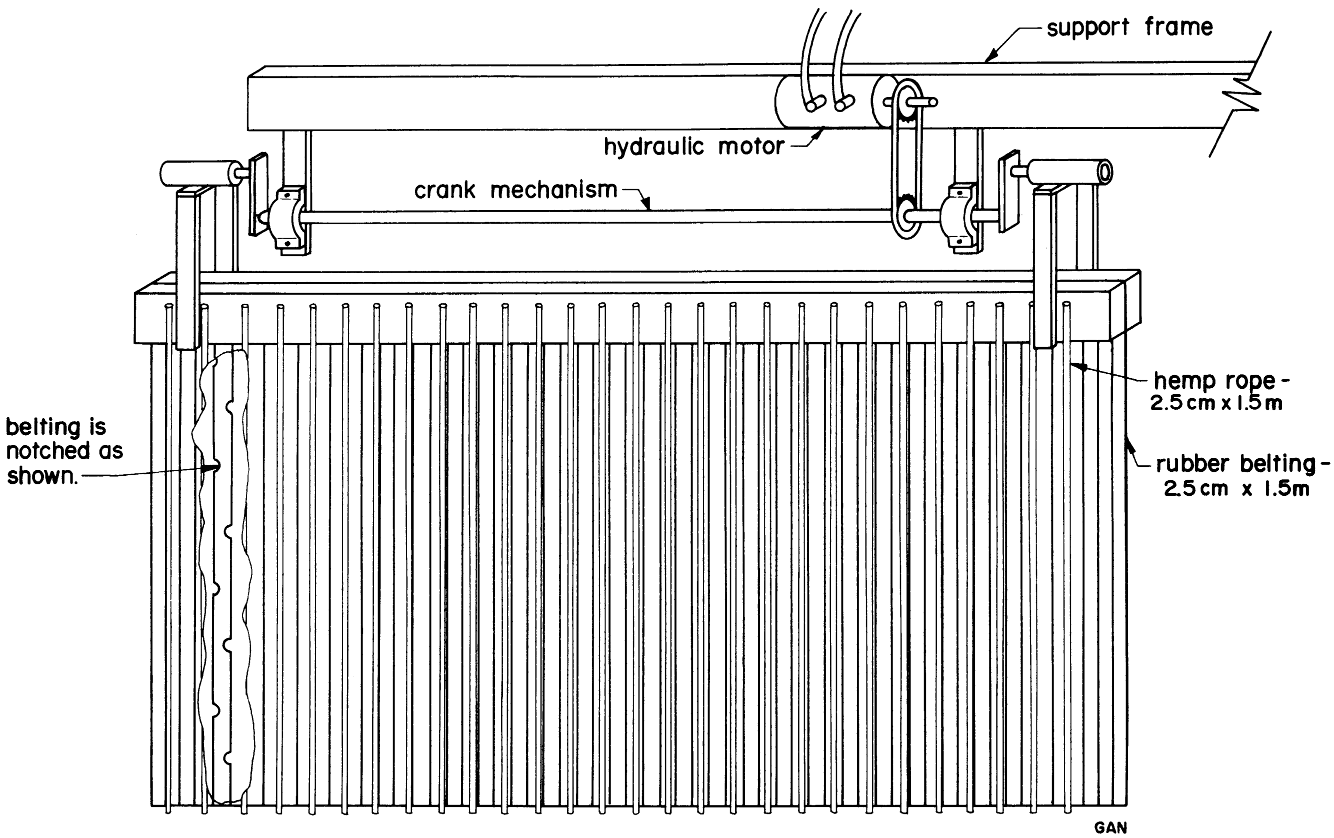

Fig. 1. Schematic drawing of test unit used to mechanically bloom thin 'Early Loring' peach.

2). Thinning on limbs in the bottom 0.5 m was 32% less than thinning in the middle section. These data suggest that it will be important to base thinning strategies on results observed in the top two-thirds of open-center trained trees to avoid overthinning. Shoot orientation and flower position had no apparent effect on flower removal.

Flower removal in the main experiment was greatest at full bloom and with four to eight passes (Table 1). Thinning at 3.2 km·hr^{-1} removed significantly more flowers than thinning at 1.6 km·hr^{-1}. Rope vs. belting vs. belting plus rope (four passes at full bloom) treatments were not significantly different. Oscillating belting plus ropes was not one of the most effective treatments based on measurements made the day of thinning, but following June drop the number of fruit/cm^2 limb CSA was equal to the best treatments. Hand thinning time was reduced by 15% to 30% with the most effective treatments but fruit size was significantly increased only in treatment 8. Increases in fruit size were not as pronounced as in previously reported bloom-thinning studies (3, 7) possibly as a result of early-season periodical cicada damage and dry weather before harvest. None of the treatments caused shoot breakage or bark damage.

Mechanical thinning conducted at full bloom was 30% greater than thinning conducted at the pink stage and 80% greater than

Table 1. Effects of various mechanical bloom-thinning conditions on flower removal, fruit-set, hand-thinning requirement and fruit size.

Treatment (No.)	Passes (No.)	Strand type	Travel speed (km·hr^{-1})	Developmental stage	Measurements before follow-up thinning: Flower (fruit) removal^{z,x} (%)	Measurements before follow-up thinning: No. fruit/cm^2 limb CSA^{y,x}	Follow-up hand thinning time^x (min/tree)	Fruit diameter at harvest^x (cm)
1	2	Belt and rope	1.6	Pink	25	23	25	5.65
2	4	Belt and rope	1.6	Pink	36	17	27	5.59
3	2	Belt and rope	1.6	Full bloom	35	14	22	5.54
4	4	Belt and rope	1.6	Full bloom	51	11	22	5.66
5	2	Belt	1.6	Full bloom	49	11	29	5.65
6	4	Belt	1.6	Full bloom	52	13	27	5.65
7	4	Rope	1.6	Full bloom	54	9	24	5.65
8	4	Oscillating belt and rope	1.6	Full bloom	45	11	20	5.70
9	8	Belt and rope	1.6	Full bloom	59	10	24	5.68
10	2	Belt and rope	1.6	30 days after bloom	18	15	25	5.55
11	4	Belt and rope	1.6	30 days after bloom	10	19	30	5.52
12	2	Belt and rope	1.6	Full bloom	26	14	-	-
13	2	Belt and rope	3.2	Full bloom	38	11	-	-
14		Hand thinned control			-	18	28	5.57
		LSD 0.5			10	6	7	0.11

^{z}Determined day of thinning.
^{y}Determined following physiological drop.
^{x}Number of observations represented by mean values: columns 6 and 7, 12; column 8, 6; column 9, 60.

Table 2. Percentage flower removal from different parts of the peach tree canopy by mechanical bloom thinning.

Position in tree/on shoot	Flower removal[z] (%)
Limb location in tree	
Top 0.5 m	42
Middle 0.5 m	38
Bottom 0.5 m	26
LSD 0.05	13
Shoot orientation	
Vertical	35
Horizontal	27
LSD 0.05	18
Flower position on shoot	
Top	35
Underside	32
LSD 0.05	18

[z]There were 12 observations per mean.

thinning at 30 days after bloom. Based on this and previous work on manual blossom thinning (8, 10), mechanical thinning in a commercial orchard could begin as the first blossoms open and should be completed within 2 to 3 days after full bloom. This will give the fruit grower a wider effective thinning period than currently provided by chemical thinners.

Number of passes through a tree is a factor that can be manipulated easily to improve thinning response. A major advantage of mechanical bloom thinning is that results are immediately apparent, and if a greater thinning response is desired, the operator can simply drive the thinner through the orchard again. Preliminary tests with our thinning unit quickly indicated that an insufficient number of blossoms was removed with just one trip through a tree; therefore, the minimum treatment was two passes through a tree. Future studies will focus on modifying the mechanical thinner to decrease number of trips through the orchard.

Before the peach mechanical bloom thinning concept is ready for commerical adoption, improvement of fruit size and/or reduction in hand thinning requirements must be demonstrated. Our initial experience with a mechanical bloom thinner indicates a number of advantages over other methods, including predictability (regardless of weather conditions), low cost, simplified timing, immediately apparent response, avoidance of chemicals and the associated regulations, and ease and flexibility of construction. Additionally, there is no danger of phytotoxicity and there are no calibration problems.

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Tree Characteristics, Fruiting, and Mineral Nutrition of Apple Trees on M.27 EMLA and Three Interstocks

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Abstract. **A planting of 'Starkrimson Delicious' (Bisbee strain) apple trees was established in 1981 on M.27 EMLA, P.2/KA313, P.22/KA313, and C.6/KA313. After 6 years, trees on P.2/KA313 and C.6/KA313 were similar in size and larger than those on M.27 EMLA and P.22/KA313. P.22/KA313 induced profuse suckering, whereas trees on M.27 EMLA were virtually sucker-free. Cumulative yields per tree (1984–86) were the highest on P.2/KA313 and C.6/KA313. However, cumulative production efficiencies were highest for trees on M.27 EMLA and P.2/KA313. The least efficient trees were on P.22/KA313. Foliar analyses indicated that trees on M.27 EMLA had the highest levels of N, Ca, Mn, and Zn.**

Interest in interstem apple trees emerged in the 1970s in an attempt to replace dwarf trees on M.9, which require expensive posts or trellises for support, with a more economical, free-standing dwarf tree (13). Trees with an M.9 interstock on MM.106 or MM.111 roots have been the most frequently tested in the United States. However, both MM.106 and MM.111 with an M.9 interstock produce trees too large for high density plantings. In addition, these rootstocks possess undesirable characteristics, i.e. susceptibility to collar rot exhibited by MM.106 (6), and delay of fruit production (2) and excessive basal suckering (10) caused by MM.111. Thus, we were interested in evaluating hardy interstocks that may result in significant dwarfing when grafted to a hardy rootstock with desirable disease resistance, propagation, and horticultural characteristics. Specifically, we observed the effects of P.2, P.22, and C.6 interstocks grafted to KA313 rootstocks on tree and fruiting characteristics of 'Starkrimson Delicious' (Bisbee strain) in comparison to M.27 EMLA.

M.27 EMLA produces a tree smaller than M.9 (12). The use of it as a control in this study presented us with the opportunity to verify a recent study (10) showing that M.27 resulted in much higher foliar Mn levels in 'Empire' apple trees. The rootstock used for interstem trees, KA313, is a clonally propagated Antonovka seedling selected by Adams Rootstock Company, Toledo, Wash., for disease resistance and ease of propagation. Because of these characteristics, along with its winterhardiness, KA313 may provide a desirable base for interstem trees. The interstocks used in this study provided different degrees of dwarfing. P.2 and P.22 are recent releases from the Polish breeding program and were the result of a cross of M.9 and Antonovka (6). Both rootstocks are reported to be hardier than Malling or Malling-Merton series rootstocks. Under European conditions, P.2 produces a tree larger than M.9 but smaller than M.7, and P.22 produces a tree smaller than M.9 (4). C.6 originated from an open-pollinated seedling of M.8 (11), and, when used as an interstock,

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