Innovations in Peach Thinning

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Hand thinning is a necessary and costly management practice in peach production. Stone fruit producers are finding it increasingly difficult to find a workforce to manually thin fruit crops, and the cost of farm labor is increasing. The conventional method for adjusting cropload in peach and nectarine orchards is to remove excess fruit by hand at 35 to 40 days after full bloom. Plant growth regulators are available for thinning pome fruit; however, chemical thinning options for stone fruit are limited and unpredictable. Three years of research on chemical blossom thinners, reported at the 2007 New England Vegetable and Berry Conference, demonstrated that while the treatments often increased peach fruit size, they were inconsistent in reducing follow-up hand thinning requirement. An initial year of research on string blossom thinning was also reported, and the results indicated that mechanical thinning with this new technology from Germany reliably reduced labor requirement, reduced cropload, and increased fruit size beyond that achieved with conventional hand thinning at the green fruit stage.

In subsequent trials conducted over four seasons, string thinner cropload management technologies have been tested in four peach producing states, and detailed research on pruning modifications and application timing have provided information to guide producers in maximizing mechanical bloom thinning benefits. Technology adoption socioeconomic surveys and case study interviews were also conducted, and graduate students from both Penn State and Carnegie Mellon University designed and tested sensors to automatically adjust positioning of the thinning spindle relative to tree canopy distance and angle.

The string thinner evaluated in 2007 (Darwin 300, Fruit-Tec, Deggenhausertal, Germany) was designed to thin narrow vertical canopies and therefore was evaluated on peach trees trained to either a perpendicular V or quadrilateral V system; a prototype designed in 2008 was successfully tested to operate in a horizontal position for thinning trees trained to an open-center system. A “hybrid” string thinner (PT250) designed to adjust cropload in either vase or angled tree canopies was evaluated in fresh fruit and processing plantings in varying production systems in four U.S. growing regions in 2009 to 2011. Data were uniformly collected across regions to determine blossom removal rate, fruit set, labor required for follow-up green fruit hand thinning, fruit size distribution at harvest, yield, and economic impact.

Trials Conducted in Four U.S. Peach Growing Regions

String thinner trials with variable tree forms utilized by producers in California, Washington, South Carolina, and Pennsylvania demonstrated reduced labor costs compared to hand-thinned controls and increased crop value due to a larger distribution of fruit in marketable and higher market value sizes. Blossom removal ranged from 17% to 56%, hand thinning requirement was reduced by 19% to 100%, and fruit yield and size distribution improved in at least one string-thinning treatment per experiment. The savings in hand thinning requirement and increases in fruit size distribution realized in all trials increased the economic value of the peach crops beyond that of hand thinning alone. Gross income ranged from $4267 to $9127 per acre in processing plantings and $5097 to $12,288 per acre in fresh fruit plantings. Net positive economic impact from mechanical thinning (realized economic savings beyond hand thinning alone) ranged from $236 to $1490 per acre and $264 to $934 per acre, respectively, with the exception of one treatment in two processing peach trials in which the economic impact was negative. Economic impact also was negative in a hand blossom thinned control treatment. Increased fruit size had a greater positive impact for fresh market producers while labor savings and yield increases (due to larger fruit size) were of greater importance for canning peach growers.

In-Depth Studies on Bloom Stage and Pruning Modifications

Research in Pennsylvania orchards was conducted over two years on 'Sugar Giant' peach and 'Arctic Sweet' nectarine to evaluate string blossom thinner efficacy at variable stages of bloom development, ranging from pink to petal fall. Blossom removal at the pink stage of bloom development was lower than at other stages in 2008; however, a 150 rpm versus 120 rpm spindle rotation speed resulted in blossom removal similar to the 80% full bloom (FB) treatment in 2009. Blossom removal at the petal fall stage was similar to the open bloom stage. Flower density and fruit set of the bloom stage compared to hand thinned control treatments followed a similar trend, with the exception that there were fewer differences in 2009 and in lower canopy regions. Follow-up hand thinning time was reduced by all string thinning/year combinations except 'Arctic Sweet' at pink in 2008 and 2009 and at petal fall in 2009. The best treatments reduced follow-up hand thinning time compared to green fruit hand thinning alone by 51% and 41% for 'Sugar Giant' and by 42% and 22% for 'Arctic Sweet' in years 1 and 2, respectively. In 2008, the percentage of fruit in the '2 ¾ inch or greater' size category was increased by all bloom stage treatments in both cultivars. The 2009 size distribution of 'Arctic Sweet' fruit was unaffected, but the percentage of 'Sugar Giant' fruit in higher market value size categories was increased by the 80% FB and higher rpm pink treatments. Savings in hand thinning time and/or increases in fruit size in both years associated with the bloom stage treatments resulted in a net positive impact of $49 to $554 per acre compared to hand thinning alone.

Pennsylvania studies also were conducted over two seasons in peach orchards trained to perpendicular V or open center systems to evaluate possible pruning strategies to improve tree canopy access by string thinners. The objectives were to demonstrate if modifications in fruiting shoot orientation, pruning detail, and/or scaffold accessibility improved flower removal, reduced follow-up hand thinning requirement, and/or increased fruit size. Blossom removal was improved by either detailed pruning (elimination of short or excessively long shoots) or partial pruning (elimination of all shoots on the side of a limb inaccessible by the thinner spindle) in both training systems. Flower density and fruit set measurements revealed greater differences among pruning treatments compared to hand thinned control treatments, with both fruiting shoot orientation pruning modifications and detail pruning resulting in improved thinning. Thinning efficacy was unaffected by scaffold angle but increased as canopy accessibility ranking increased. Follow-up hand thinning time was reduced by all treatment, system/cultivar, and year combinations except standard pruning in an open center-trained 2009 trial. Detail pruning consistently improved fruit size compared to hand thinned control and other pruning treatments in both perpendicular V- and open center-trained orchard plots. The best treatments resulted in a thinning savings of $49 to $282 per acre in perpendicular V plantings and $11 to $19 per acre in open center plantings. Realized economic savings beyond hand thinning alone ranged from $191 $1163 per acre in perpendicular V trials and $11 to $119 per acre in open center trials.

Technology Adoption Surveys and Case Study Interviews

Participants in a technology adoption survey rated fruit thinning, harvesting, spraying, and monitoring crop and nutrient status the greatest areas of need to increase efficiency and precision in specialty crop enterprises, and among these, thinning and harvesting tended to receive the highest need scores. Case study interviews of 11 Pennsylvania growers and orchard managers who had thinned a total of 154 acres suggested that commercial adoption of mechanical string-thinning technology would have positive impacts on the work place. All case study cooperators reported that blossom string thinning impacted orchard management by making cropload management more efficient and by reducing follow-up hand thinning time. Eighty percent of the growers noted fruit from thinned trees were larger. Additional observations included the following: 1) hand thinning of peaches was completed earlier allowing more timely work in other crops, 2) employees were satisfied with mechanical thinning as it saved them time and minimized ladder use, and 3) the seasonal distribution of labor-intensive work was improved.

Sensor Technologies Developed by Graduate Students to Automate Positioning of the String Thinner Spindle

Reuben Dise, Penn State Department of Agricultural and Biological Engineering, and Matt Aasted, Carnegie Mellon University Robotics Institute, designed and compared two sensor-based systems for automating the positioning of the thinning spindle. The manually controlled mechanical string thinner requires the operator to constantly steer the tractor to maintain tree canopy engagement. To address this constraint, they tested ultrasonic and laser sensors to detect canopy shape and distance and automatically control the position of the string thinner. Based on blossom removal comparisons between automated and operator controlled string thinning, the automated systems were generally as good as a human at maintaining canopy engagement and may be economically viable methods of augmenting mechanical thinning. To view a video on this new technology, please visit www.abe.psu.edu/scri.

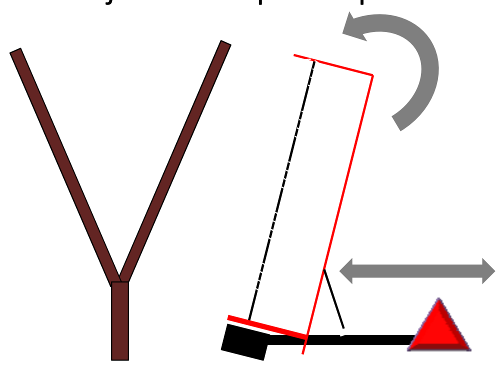
Summary

Mechanical thinning, being a physical removal technique, has greater predictability than chemical thinning. Since the effects of physical removal are immediately visible, the level of crop removal can be determined by comparing pre- and post-thinning flower or fruit counts. A grower can therefore assess the level of crop removal and adjust the machinery to increase or reduce thinning as needed. However, the ability to ascertain the optimal crop load level and thus obtain the optimal balance of yield and fruit size distribution is still required. Since the potential negative economic consequence of over-thinning a high value crop such as stone fruit is great, it may be a safer strategy to use non-selective mechanical thinners to reduce but not entirely replace hand thinning.

In trials conducted over the past four years, tree pruning and training modifications were shown to be factors that warrant special attention for obtaining the most consistent results from mechanical string thinning. Canopy accessibility by the string thinner can be improved by detail pruning to eliminate excessively long or short fruiting shoots, by pruning to remove shoots in less accessible regions of the canopy, and by tree training to maintain straight scaffolds. Given the current premiums for large fruit in the fresh fruit market, and the growing expense and potential shortage of farm labor, the application of mechanical thinners and adoption of narrow tree wall systems that enhance the benefits of this technology offer a near-term solution to these two critical components of fruit grower profitability.

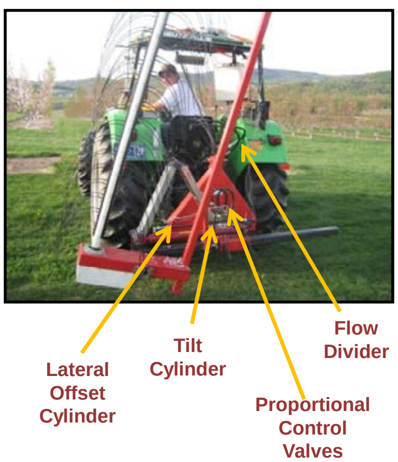
Modifications to String Thinner to Automate Positioning:

A. Controller adjusts the spindle position



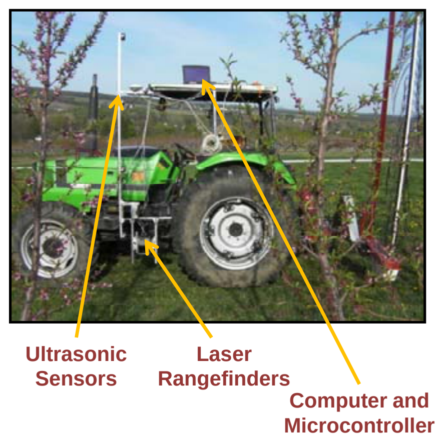
Two degrees of motion: angle of spindle, lateral position of spindle

B. Hydraulics and controls added



components:

C. Ultrasonic and laser sensors tested



components: