Blossom Thinning Results in an Early Bloom Season

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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 crop load 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.

In mechanical blossom thinning trials conducted over five seasons, string thinner crop load management technologies (Figure 1) were tested in four peach producing states, and detailed research on pruning modifications and application timing provided information to guide producers in maximizing mechanical bloom thinning benefits. The original string thinner evaluated in 2007 (Darwin 300, Fruit-Tec, Deggenhausertal, Germany; Schupp et al., 2008) was designed to thin narrow vertical apple 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 (Baugher et al., 2009). A "hybrid" string thinner (PT250; Figure 1) designed to adjust crop load in either vase or angled tree canopies was evaluated in fresh fruit and processing plantings in 2009 to 2011.

Figure 1. Blossom thinning in peach with a prototype Fruit-Tech PT250. Photo by Mark Wherley.

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 (Baugher et al., 2010a). 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.

Research in Pennsylvania orchards was conducted over two years to evaluate string blossom thinner efficacy at variable stages of bloom development, ranging from pink to petal fall (Baugher et al., 2010b). 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 a 80% full bloom treatment in 2009. Blossom removal at the petal fall stage was similar to the open bloom stage. 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 (Schupp et al., 2011). 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. 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.

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 crop load 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.

What about Thinning during an Early Bloom Season?

One lingering question that producers considering bloom thinning have had is "Should we bloom thin in an early season when the potential for freeze injury may be greater?" The hypotheses tested were: 1) bloom thinning in an early season should only be conducted on cultivars that will withstand some additional thinning from freeze injury, and 2) string thinner spindle rotation speed should be reduced in a year when there may be more potential for freeze injury.

Materials & Methods

In 2012, South-central Pennsylvania peach orchards began to bloom four weeks ahead of the normal timing (early March vs. mid-April). Many producers kept their string thinners in their equipment sheds, but two growers agreed to participate in trials in open-center trained orchards with two early maturing cultivars for which optimizing fruit size is important—'Rising Star' and 'Glenglo'—and in two 'John Boy' blocks that tend to be reliable producers. In each of the four trials, two string thinner spindle rotation speed treatments were compared to control treatments that were hand thinned at the green fruit stage. Flowers/fruit were counted before thinning, during the physiological drop stage, and prior to follow-up hand thinning. Follow-up hand thinning at the green fruit thinning stage was conducted on the rpm treatments to assess effects on labor requirement. Fruit were measured at harvest to assess effects on fruit size. The plots were arranged in randomized complete block designs with six multiple tree replicates. Data were collected from center trees and subjected to analysis of variance. Labor costs were provided by cooperating growers, and machine costs were obtained from equipment manufacturers. Peach market values for various size categories were obtained from the USDA Agricultural Marketing Service report for the Appalachian region (USDA, 2012).

Results & Discussion

Peach Blossom Thinning and Fruit Set Response in a Year with Increased Potential for Freezing Temperatures during Bloom. Initial flower density ranged from 15.3 to 25.1 flowers per cm2 limb cross-sectional area across the four orchard plots. Flower density was reduced by thinning treatments in two of the four peach orchard plots (Table 1). In the plots where flower density was not reduced (Orchard A), flower removal ranged from 6.8% to 22%; whereas in the plots where flower density was reduced, the grower (Orchard B) had selected rpm treatments that removed 42% to 61% of the blossoms. In 'John Boy', Orchard B, the 220 rpm treatment removed more flowers than the 200 rpm treatment; however flower removal in 'Rising Star' was equal in 175 and 200 rpm treatments. Prior to the green fruit thinning stage, crop load was more than desired across all treatments and all required follow-up hand thinning.

There were two freeze events prior to thinning (low temperatures of 29° to 32°F) and three freeze events following bloom thinning (low temperatures around 32°F) (Figure 2, minimum temperatures from weather station at Penn State Fruit Research and Extension Center, Biglerville, PA). The freeze events prior to thinning reduced crop load by approximately 10%. In Orchard B, percent change in flowers/fruit remaining from the dates of bloom thinning to fruit set was significantly higher in the control treatments than in the string thinning treatments. The reduced natural drop might be explained by the reduced competition between fruitlets, which may provide a "cushion" in years with an increased possibility of freeze injury. During the prior six years during which we conducted bloom thinning studies in Pennsylvania orchards, there was one trial that was subjected to freezing temperatures following bloom, and a similar trend was observed. In this case, flower density was reduced by 90% by freezing temperatures, but at fruit set, the crop load in string thinned treatments was equal to that in the control treatment (Baugher et al., 2010b). Since temperatures did not drop below 32°F in the current study, we cannot draw conclusions about critical temperature events that kill 90% of blossoms.

Mechanical Blossom Thinning Effects on Labor Requirement and Fruit Size. Hand thinning in Orchard B's 'Rising Star' and 'John Boy' was reduced by all bloom thinning treatments, and the thinning savings ranged from $25 to $48 per acre. Although the crop load comparisons in Orchard A were non-significant, hand thinning of 'John Boy' was reduced by the 210 rpm treatment, which resulted in a $36 savings per acre. The loss in the other Orchard A treatments was $15 per acre—the cost of mechanical thinning.

Fruit diameter was improved in the 200 rpm treatment in 'Rising Star' and the 200 and 220 rpm treatments in Orchard B 'John Boy'. Fruit in the higher value 2 ¾ inch and higher fruit size categories was increased in both 'John Boy' plots and in 'Rising Star'. As the season progressed, fruit of variable sizes and shapes were observed in the two early season cultivars, which were probable effects of sub-lethal temperature injury and pollination conditions interacting with genetics, and harvestable yields were reduced across the bloom thinning treatments and the controls. In these plots, the net impact per acre of bloom thinned compared to hand-thinned control treatments (taking into account effects on labor requirement and fruit size) ranged from -$15 per acre for 'Glenglo' to $171 per acre for the 200 rpm treatment in 'Rising Star'. By comparison, value added by increases in fruit size, increased in both 'John Boy' plots, and net impact ranged from $619 to $1624 per acre, which is consistent with the impacts in prior research conducted in more normal bloom seasons (Baugher et al., 2010a, 2010b; Schupp et al., 2009, 2011).

Conclusions. In a growing season that began four weeks early, temperatures dropped to freezing levels on three occasions but did not reach critical lows. Therefore, the hypotheses could not be fully tested. Across four research plots, the thinning effects on a reliable producing cultivar were generally positive, but effects on early maturing cultivars were variable. The higher compared to the lower rpm resulted in more fruit in higher value size categories in two of the four trials but equal reductions in follow-up hand thinning requirement. The economic impacts from the increases in fruit size were $146 and $562 per acre greater for the higher rpm treatments in 'Rising Star' and Orchard B 'John Boy', respectively. The question of whether or not to bloom thin in an early bloom season will remain a question to be addressed for specific orchard blocks based on site history and cultivar susceptibility, but the early 2012 season provided an opportunity to obtain some guiding information. As producers gain experience with optimum spindle speed in various cultivars and sites in a normal bloom season, they will learn how to adjust rpm for a year in which crop potential may be reduced.

Table 1. Peach blossom thinning and fruit set response to mechanical thinner treatments applied in an early growing season.

Cultivar/Orchard	Treatment[z]	Flower removal (%)	Flower density before/after thinning (flowers/cm^2 LCSA[y])	Crop load (fruit set) 30 DAFB[x] (fruit/cm^2 LCSA)
Glenglo Orchard A	Hand-thinned control 30 DAFB	--	25.1/25.1 a	8.3 ab
	String thinned 150 rpm	6.8 b[w]	20.5/17.1 a	11.3 a
	String thinned 180 rpm	18.4 a	21.5/15.6 a	6.4 b
John Boy Orchard A	Hand-thinned control 30 DAFB	--	19.3/19.3 a	9.8 a
	String thinned 180 rpm	15.2 a	17.1/14.4 a	7.9 a
	String thinned 210 rpm	21.6 a	20.1/15.7 a	7.6 a
Rising Star Orchard B	Hand-thinned control 30 DAFB	--	11.8/11.8 a	9.3 a
	String thinned 175 rpm	50.7 a	12.2/6.6 b	5.5 ab
	String thinned 200 rpm	61.1 a	10.6/4.4 b	3.6 b
John Boy Orchard B	Hand-thinned control 30 DAFB	--	17.8/17.8 a	11.2 a
	String thinned 200 rpm	42.2 b	15.3/8.4 b	6.5 b
	String thinned 220 rpm	61.0 a	17.5/6.9 b	5.0 b

[z] Peach trees were thinned at 50 to 100% full bloom. Tractor speed was 2 mph.
[y] Limb cross-sectional area.
[x] Crop load assessed just prior to hand thinning at the green fruit stage. DAFB = Days after full bloom
[w] Mean separation within columns and cultivars by Fisher's protected least significant difference at $P \leq 0.05$.

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Table 2. Follow-up hand thinning required for mechanical thinner treatments applied in an early growing season.

Cultivar/Orchard	Treatment[z]	Hand thinning at 30 to 35 DAFB (h/acre/1 person)	Thinning savings[z] ($/acre)
Glenglo Orchard A	Hand-thinned control 30 DAFB	28.2 a[y]	--
	String thinned 150 rpm	28.8 a	(15)
	String thinned 180 rpm	29.7 a	(15)
John Boy Orchard A	Hand-thinned control 30 DAFB	26.8 a	--
	String thinned 180 rpm	24.5 ab	(16)
	String thinned 210 rpm	22.8 b	36
Rising Star Orchard B	Hand-thinned control 30 DAFB	9.9 a	--
	String thinned 175 rpm	7.2 b	25
	String thinned 200 rpm	6.1 b	35
John Boy Orchard B	Hand-thinned control 30 DAFB	17.9 a	--
	String thinned 200 rpm	12.5 b	48
	String thinned 220 rpm	13.4 b	41

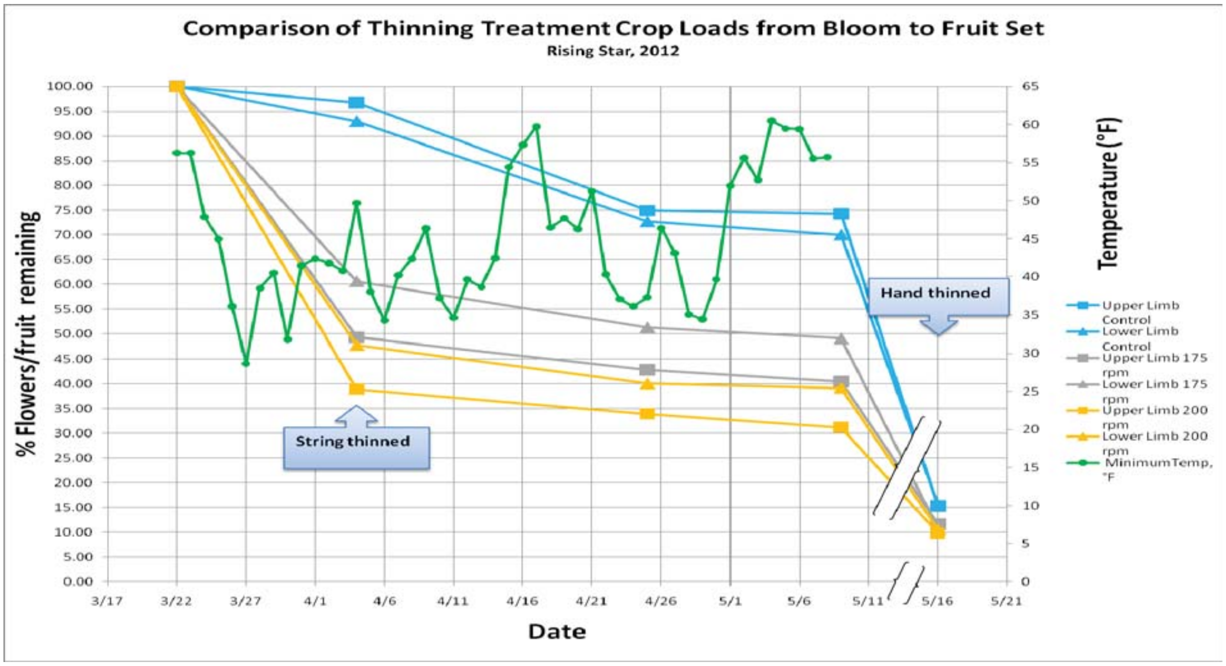
[z] Thinning savings includes reduced follow-up hand thinning inputs and added mechanical thinner, tractor, and labor inputs. Values in parentheses are negative and represent cost of mechanical thinning.
[y] Mean separation within columns and cultivars by Fisher's protected least significant difference at $P \leq 0.05$.

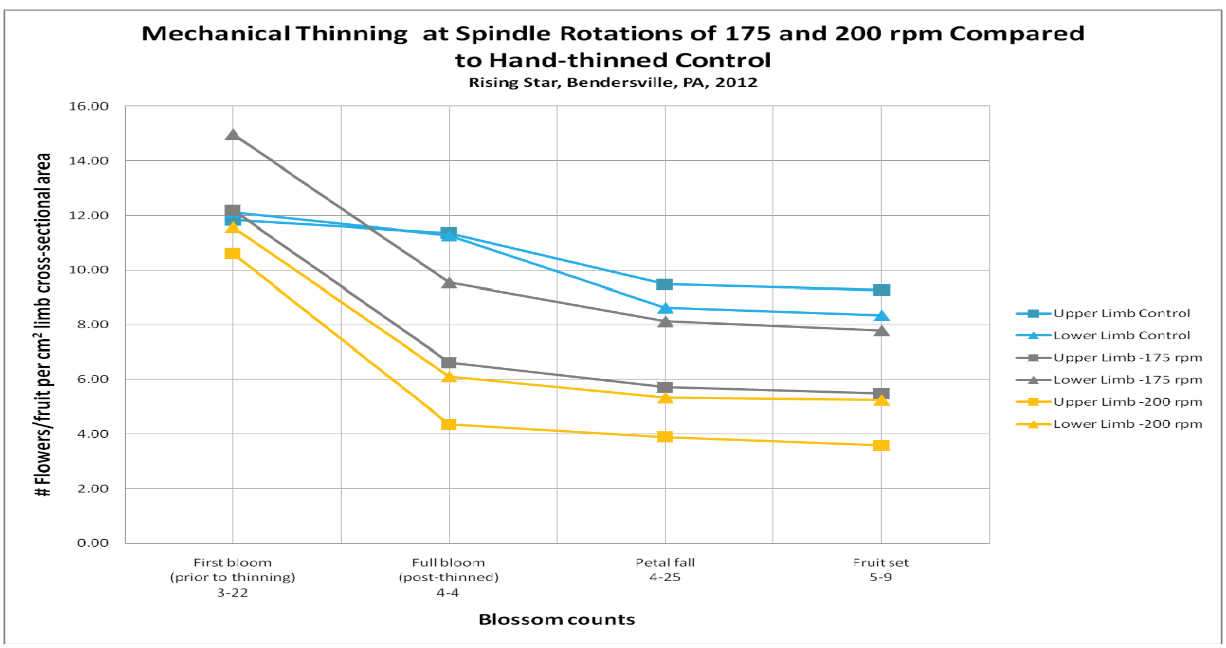
Table 3. Peach fruit size, high value packout distribution, market value based on fruit size, and net economic impact from both labor savings and/or fruit size increase.

Cultivar/Orchard	Treatment	Fruit diameter[z] (cm)	Fruit ≥2 ¾ inch[z] (%)	Added value ($/acre)	Net impact ($/acre)[y]
Glenglo Orchard A	Hand-thinned control 30 DAFB	7.4 a	69 a	--	--
	String thinned 150 rpm	7.4 a	60 a	--	(15)
	String thinned 180 rpm	7.4 a	63 a	--	(15)
John Boy Orchard A	Hand-thinned control 30 DAFB	7.4 a	48 b	--	--
	String thinned 180 rpm	7.4 a	60 a	635	619
	String thinned 210 rpm	7.5 a	62 a	648	668
Rising Star Orchard B	Hand-thinned control 30 DAFB	7.7 b	79 b	--	--
	String thinned 175 rpm	7.7 b	79 b	---	25
	String thinned 200 rpm	7.9 a	89 a	171	171
John Boy Orchard B	Hand-thinned control 30 DAFB	7.5 b	40 b	--	--
	String thinned 200 rpm	7.7 a	55 ab	1015	1062
	String thinned 220 rpm	7.8 a	79 a	1584	1624

[z] Fruit diameter and high value packout distribution determined on 40 fruit harvested per treatment from each of six replicates.
[y] Net economic impact (realized economic savings) is defined as cost or benefit beyond hand thinning alone and takes into account reduced hand thinning inputs and increased value of fruit in higher size categories. Values in parentheses are negative.
[x] Mean separation within columns and cultivars by Fisher's protected least significant difference at $P \leq 0.05$.

Figure 2. Crop load and low temperature mean comparisons from bloom to fruit set (minimum temperatures from weather station at Penn State Fruit Research and Extension Center, Biglerville, PA).





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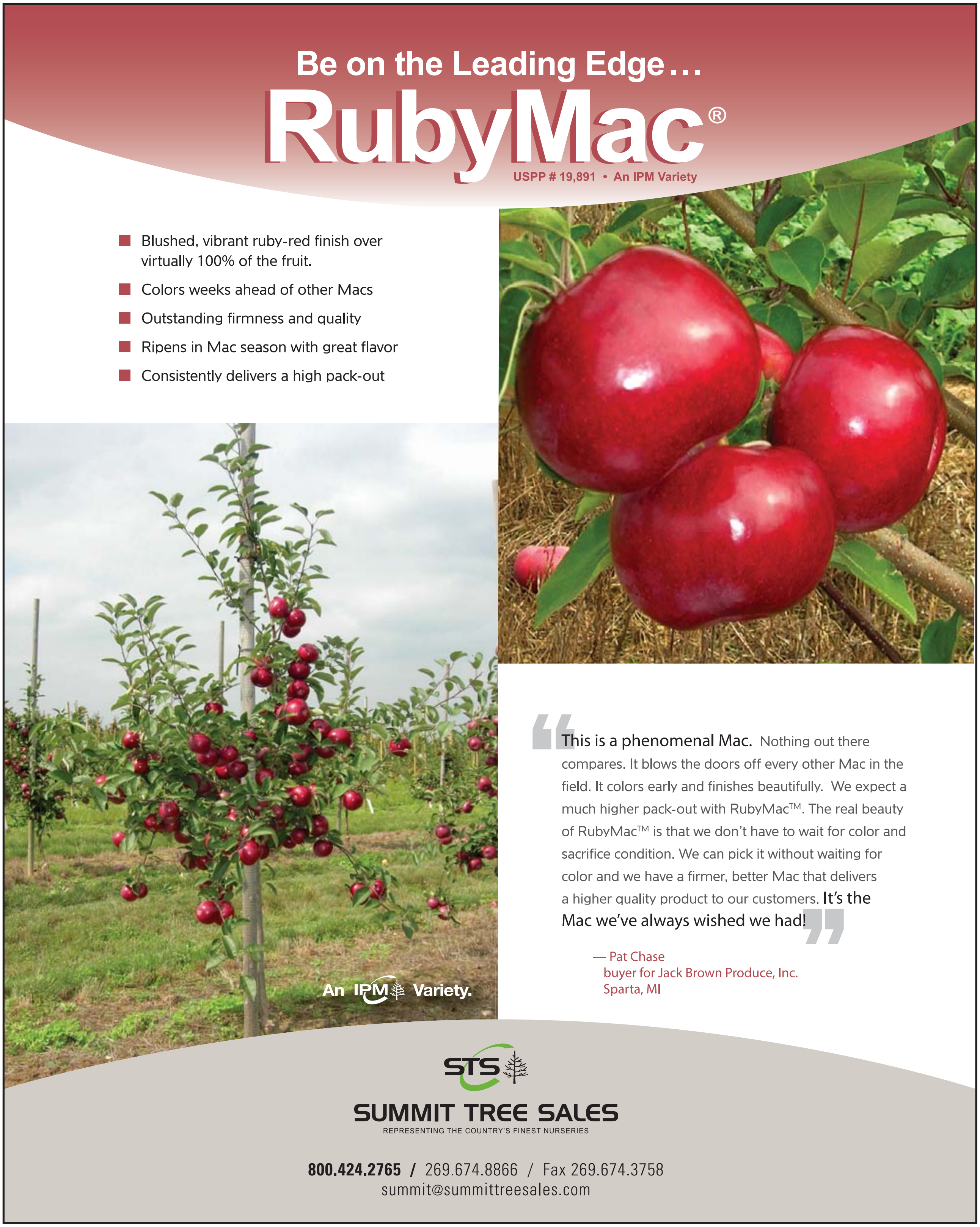
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