Mechanical String Thinner Reduces Crop Load at Variable Stages of Bloom Development of Peach and Nectarine Trees

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Abstract. Thinning of blossoms or fruitlets is a labor-intensive requirement in the production of peach and nectarine (*Prunus persica*) fruit of optimum size and quality. Prior research conducted by the authors on string blossom thinners for managing peach tree crop load demonstrated that this new technology reduces labor requirement and improves fruit size. The research reported in the current article was conducted over 2 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 with the exception of the 2009 ‘Sugar Giant’ trial, in which blossom removal was higher at 80% FB. Flower density and fruit set of the bloom stage compared with 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 with 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 “7.0 cm 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 \$123/ha to 1368/ha compared with hand thinning alone.

Tree fruit typically set an excessive number of fruit, and blossom or fruit thinning is required to ensure that the remaining fruit attain marketable size. The conventional method for adjusting crop load in peach and nectarine orchards is to remove excess fruit by hand at 35 to 40 d after full bloom (DAFB). This is one of the more labor-intensive practices in stone fruit production with the time for hand thinning ranging from 62 h·ha⁻¹ to over 247 h·ha⁻¹ (Glozer and Hasey, 2006; Krawczyk, 2010). Plant growth regulators are available for thinning pome fruit; however, chemical thinning options for stone fruit are limited and unpredictable (Stover and Greene, 2005). Three years of research on chemical blossom thinners (Baugher et al., 2008) demonstrated that although the treatments often increased peach fruit size, they were inconsistent in reducing follow-up hand thinning requirement. These results are similar to reports

from other peach producing regions (Byers, 1999; Fallahi et al., 2006; Klein and Cohen, 2000; Osborne et al., 2005; Wilkins et al., 2004).

String blossom thinning research conducted in 2007 (Schupp et al., 2008) and in 2008 (Baugher et al., 2009) demonstrated that mechanical thinning reliably reduces crop load, reduces labor requirement, and increases fruit size beyond that achieved with conventional hand thinning at 30 to 45 DAFB. The string thinner evaluated in 2007 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 evaluated in 2008 was designed to operate in a horizontal position for thinning trees trained to an open-center system. Trials in 2007 to 2008 were generally conducted when peach trees had 60% to 80% of their blossoms open. How-

ever, several trials included string thinning treatments at pink or 20% full bloom (FB), and fruit size was improved compared with treatments applied at later bloom stages (Baugher et al., 2009; Schupp et al., 2008).

A 2-year study was initiated in 2008 to evaluate string blossom thinning at variable stages of bloom development ranging from pink to petal fall. The objectives were to assess the effects of mechanical thinning at various bloom stages compared with conventional green fruit hand thinning: 1) on blossom removal and follow-up hand thinning requirement; and 2) on crop load, fruit size, and net economic impact.

Materials and Methods

Mechanical string thinner description.

The string thinner was originally designed to remove apple blossoms in organic orchards trained to narrow conical systems (Bertschinger et al., 1998). The thinner (Darwin 300; Fruit-Tec, Deggenhausertal, Germany) has a 3.0-m-long spindle that is oriented in a vertical position and tilts 30° in either direction from center (Fig. 1). The spindle is turned by a hydraulic motor and speed is adjusted by a proportional flow control valve. The height and angle of the frame supporting the spindle are adjustable to conform to the height and inclination of the tree canopy, and the intensity of thinning is adjustable by changing the spindle rotation speed, the tractor speed, and the string arrangement. String length was 50 cm. Two columns of cords were used, arranged with alternating gaps (Fig. 2). The string thinner was fitted with plastic cords and operated at 180 rpm and 4.0 km·h⁻¹ in 2008 and fitted with molded cords and operated at 150 rpm and 4.0 km·h⁻¹ in 2009 (with the exception of a second pink treatment conducted at 120 rpm). The string thinner manufacturer changed the string technology in 2009, and it was important to test the strings that commercial growers would be using as they adopted the non-selective thinning strategy. Extensive pre-tests were conducted in 2009 to ensure that the string arrangement, rpm, and tractor speed used with both string types produced similar levels of thinning.

Commercial orchard trials conducted over two seasons. Mechanical thinning trials were conducted over two seasons in commercial plantings of mature ‘Sugar Giant’ peach trees and ‘Arctic Sweet’ nectarine trees on Arendtsville gravelly loam soil. The orchards were located in Biglerville, PA, and were trained to narrow canopy (60 to 75 cm), perpendicular V systems. Bloom stage treatments included pink, 20% FB, 80% FB, and petal fall in 2008 and pink at 150 rpm, pink at 120 rpm, 80% FB, and petal fall in 2009.

The experimental design in each trial was a randomized complete block with six blocks and six-tree plots. Data were collected from two center trees in each plot. The mechanical treatments in all trials were compared with hand thinning at 35 to 40 DAFB. Flower density and crop load were determined on two pre-tagged scaffolds on each of the test

trees. Initial blossom density ranged from six to nine flowers/cm² limb cross-sectional area in 2008 and from three to nine flowers/cm² limb cross-sectional area in 2009. Blossom removal with mechanical thinners was evaluated by counting all blossoms in the upper (1.5- to 3.0-m height) and lower (0.5- to 1.5-m height) canopy regions of the tagged scaffolds immediately before and after thinning. The total number of blossoms per scaffold also was compared. Reduction in flower/fruit density was evaluated the day of thinning and again after physiological drop (35 to 40 DAFB) by calculating number of blossoms or fruit per limb cross-sectional area in the upper and lower canopy. All trees were uniformly hand thinned by growers to commercial levels, during which follow-up hand thinning time was recorded. At harvest, a sample of 40 to 50 firm-ripe fruit collected from the two center trees in each plot was evaluated for mean fruit diameter, fruit size distribution, and possible defects from mechanical thinning. Yields were calculated from fruit per scaffold counts and percent size distribution. All data were subjected to an analysis of variance and treatments were separated using Fisher's protected least significant difference test.

Economic partial budget analyses (described by Harper et al., 2002) were performed to evaluate the potential impact of each thinning treatment on fruit returns. Mechanical thinning costs were based on a 15-year useful life of equipment (commercially available price of \$13,280) and 8% interest rate averaged \$37/ha for the string thinner, including tractor cost (\$12.00/h) and labor (\$12.00/h). Realized economic savings were calculated from follow-up hand thinning time, fruit size distribution, and average yield. Follow-up hand thinning costs were

Fig. 1. A rotating string thinner for narrow vertical canopies was used to thin peach and nectarine trees trained to a perpendicular V system. The spindle is 3.0 m in length and tilts 30° either direction from center. Photograph by M. Wherley.

Fig. 2. The string thinner spindle was fitted with two columns of cords arranged with alternating gaps. Plastic cords (A) made for pre-2009 versions of the string thinner were used in 2008 and molded cords (B) developed for 2009 and 2010 string thinner models were used in 2009. Extensive pre-tests were conducted to ensure that the string arrangement, rpm, and tractor speed used with both string types produced similar levels of thinning.

based on a labor rate of \$8.50/h in 2008 and \$8.75/h in 2009. Commercial prices for the various size categories for each cultivar and year were obtained from the *USDA Agricultural Marketing Service Report, Appalachian Region* (U.S. Department of Agriculture, 2009).

Results and Discussion

Blossom removal, flower density, fruit set, and follow-up hand thinning comparisons. Blossom removal with the string thinner was significant across years, cultivars, and canopy regions for the various bloom stages in which there were open flowers (Fig. 3). 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% FB treatment in 2009. Blossom removal at the petal fall stage was similar to the open bloom stage with the exception of the 2009 'Sugar Giant' trial, in which blossom removal was higher at petal fall. Percent blossom removal for the most effective treatments ranged from 38 to 60 in 2008 and 30 to 50 in 2009. The increased blossom removal at higher spindle speeds is

consistent with results reported in a multistate mechanical thinning project conducted in 2009 (Baughert et al., 2010).

Flower density immediately after thinning and fruit set of the bloom stage compared with hand thinned control treatments followed a similar trend with the exception that there were fewer differences in 2009 and in lower canopy regions (Table 1). The year 2009 was a lighter crop year compared with 2008 with the hand thinned control bloom being only 3.1 flowers/cm² limb cross-sectional area in 'Arctic Sweet'. The best treatments reduced flower density in upper canopy regions by 60%, 63%, 64%, and 27% for 'Sugar Giant' and 'Arctic Sweet' in Years 1 and 2, respectively. The corresponding decreases in crop density, measured at 35 to 40 DAFB and before follow-up hand thinning, were 50%, 41%, 48%, and 25%, respectively.

As a further illustration of the differences in initial crop potential between the 2 years, hand thinning time for the green fruit thinned control treatments averaged 144 h·ha⁻¹ in 2008 and 34 h·ha⁻¹ in 2009 (Table 2). Follow-up hand thinning time was reduced by all treatment and year combinations except the 'Arctic Sweet' at pink in 2008 and 2009 and at petal fall in 2009. The best treatments reduced

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Table 1. 'Sugar Giant' peach and 'Arctic Sweet' nectarine flower and fruit density response to string thinner treatments at varying bloom stages compared with hand thinned controls in 2008 and 2009.

Thinning treatment ^z	Flower density after thinning (flowers/cm ² limb-cross-sectional area)			Crop load (density) at 35 DAFB ^y (fruit/cm ² limb-cross-sectional area)		
	Upper canopy	Lower canopy	Scaffold	Upper canopy	Lower canopy	Scaffold
<i>'Sugar Giant' 2008</i>						
Pink	10.4 a ^w	3.9 a	9.1 a	4.5 ab	1.8 a	4.0 ab
20% FB ^x	5.4 b	1.7 b	4.6 b	3.0 bc	0.7 b	2.3 c
80% FB	5.4 b	2.0 b	4.7 b	3.0 bc	1.0 ab	2.5 ab
Petal fall	4.2 b	2.1 b	4.4 b	2.3 c	0.9 b	2.2 c
Hand thinned control, 35 DAFB	10.5 a	3.9 a	9.0 a	5.3 a	1.8 a	4.4 a
<i>'Sugar Giant' 2009</i>						
Pink, 150 rpm	6.1 b	1.8 bc	6.4 b	2.3 b	0.7 ab	2.4 ab
Pink, 120 rpm	5.8 b	2.0 abc	5.8 b	2.3 b	0.8 ab	2.3 b
80% FB	6.4 b	2.6 ab	6.9 b	2.7 ab	1.2 a	3.0 ab
Petal fall	3.6 c	1.3 c	3.6 c	2.0 b	0.7 b	2.0 b
Hand thinned control, 35 DAFB	9.7 a	2.7 a	9.2 a	3.6 a	1.0 ab	3.4 a
<i>'Arctic Sweet' 2008</i>						
Pink	3.4 b	1.5 a	3.7 b	1.2 b	0.6 ab	1.4 b
20% FB	3.4 b	1.3 a	3.7 b	0.9 bc	0.6 ab	1.2 b
80% FB	2.0 c	0.7 b	2.3 c	0.8 c	0.4 b	1.1 b
Petal fall	2.8 bc	0.8 b	3.0 bc	1.0 bc	0.5 b	1.2 b
Hand thinned control, 35 DAFB	5.5 a	1.4 a	5.6 a	1.7 a	0.8 a	2.1 a
<i>'Arctic Sweet' 2009</i>						
Pink, 150 rpm	2.9 ab	0.7 ab	2.9 ab	1.1 ab	0.3 a	1.1 b
Pink, 120 rpm	3.3 a	0.9 a	3.5 a	1.4 a	0.4 a	1.5 a
80% FB	2.2 b	0.7 ab	2.4 b	0.7 b	0.3 a	0.9 b
Petal fall	2.2 b	0.7 b	2.4 b	1.0 b	0.3 a	1.1 b
Hand thinned control, 35 DAFB	3.0 ab	0.9 ab	3.1 a	1.0 b	0.4 a	1.2 ab

^zExcept where noted differently, the string thinner was fitted with plastic cords and operated at 180 rpm and 4.0 km·h⁻¹ in 2008 and fitted with molded cords and operated at 150 rpm and 4.0 km·h⁻¹ in 2009.

^yDAFB = days after full bloom; before follow-up hand thinning.

^xFB = full bloom.

^wMean separation within columns, cultivars, and years by Fisher's protected least significant difference at $P \leq 0.05$.

Fig. 3. Blossom removal from the scaffolds of perpendicular V-trained peach trees in response to string thinner treatments at varying bloom stages. Except where noted differently, the string thinner was fitted with plastic cords and operated at 180 rpm and 4.0 km·h⁻¹ in 2008 and fitted with molded cords and operated at 150 rpm and 4.0 km·h⁻¹ in 2009. FB = full bloom. Mean separation within cultivars and years by Fisher's protected least significant difference at $P \leq 0.05$.

follow-up hand thinning time compared with green fruit thinning alone (hand thinned control, 35 to 40 DAFB) by 51%, 41%, 42%, and 22% for 'Sugar Giant' and 'Arctic Sweet' in Years 1 and 2, respectively. These percentages parallel the reductions in crop load.

Follow-up hand thinning costs for the green fruit thinned control treatments averaged \$1221/ha in 2008 and \$297/ha in 2009 (Table 3). The best treatments resulted in a thinning savings of \$415/ha to \$530/ha in 2008 and \$45/ha to \$67/ha in 2009. The bloom, fruit set, and follow-up hand thinning data confirm previous reports indicating the importance of careful assessment of bloom density to determine best use of mechanical thinning technology (Baughner et al., 2009, 2010; Schupp et al., 2008).

Fruit size and yield comparisons. Average fruit diameter was unaffected by thinning treatments in the 2009 low bloom density year (Table 4). The 2009 size distribution of 'Arctic Sweet' fruit also was unaffected, but the percentage of 'Sugar Giant' fruit in higher market value size categories was increased in the 80% FB and higher rpm pink treatments. In 2008, average 'Sugar Giant' fruit diameter was increased by the 20% FB treatment, and average 'Arctic Sweet' fruit diameter was increased by the petal fall treatment. In addition, the percentage of fruit in the "7.0 cm or greater" size category was increased by all bloom stage treatments in both cultivars, and the percentage of fruit in the "7.6 cm or greater" size category was increased by bloom treatments in 'Sugar Giant'. Previous research showed no difference in effects on fruit size in the upper versus lower canopy (Schupp et al., 2008). Although total calculated yield of mechanically thinned trees was sometimes reduced compared with hand thinned control trees, yield of high market value size fruit (7.6 cm or greater and 7.0 cm or greater for 'Sugar Giant' and 'Arctic Sweet', respectively) was sometimes increased. This contrasts earlier research in which there were more consistent increases in high market value yield (Baughner et al., 2010; Schupp et al., 2008). A 2008 mechanical thinning trial in which detailed yield data were collected at each harvest date demonstrated that early harvest yield of mechanically blossom thinned trees was greater than early yield of trees in hand thinned control and non-thinned treatments (Baughner et al., 2009). Fruit quality of the petal fall treatments was carefully assessed, and less than 1% of the peach or nectarine fruit had scars or other injuries that may have been caused by the string thinner.

Realized economic savings. The savings in hand thinning time and increases in fruit size associated with the bloom stage treatments increased the value of the peach and nectarine crops beyond that of hand thinning alone (Table 3). In 2008, reductions in follow-up hand thinning time had a significant effect on net positive economic impact, whereas in 2009, increases in fruit size were more important. For example, although the 2009 'Arctic Sweet' pink treatments increased follow-up hand thinning cost (Table

Table 2. Follow-up hand thinning time required in string thinner treatment at varying bloom stages compared with hand thinned controls in 2008 and 2009.

Thinning treatment ^z	Hand thinning at 35–40 DAFB ^y (h·ha ⁻¹)
<i>'Sugar Giant' 2008</i>	
Pink	104.2 b ^x
20% FB	68.4 c
80% FB	74.8 c
Petal fall	69.2 c
Hand thinned control, 35 DAFB	139.8 a
<i>'Sugar Giant' 2009</i>	
Pink, 150 rpm	20.4 bc
Pink, 120 rpm	23.2 b
80% FB	23.1 b
Petal fall	16.9 c
Hand thinned control, 35 DAFB	28.5 a
<i>'Arctic Sweet' 2008</i>	
Pink	122.0 ab
20% FB	104.5 bc
80% FB	85.2 b
Petal fall	91.1 b
Hand thinned control, 35 DAFB	147.5 a
<i>'Arctic Sweet' 2009</i>	
Pink, 150 rpm	36.7 ab
Pink, 120 rpm	41.5 a
80% FB	30.6 b
Petal fall	35.4 ab
Hand thinned control, 35 DAFB	39.4 a

^zExcept where noted differently, the string thinner was fitted with plastic cords and operated at 180 rpm and 4.0 km·h⁻¹ in 2008 and fitted with molded cords and operated at 150 rpm and 4.0 km·h⁻¹ in 2009.

^yDAFB = days after full bloom; FB = full bloom.

^xMean separation within cultivars and years by Fisher's protected least significant difference at $P \leq 0.05$.

Table 3. Follow-up hand thinning cost, thinning savings, and net economic impact as affected by string thinner treatments at varying bloom stages in 2008 and 2009.

Thinning treatment	Follow-up hand thinning cost (\$/ha) ^z	Thinning savings (\$/ha) ^y	Net economic impact (\$/ha) ^x
<i>'Sugar Giant', 944 trees/ha 2008</i>			
Pink	956	232	876
20% FB ^w	652	536	1368
80% FB	706	481	1106
Petal fall	657	530	1309
Hand thinned control, 35 DAFB ^y	1186	—	—
<i>'Sugar Giant', 944 trees/ha 2009</i>			
Pink, 150 rpm	178	37	850
Pink, 120 rpm	203	13	462
80% FB	202	13	1031
Petal fall	148	67	154
Hand thinned control, 35 DAFB	249	—	—
<i>'Arctic Sweet', 897 trees/ha 2008</i>			
Pink	1104	151	738
20% FB	953	299	617
80% FB	790	464	1184
Petal fall	840	415	588
Hand thinned control, 35 DAFB	1255	—	—
<i>'Arctic Sweet', 897 trees/ha 2009</i>			
Pink, 120 rpm	321	(9)	205
Pink, 150 rpm	363	(51)	248
80% FB	268	45	149
Petal fall	310	3	123
Hand thinned control, 35 DAFB	345	—	—

^zFollow-up hand thinning cost is based on a labor rate of \$8.50/h in 2008 and \$8.75/h in 2009.

^yThinning savings includes reduced follow-up hand thinning inputs and added mechanical thinner, tractor, and labor inputs. Mechanical thinner cost is based on a 15-year useful life of equipment and 8% interest rate. Tractor cost is \$12.00/h; equipment operator cost is \$12.00/h.

^xNet 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.

^wFB = full bloom; DAFB = days after full bloom.

3), the economic impact was increased as a result of a greater yield of high market value fruit (Table 4). Net positive economic impact (realized economic savings beyond hand

thinning alone) ranged from \$588/ha to \$1368/ha in 2008 and \$123/ha to \$1031/ha in 2009. The economic savings were less consistent for petal fall treatments than for

Table 4. Peach and nectarine fruit size, packout distribution, and high market value yield as affected by string thinner treatments at varying bloom stages in 2008 and 2009.

Thinning treatment	Fruit diam (cm) ^z	Fruit in high market value size categories (%) ^z		Total yield (kg·ha ⁻¹) ^y	Yield of high market value size fruit (kg·ha ⁻¹) ^x
		Fruit 7.0 cm or greater (%)	Fruit 7.6 cm or greater (%)		
'Sugar Giant' 2008					
Pink	7.8 ab ^v	100 a	95 a	22,221 a	21,349 a
20% FB ^w	8.0 a	100 a	100 a	15,936 b	15,936 b
80% FB	7.7 ab	100 a	94 a	19,154 b	18,323 ab
Petal fall	7.9 ab	100 a	99 a	16,947 b	16,760 b
Hand thinned control, 35 DAFB	7.4 b	99 b	78 b	23,604 a	19,115 a
'Sugar Giant' 2009					
Pink, 150 rpm	7.9 a	92 a	52 ab	8,444 b	4,948 ab
Pink, 120 rpm	7.8 a	90 ab	44 bc	10,099 ab	4,879 ab
80% FB	7.9 a	93 a	61 a	10,453 ab	6,911 a
Petal fall	7.7 a	90 ab	36 c	9,645 ab	3,872 b
Hand thinned control, 35 DAFB	7.7 a	84 b	36 c	10,835 a	4,673 ab
'Arctic Sweet' 2008					
Pink	6.7 a	42 a	14 a	— ^u	—
20% FB	6.6 a	37 a	7 a	—	—
80% FB	6.6 a	48 a	6 a	—	—
Petal fall	6.5 b	38 a	15 a	—	—
Hand thinned control, 35 DAFB	6.5 b	33 b	8 a	—	—
'Arctic Sweet' 2009					
Pink, 150 rpm	6.4 a	18 a	1 a	6,483 a	1,395 a
Pink, 120 rpm	6.4 a	16 a	1 a	7,994 a	1,767 a
80% FB	6.4 a	10 a	0 a	6,666 a	863 c
Petal fall	6.4 a	14 a	0 a	6,488 a	1,162 b
Hand thinned control, 35 DAFB	6.4 a	7 a	0 a	7,128 a	680 c

^zFruit diameter and packout distribution determined on 40 fruit harvested per treatment from each of six replicates.

^yYield calculated from fruit counts per scaffold and percent size distribution at harvest.

^xHigh market value fruit are all fruit 7.62 cm or greater diameter for 'Sugar Giant' and all fruit 6.985 cm or greater for 'Arctic Sweet'.

^wFB = full bloom; DAFB = days after full bloom.

^vMean separation within columns, cultivars, and years by Fisher's protected least significant difference at $P \leq 0.05$.

^uNo yield estimates conducted.

treatments applied earlier. This finding further illustrates the potential fruit size benefit of earlier thinning times shown in this and previous studies (Baugher et al., 2010; Schupp et al., 2008).

Implications for growers. Before the initiation of this research on bloom stage, peach producers who were assessing whether string blossom thinning was a cost-effective option in a given situation asked questions about the range of thinning timings. Some were concerned about spring freezes and wanted to thin as late as possible, and some wanted to obtain as many hours of use from the mechanical thinner as possible. Based on this 2-year study on one peach and one nectarine cultivar, the thinning timeframe is from pink to petal fall, which is good news for both commercial situations. The thinning time frame for the two cultivars with similar bloom development was 10 Apr. to 25 Apr. in 2008 and 15 Apr. to 1 May in 2009. The length of the bloom period was similar in both years, and the number of days a single cultivar could be successfully thinned was 26 d. Growers who have additional cultivars with earlier and/or later bloom development may find that they have an additional week to complete the mechanical thinning operation. In other years and production regions, the timeframe may be less or more, depending on weather conditions (Baugher et al., 2010). This study demonstrated that it is more difficult to remove blossoms at pink compared with other bloom stages, which indicates that producers will need to thin more aggressively at earlier bloom stages, e.g., by increasing spindle

rpm. Previous research suggested that increasing tractor speed or increasing number of strings will also increase string thinner performance (Baugher et al., 2010). A benefit of using the string thinner at earlier stages of bloom development is that there can be an increased effect on fruit size and market value. Mechanical blossom thinning often reduces labor costs and increases fruit size, and both should be considered in deciding when to thin.

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