Bloom Mechanical Thinning Improves Fruit Quality and Reduces Production Costs in Peach

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Abstract

Crop load regulation is essential to achieve high fruit quality. In peach no reliable chemical thinners are available and hand thinning is the standard method used although it requires a high number of persons in a short span of time and is very expensive. To search for an alternative to hand-thinning operation, in 2009 bloom mechanical thinning trials were set up on peach testing a German mechanical device originally designed to thin apple flowers. First trials in Italy, they were made possible by the wide presence in Piedmont, North-West Italy of peach orchards trained to narrow canopy systems, which allow optimal string penetration through the canopy. The efficiency of string thinner Darwin 300 was assessed in peach and nectarine orchards trained to perpendicular Y or central leader. Trees were mechanically thinned at 150-180 rpm rotor speed and 6-7 km/h vehicle speed; hand thinned trees served as control. Since spring frosts occur in the study area, mechanical thinning was performed at full bloom and until phase 72, BBCH scale. Mechanical thinning reduced labor costs as compared with hand-thinning control and increased crop value due to larger fruit size. Mechanical blossom/fruitlet removal ranged from 14% to 70%, according to rotor and vehicle speeds and labor requirement for follow-up hand thinning was reduced by 29% to 75%. Distribution of fruits in high value sizes increased, determining a positive economic impact. No damages were detected on fruit, pointing out that mechanical thinning could represent an interesting alternative to hand thinning also in peach production regions characterized by spring frosts.

INTRODUCTION

Crop load regulation is a necessary practice to achieve high quality fruit productions and to obtain constant yield throughout the years. Differently from other fruit species, in peach no reliable chemical thinners are available. Several surfactants and fertilizers have been tested over the years as peach blossom thinners (Byers, 1999; Costa *et al.*, 2003; Wilkins *et al.*, 2004; Fallahi *et al.*, 2006) with limited results. Different mechanical thinners have also been tested in the past including rotating rope curtains (Baugher *et al.*, 1991), limb shakers (Diezma and Rosa, 2005) and spiked drum shaker fruit removal systems (Schupp *et al.*, 2008), but none of them gave satisfactory outcomes. Fruit hand thinning remains the most adopted technique for crop load regulation in peach, although it is very expensive as well as complex in terms of labor management, since it requires a high number of persons in a short span of time. With labor requirements ranging from 100 to 200 hours per hectare according to cultivar, orchard and season, it represents 10-15% of all cultural costs related with peach production (CReSO, unpublished data).

In this study we evaluated the efficacy in peach of mechanical string thinner Darwin 300 (Fruit-Tec, Germany), a device originally designed to thin apple blossoms in organic orchards. This mechanical device has already been widely tested in apple, where it was shown to be as effective as chemical thinners (Kelderer *et al.,* 2009; Dorigoni *et al.,* 2010; Vittone and Asteggiano, 2010). Its application on peach trees was tested by Pennsylvania State University in 2007 (Schupp *et al.*, 2008), while at the national level first trials were conducted in Piedmont, North-West Italy in 2009

(Vittone *et al.,* 2010). Here, the introduction of mechanical thinners in peach was made possible by the wide presence of fruiting wall trained peach orchards, which do allow automation and, as was observed during the study, optimal string penetration through the canopy. Since spring frosts do occur in Piedmont, we also evaluated whether an intervention subsequent the full bloom is possible in order to delay thinning operations to a period characterized by smaller frost risks.

MATERIALS AND METHODS

Mechanical Thinning Device

String thinner Darwin 300 is a tractor-mounted device with a 3 m tall rotating spindle. On the spindle there are plastic cords each measuring 60 cm long. Height and angle of the spindle can be adjusted according to the inclination of the tree canopy and thinning intensity can be varied by changing spindle rotation speed and tractor speed. Spindle rotation speed can be set from the driver's cabin and is independent from tractor speed.

Preliminary trials were set up in 2009 to adjust the device, in collaboration with the manufacturer. This lead to halving the number of strings present on the spindle from 648 to 324, enlarging the gap between the cords in order to avoid over-thinning and to reduce the impact on the vegetation. All described trials were conducted with reduced number of strings on the spindle.

Commercial Orchard Trials

Trials were conducted in 2009-2011 in 12 commercial peach and nectarine orchards located in the province of Cuneo, Piedmont, North-West Italy. Nectarine cultivars were: 'Alitop', 'Big Top', 'Diamond Ray' 'Magique', 'Miluna' and 'Sweet Red'. Peach cultivars were: 'Rome Star', 'Glohaven', and 'Summer Rich', and one trial was conducted on 'Ufo3' flat peach. Canopy width ranged from 1.2 to 1.8 m and trees were trained to perpendicular Y or central leader. Tree distance on the row ranged from 1.1 to 1.6 m in central leader trained orchards and from 2 to 2.2 m in perpendicular Y trained orchards. Rows distance ranged from 4 to 4.5 m.

Mechanical thinning was performed at full bloom in 2009 trials and delayed to phase 72, BBCH scale (green ovary surrounded by dying sepal crown) in 2010 and 2011 trials. Depending on training systems, pruning technique and bloom density, rotation speed ranged from 150-220 rpm and tractor speed ranged from 5.5 to 7 km/h. Hand thinned trees at 50 to 60 days after bloom (DAFB) served as control.

Intensity of thinning was assessed by counting the number of flowers or fruitlets left per meter of branch on 40 branches perpendicular to the row and 40 branches parallel to the row. In some of the trials thinning intensity data were separated for internal and external branches as well as lower and upper canopy. Following physiological drop trees were uniformly hand thinned to commercial levels; number of hand thinned fruits and time needed for hand thinning were recorded. For each plot, data were always gathered on the 5 central trees. Fruits present on 5 trees per plot were harvested at commercial harvest dates, realizing up to three pickings when necessary. Yield per tree was recorded and fruit size distribution was determined by measuring all harvested fruits.

RESULTS

The number of flowers/fruitlets per meter of branch on mechanically thinned trees was reduced in the different trials by 14.1% to 70.5% compared to hand thinned control trees depending on tractor speed and spindle rotation speed (Table 1). In most trials Darwin 300 thinned uniformly lower and upper parts of the canopy. Thinning intensity on the internal and external parts of the canopy as well as on branch position largely varied depending on varieties, growth habit and canopy size (data not shown). Trees presenting large canopy width resulted in over-thinning of external branches and little effect on internal branches.

Labor requirement for follow-up hand thinning was reduced by 29.2% to 74.6% compared to control trees, depending on tractor and spindle speeds and cultivars (Fig. 1). On 'Diamond Ray' and ‘Alitop’ 2010 trials there was no need for follow-up hand thinning, but this was mainly due to poor fruit set which determined a reduced need for hand thinning also on control trees.

Yields ranged from 15.8 to 25.2 kg/tree across the different trials and did not differ significantly between treatments and control. Fruit size was larger on mechanically thinned trees than on manually thinned trees and determined higher incidence of high economic value size classes even on cultivars characterized by excellent fruit size, such as ‘Sweet red’ and ‘Alitop’ nectarines (Fig. 2).

In several trials the amount of fruits harvested at the first pickings was higher in mechanically thinned trees than on manually thinned control. To cite an example, on ‘Alitop’ nectarine, the first and second pickings allowed to pick 50.0% of total production on mechanically thinned tress (180 rpm, 6 km/h) and only 22.5% of total production on hand-thinned control trees (Fig. 3). Intervention at phase 72, BBCH scale did not harm fruitlets, which were still protected by dying sepals.

DISCUSSION

Mechanical thinning was shown to be an effective technique for crop load regulation in fruiting wall trained peach and nectarine orchards. Similarly to what reported by Baugher *et al.* (2010), in most trials labor requirement was considerably reduced as compared to hand thinned trees, determining a reduction of production costs. At the same time the reduced need of labor for follow-up hand thinning after mechanical intervention facilitates farm labor management, since effective fruit hand thinning requires a high number of qualified persons for a short period of time. As a non-selective thinning, mechanical devices also remove potentially good quality fruits; however, the fruits left on the tree take great advantage by reduced competition from the very early stages of their development (50-60 days earlier than on hand thinned control trees), resulting in increased fruit size.

In some cases, the amount of fruits harvested at the first picking was considerably higher in mechanically thinned trees than on control trees. This might represents an important advantage in Piedmont, where climatic conditions do not allow early fruit ripening. Especially on early cultivars, to increase the amount of fruits harvested at the first picking might mean selling quality productions when the competition is lower and at higher prices.

Thinning intensity depends on the combination of spindle rotation speed and tractor speed. However, speeds can be variously combined and trials showed that it is neither possible nor recommendable to strictly define optimal speeds to be adopted. Appropriate speeds should rather be chosen each time according to blossom intensity, cultivar phenology, and canopy size and shape. Due to physical removal of flowers or fruitlets, the effect of mechanical thinning is immediately visible, which allows for adjustments of speeds in order to lower or increase thinning intensity. Understanding whether appropriate load regulation is reached requires some experience, which the farmer can acquire by himself with accurate observations.

Thinning uniformity between the internal and external portions of the canopy is strongly connected with canopy width and dormant pruning technique. The presence of large branches partially obstacles the action of the strings, making thinning absolutely uneven and determining an on/off effect, with the presence of over-thinned and non-thinned areas in the canopy. An excessive canopy width makes difficult the thinning in the central portion of the canopy, where fruit quality is lower due to foliage shading. To effectively perform mechanical thinning is therefore essential to keep canopy width as narrow as possible (1.0-1.4 m) and remove large branches.

For what concerns time of intervention, some authors reported bloom stages as the optimal time for mechanical thinning intervention (Schupp *et al.*, 2008). In North-West Italy this might be dangerous due to spring frost occurrence, which might strongly reduce crop load. Intervention at fruit set was shown not to harm fruitlets as long as they are still protected by dying sepals. This allows intervention delay of about 15 days after bloom, reducing risks deriving from sudden spring frosts and makes mechanical thinning an interesting alternative to hand thinning also in peach production regions characterized by cold springs.

Further research is needed to refine operational parameters and to adjust dormant pruning techniques in order to better adapt orchards to thinning automation.

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Tables

Table 1. Peach and nectarine mechanical blossom/fruitlets thinning by means of Darwin 300 string thinner compared to control in Piedmont, North-West Italy in 2009-2011.

Trial	Thinning treatment	Flowers or fruits density after mechanical thinning (no./meter of branch)[b]	Flowers/Fruits removed (%)
'Magique' nectarine, central leader training	Phase 72[a], 170 rpm - 7 km/h	2.9 b	70.5%
	Control	9.8 a	-
'Magique' nectarine, perpendicular Y training	80% bloom, 150 rpm - 6 Km/h	6.2 ab	46.7%
	80% bloom, 170 rpm - 6/km/h	4.7 b	59.0%
	Control	11.6 a	-
'Magique' nectarine, central leader training	Full bloom, 155 rpm – 7 km/h	12.3 b	37.2%
	Control	19.6 a	-
'Summer Rich' peach, perpendicular Y training	Phase 72[a], 150 rpm- 7 km/h	8.7 b	37.6%
	Phase 72[a], 170 rpm – 7 km/h	8.3 b	40.5%
	Control	13.9 a	-
'Rome Star' peach, perpendicular Y training	Phase 72[a], 170 rpm - 7 km/h	4.6 b	43.7%
	Control	8.2 a	-
'Miluna' nectarine, central leader training	Phase 72[a], 220 rpm - 6 km/h	14.2 b	44.6%
	Phase 72[a], 220 rpm - 7 km/h	17.4 ab	31.8%
	Control	25.6 a	-
'Sweet red' nectarine, central leader training	Phase 72[a], 220 rpm - 5.5 km/h	19.5 b	37.3%
	Control	31.1 a	-
'Big Top' nectarine, perpendicular Y training	Full bloom, 180 rpm – 7.2 km/h	6.7 b	59.9%
	Control	16.8 a	-
'Alitop' nectarine, central leader training	Phase 72[a], 160 rpm - 7km/h	15.0 b	30.2%
	Phase 72[a], 180 rpm - 7km/h	11.2 b	48.2%
	Control	21.5 a	-
'Diamond Ray' nectarine, perpendicular Y training	Phase 72[a], 160 rpm - 6.5km/h	5.5 b	60.5%
	Phase 72[a], 160 rpm - 7km/h	5.2 b	62.7%
	Control	13.9 a	-
'Ufo 3' flat peach, perpendicular Y training	Full bloom, 160 rpm – 6.5 km/h	41.2 ab	14.1%
	Full bloom, 200 rpm – 6 km/h	33.2 b	30.7%
	Full bloom, 200 rpm – 5.5 km/h	31.3 b	34.8%
	Control	47.9 a	-
'Glohaven' peach, perpendicular Y training	Phase 72[a] , 170 rpm - 6 km/h	6.9 b	42.7%
	Phase 72[a], 180 rpm - 6 km/h	6.4 b	47.4%
	Control	12.1 a	-

[a] BBCH scale (green ovary surrounded by dying sepal crown)

[b] One way ANOVA, Tukey post-hoc test; means separation at 5% level.

Figures

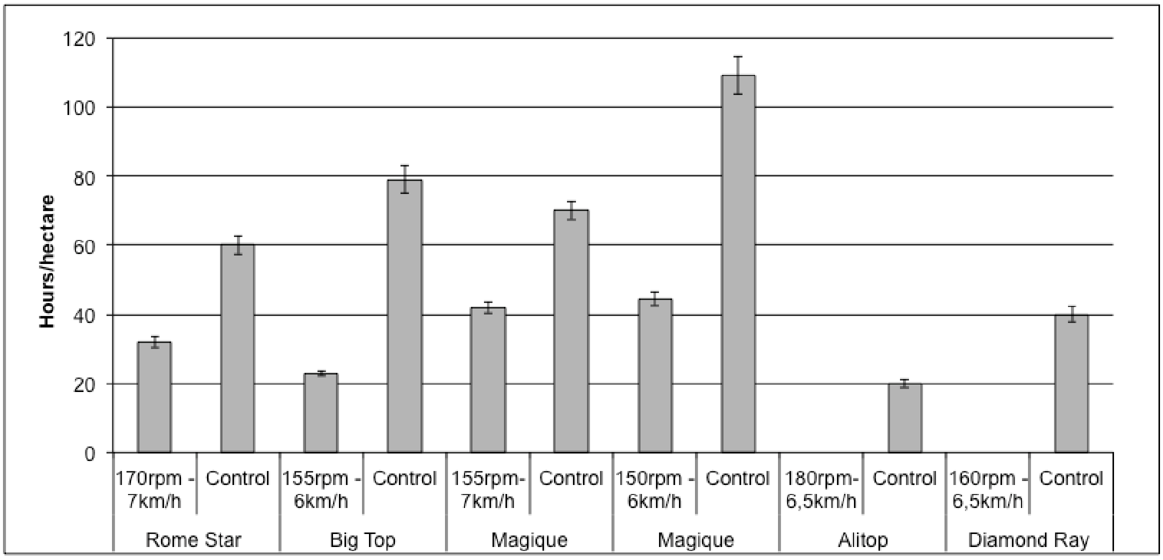

Figure 1. Follow-up hand thinning time (± S.E.) required in string mechanically thinned trees and hand-thinned control trees in Piedmont, North-West Italy in 2009-2011.

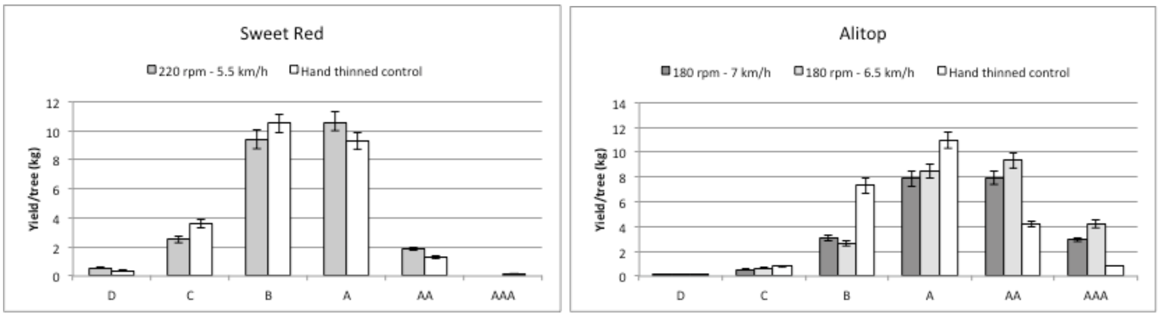

Figure 2. 'Sweet Red' and 'Alitop' nectarines fruit size distribution (kg/tree * size class ± S.E.) in string mechanically thinned trees and hand-thinned control trees in Piedmont, North-West Italy in 2011.

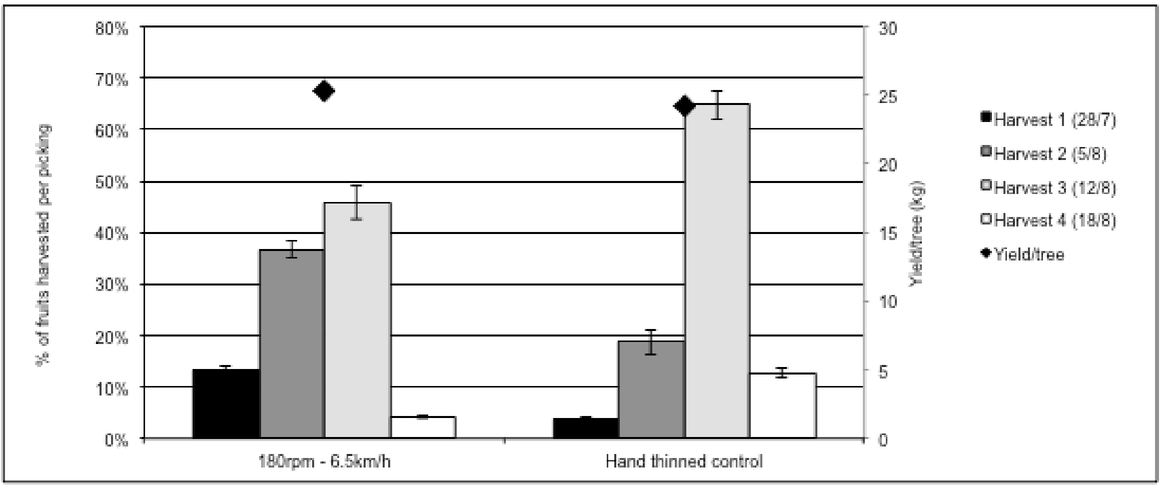

Figure 3. Percentage (± S.E.) of fruits harvested at each harvest on string mechanically thinned trees and on control trees on 'Alitop' nectarine, in Piedmont, North-West Italy in 2009. Yield/tree did not differ between treatments (One way ANOVA