Mechanical Blossom Thinning Using a Darwin String Thinner

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Abstract

The Darwin String Thinner is a mechanical thinning device invented in Germany for blossom thinning of fruit trees. It is composed of many plastic strings, each 1/8" in diameter and 24" long and spaced every inch along a 10' long rotating spindle. Six rows of strings can be placed around the spindle, but we found two opposing rows were sufficient for thinning peach blossoms. The rotation speed of the spindle can be controlled between 150 and 400 rpm. The device is mounted on the front of a tractor and the angle of the spindle can be adjusted between vertical and 35 degrees from vertical. Thus, the machine works best with vertical hedgerow or perpendicular "V" type canopies. By adjusting rotation speed, tractor speed and/or string configuration we found it easy to get thinning results anywhere from few flowers removed to almost all flowers removed.

Demonstrations

The Darwin String Thinner was demonstrated in about 12 orchards during bloom in February and March 2009. Many growers attended and were very interested in the performance of this unit. As long as fruiting shoots were in the path of the rotating strings, a reasonable level of thinning was achieved. At each location, we varied the rotation speed (usually between 200 and 275 rpm) so the growers could assess the performance. Most in attendance felt the Darwin Thinner gave quite consistent results and thus had potential as an aid to hand thinning.

Replicated Trial

A replicated trial was conducted in an orchard of Summer Fire nectarines at the Kearney Ag Center. Trees were planted 6' apart and had been trained to a perpendicular "V" system. They were pruned for this experiment so that most of the fruiting wood was on the outside of the scaffolds. Thus, the Darwin Thinner was able to engage almost all fruiting shoots as it traveled down the row. A given treatment was imposed on a row of 24 trees. Each of the five treatments was replicated in six separate rows selected randomly throughout the orchard.

TREATMENTS

1. **Control -** These trees were not blossom thinned. Normal hand thinning of small fruitlets was performed on April 20 with a goal of leaving 175 fruit per tree.

2. **Treatment 1 -** The Darwin Company recently introduced a new design of molded strings which will be referred to as "New Strings". This treatment tested these new strings with every other one removed (2" between strings) at a rotation speed of 175 rpm and a tractor speed of 2 mph. The treatment was imposed on March 2, close to full bloom. About 25% of the flowers were removed.

3. **Treatment 2 -** The "Old Strings" are threaded through a plate bolted to the spindle and thus are easier than the new strings to change to different configurations. Therefore, treatments 2-4 all used the old strings. Treatment 2 had a pattern of 4 strings (1" apart) followed by a gap of 4 strings (4") and was run at a rotation speed of 200 rpm and tractor speed of 2 mph. It was also imposed on March 2 and achieved a removal rate of about 25%.

4. **Treatment 3 -** The goal of this treatment was to achieve greater thinning in the top of the tree compared to treatment 2. Therefore the gaps in the top half of the spindle were filled in leading to strings every inch. The bottom half of the spindle and all other variables remained the same as treatment 2. Overall, about 35% flower removal was achieved.

5. **Treatment 4 -** The goal of this treatment was to achieve at least 50% flower removal in hopes of eliminating hand thinning. Therefore, everything was left the same as treatment 3 except rotation speed was increased to 275 rpm, which resulted in about 60% flower removal.

HAND THINNING

Summer Fire does not generally have a heavy bloom. In addition, fruit set was a little less than normal in 2009 due to a mild frost event in March. Therefore, by early April it was clear that fruit counts on the trees were not excessive. On the control trees, the thinning crew was able to achieve the goal of 175 fruit/tree and still space fruit well along shoots and throughout the tree. However, to get similar fruit counts on the other treatments, it was clear that different instructions would have to be given to the thinning crew. For treatments 1 and 2, the crew was told to ignore clusters of 2 or 3 fruit and focus their attention only on areas with major fruit crowding. This allowed them to move along much faster than they had on the control trees (Table 1) but they still achieved fruit loads very similar to the control. Treatment 3 also had clusters of fruit throughout the canopy but breaking them up would have reduced fruit counts. Therefore, the project leader thinned all these trees himself with a bamboo pole and no ladder. Only the most obvious situations of fruit crowding were broken up with the pole or by hand. Once again, fruit loads similar to the control were achieved in this treatment (Table 1). Treatment 4 was clearly over thinned by the Darwin Thinner so no additional hand thinning was imposed, even though there were situations of major fruit crowding in many locations within these trees. Overall, substantial savings in hand thinning costs were achieved by treatments 1-3 without sacrificing fruit counts per tree.

Table 1. Percent flower removal, follow up hand thinning time and cost and fruit loads achieved by different treatments with the Darwin String Thinner on Summer Fire nectarine in 2009.

Treatment	Flowers Removed	Hand Thinning	Hand Thinning Cost @ $11.73/hr	Fruit Load Harvested (fruit/tree)
	(%)	(hrs/ac)	($/acre)	(fruit/tree)
Control	0	99	$1161	159
Treatment 1	25	43	$504	154
Treatment 2	25	38	$446	162
Treatment 3	35	9	$106	170
Treatment 4	60	None	$0	125

HARVEST

Out of each row of 24 trees, 10 uniform and contiguous trees were selected for harvest. The fruit were picked as they matured on three harvest dates of 7/23, 7/29 and 8/6. All fruit were run through an electronic sorter, which separated them into 10 size categories. In general all treatments produced good sizes with few small (80s and 70s) and undersized fruit. Treatments 1-3 all had similar total box counts as the hand thinned control (Table 2). However, there was a distinct shift in the distribution among size categories. These treatments had less large fruit (sizes 44 to 36) and more medium sized fruit (sizes 64 and 56). Since larger fruit usually bring a higher price, there was a loss of crop value in all the treatments compared to the hand thinned control (Table 3). For treatments 1 and 2, the loss in crop value basically cancelled out the savings in hand thinning so only a small savings or loss was achieved. For treatments 3 and 4 the loss in fruit value was much greater because of smaller sizes and/or less yield. Thus, the overall net loss on these treatments was substantial.

Table 2. Number of boxes per acre of 10 different size categories harvested from Summer Fire nectarine trees under Darwin String Thinning treatments in 2009. Price/box was the average nectarine price reported by Market News Service during the harvest period.

Treatment	Size										Total
	Under	84	80	70	64	56	50	44	40	36	
Control	3	3	4	8	18	91	277	435	232	40	1,111
1	5	2	5	11	20	95	256	423	213	35	1,064
2	5	4	7	12	25	115	303	415	170	33	1,088
3	11	8	15	27	43	171	309	307	124	20	1,035
4	8	7	14	23	33	113	199	236	109	18	761
2009 Price/box	0	0	0	$12.10	$14.10	$16.10	$17.10	$17.10	$17.60	$17.60	

Table 3. Fruit value and the overall economic savings or loss due to different thinning treatments on Summer Fire nectarines in 2009.

Treatment	Fruit Value	Loss in Fruit Value	Savings in Hand Thinning	Net Savings or Loss
	$/Acre	$/Acre	$/Acre	$/Acre
Control	$18,497	---	---	---
Treatment 1	$17,642	$855	$666	-$189
Treatment 2	$17,886	$611	$721	+$110
Treatment 3	$16,452	$2,045	$1,062	-$984
Treatment 4	$12,050	$6,447	$1,166	-$5,298

LESSONS LEARNED

Clearly the Darwin String Thinner will thin flowers off peach and nectarine trees and do so rather randomly over the area it covers. Furthermore, the level of thinning can be manipulated simply by changing rotation speed, string configuration or ground speed. In 2010 we plan to quantify the effect of these variables on thinning percent and uniformity. This should help growers more precisely set the level of thinning that will achieve greatest effectiveness and profitability.

Probably the most poignant lesson learned in 2009 was different situations where the Darwin Thinner should not be used. First, the tree training system is vitally important. When the Darwin was demonstrated on open vase trees with random scaffolds or on "V" shaped trees with lots of flowers inside the "V", it was clear that not enough fruiting shoots were engaged by the rotating strings. Thus, there would be no substantial reduction in subsequent hand thinning. Second, varieties that do not flower and/or set very heavily would not benefit from the Darwin Thinner. This was certainly the lesson learned from the Summer Fire nectarine trial where adequate fruit counts could only be obtained by leaving clusters of fruit, thus reducing fruit size. Many other trials (in California, Pennsylvania, Washington and South Carolina) have demonstrated that blossom thinning of heavy setting varieties consistently increases fruit size. Therefore, both increased fruit value and reduced hand thinning have been shown, resulting in substantial economic benefit. Third, one demonstration block had over 50% doubles and the Darwin thinning only made it more difficult to find good fruit to leave for harvest. Finally, the Darwin String Thinner was demonstrated on several plum varieties and many, many flowers were removed. However, no differences in fruit set were observed. Therefore, no benefit has been shown with plums so far.

In conclusion, the Darwin String Thinner shows great potential for substantial cost savings when used on heavy setting varieties of peaches and nectarines that have been trained and pruned to position most fruiting shoots in the path of the rotating strings. In 2010 we plan to work in several orchards where this situation exists. The benefit to growers should be clearly demonstrated and details on how to operate and configure the machine should be clearly elucidated.