

PROSULFURON AFFECTS TRUNK SHAKER EFFICIENCY AND YIELDS OF VALENCIA ORANGES

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Abstract. Three replicated, split plot design harvesting experiments were conducted in 1997 and 1998 to study the effects of using prosulfuron abscission chemical and a trunk shaker on the fruit removal efficiency and yield in Valencia orange trees. The 2 main plot treatments were prosulfuron and no prosulfuron, and the subplot treatments were harvesting with a trunk shaker and handpicking. Prosulfuron was sprayed at 30 ppm in 250 gal per acre on 3 dates (late April, mid May, late May) in 1997 and harvested 2 to 3 weeks post spray. Averaged over all 3 dates, prosulfuron increased mature fruit removals by the trunk shakers an average of 6 percentage points from 82 to 88%. In 1998, prosulfuron reduced the yields of the handpicked trees by 15, 34, and 6% at the 3 dates, compared to reductions of 17, 42, and 26% by the combination of prosulfuron and the trunk shaker.

Concerns about the availability and cost of labor for citrus harvesting have prompted the citrus industry to conduct research and development programs since the late 1950s (Whitney, 1995). In 1994, the Florida citrus industry initiated a new research and development program which was administered by the Florida Department of Citrus (FDOC) and mainly involved the development of mechanical harvesting equipment for processed oranges. Field test results on most of the equipment for the 1995-96 and 1996-97 seasons have been reported (Brown, 1997; Peterson, 1997; and Whitney, 1997).

Abscission chemicals were evaluated as aids to Florida citrus harvesting from the late 1960s through the mid-1980s. In the latest field test results (Whitney et al., 1986), abscission chemicals were shown to increase trunk shaker removal of mature Valencia oranges by 17% without subsequent yield reductions. Early in 1997, an abscission chemical (prosulfuron, coded WTX 100) was made available to the FDOC for field testing. It had been reported (Wilcox and Taylor, 1996) to loosen mature Valencia oranges with no phytotoxic effects to young fruit, bloom, and foliage. The objective of this paper is to determine the effects of using prosulfuron and a trunk shaker on removal efficiency and yields in Valencia oranges.

Materials and Methods

In 1997, three field experiments were conducted in a Valencia orange grove located between Sebring and Arcadia. Sixteen ft. tall 10-yr-old Valencia trees on Cleopatra rootstock

planted on 2 row beds were used in the 3 experiments. Trees were spaced 24 ft. between rows and alternately 10 and 15 ft. in-row. Each experiment was replicated 6 times with 2 tree plots (paired trees at 10 ft. in-row spacing). A split plot experimental design was used with the abscission chemical (prosulfuron) and no abscission chemical as the whole plot treatments, and the shaker and handpick as the subplot treatments (a total of 48 trees per experiment).

Prosulfuron (Peak, Novartis) was applied at 30 ppm in 250 gal/acre with a pto airblast sprayer on 9 Apr., 30 Apr., and 15 May (each date an experiment); and the fruit was harvested on 28 Apr., 16 May, and 29 May, respectively. On each harvest date, preharvest mature fruit drop on the trees harvested by the shaker was determined by counting the fruit on the ground before shaking. Detachment pull force of mature fruit was determined using a Hunter Spring Model L-30 M force gauge on 10 fruit from each of 3 sprayed and unsprayed trees. Each of the trunk shaker trees was shaken for 5 sec. A Compton trunk shaker (Compton Enterprises, Chico, California) was used on 28 Apr. and a Fruit Harvesters International trunk shaker (Fruit Harvesters International, Inc., Alva, Florida) was used on 16 and 29 May. Mature fruit removed by the shaker and total mature fruit yields were weighed. Young Valencia fruit (representing next year's crop) removed by the shaker was counted and the range of diameters measured.

In 1998, mature fruit yields of the trees were determined by weighing. All data were analyzed using General Linear Model Procedures in SAS (SAS Institute, Cary, North Carolina). Treatment means were separated for significance as least square means at the 5% level.

Results and Discussion

The 1997-98 harvest results are shown in Table 1. In preparation for the first harvest date in 1997, prosulfuron was applied after petal bloom when most of the young fruit were less than 0.25 inches in diameter. On the first harvest date (28 Apr.), prosulfuron reduced the mature fruit detachment force (FDF) about 10% after 19 days after treatment with less than 5% preharvest mature fruit drop. Mature fruit removal by the Compton trunk shaker was increased less than 4 percentage points (not significant) with prosulfuron. Young fruit diameters ranged from 0.25 to 1.25 inches. Although no counts were made just prior to harvest, it was obvious from observing young fruit on the ground that prosulfuron increased young fruit abscission compared with the trees not sprayed. Prosulfuron-induced peel burn was found on the abscised young fruit. The smaller young fruit appeared to be more susceptible to peel burn and abscission effects. The trunk shaker removed an average of 30 to 33 young fruit/tree.

On the second harvest date (16 May), prosulfuron reduced the FDF by 66% after 16 days after treatment post spray with preharvest drop of 6%. Mature fruit removal with the Fruit Harvesters International trunk shaker was increased by 8.5 percentage points (significant) with prosulfuron, the greatest increase in prosulfuron-induced mature fruit removal of the 3 harvest dates. Young fruit diameters ranged from

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Table 1. Harvest results with Valencia oranges treated with prosulfuron and harvested by trunk shaker.

1997 harvest date	Treatment	Mature fruit detachment force, lb	Preharvest mature fruit drop, %	Young fruit diameter range, inches	Young fruit removed by shaker, no./tree	Mature fruit removed by shaker, %	1997 Mature fruit yield, boxes/tree	1998 Mature fruit yield, boxes/tree
April 28	Handpick	n/a	n/a	n/a	n/a	n/a	3.6 a	4.1 a
	Handpick with prosulfuron	n/a	n/a	n/a	n/a	n/a	3.4 a	3.5 bc
	Shaker	26.6	0.0	0.25-1.25	30 a ^c	83.7 a	3.4 a	3.8 b
May 16	Shaker with prosulfuron	23.3	<5	n/a	33 a	87.3 a	3.5 a	3.4 c
	Handpick	n/a	n/a	n/a	n/a	n/a	3.7 a	3.8 a
	Handpick with prosulfuron	n/a	n/a	n/a	n/a	n/a	3.5 a	2.5 b
May 29	Shaker	29.0	0.0	0.50-2.00	84 a	83.9 a	3.4 a	2.7 b
	Shaker with prosulfuron	10.0	6.0	0.50-2.00	72 a	92.4 b	3.5 a	2.2 b
	Handpick	n/a	n/a	n/a	n/a	n/a	3.9 a	3.1 a
May 29	Handpick with prosulfuron	n/a	n/a	n/a	n/a	n/a	4.0 a	2.9 a
	Shaker	32.0	0.0	0.75-2.125	169 a	79.0 a	4.1 a	2.3 b
	Shaker with prosulfuron	21.8	4.0	0.75-2.125	107 a	83.4 a	3.9 a	2.3 b

^aMean separation of data within dates is by least square means at 5% level of significance.

0.5 to 2 inches. As with the first harvest date, it was obvious that prosulfuron caused increased young fruit abscission compared with the trees not sprayed, and the effects appeared greater on the smaller size fruit. The number of young fruit removed/tree averaged 72 and 84 with and without prosulfuron, respectively.

On the third harvest date (29 May), prosulfuron reduced the FDF by 32% after 14 days post spray with preharvest drop of 4%. Mature fruit removal by the Fruit Harvester International trunk shaker was increased by 4.4 percentage points (not significant) with prosulfuron. Young fruit diameters ranged from 0.75 to 2.1 inches. There was visual evidence of peel burn from prosulfuron on some of the young fruit, and only a small number of the young fruit with peel burn had abscised just prior to harvest. The number of young fruit removed/tree averaged 107 and 169 with and without prosulfuron, respectively.

The 1998 mature fruit yield results from the 1997 harvest treatments are shown in the last column of Table 1. Yields were significantly reduced by prosulfuron (whole plot) on the first 2 dates and by the trunk shaker (subplot) on all 3 dates. Yields of the handpicked check (no prosulfuron) trees were significantly greater than the other 3 treatments except for the last date, when prosulfuron did not reduce the yields of the handpick trees. Comparing the handpicked with and without prosulfuron treatments, the abscission chemical reduced mature fruit yields an average of 18%. The reductions for the first and second dates, 15 and 34%, were significant. These 1998 yield reductions corresponded closely to the 1997 observations made of the effects of prosulfuron on young fruit abscission in that the effects on the first and second harvest dates appeared considerably greater. The greatest reduction on the second harvest date may have been due in part to the magnitude of mature fruit loosening of prosulfuron being higher than the other dates. In addition, the natural young fruit drop of Valencia normally becomes minimal after the first or second week of May, and young fruit removal by chemical or mechanical means during or after this period normally results in greater yield reductions than young fruit removal before that period (Whitney, 1995).

The shaker without prosulfuron reduced 1998 yields an average of 20% overall, or 7, 29, and 26% for the first, second, and third harvest dates, respectively. Yield reductions were greatest for the second and third harvest dates because more young fruit were removed than on the first harvest date during the first 2 weeks of May. Even though the shaker removed twice as many young fruit on the third harvest date compared to the second harvest date, the yield reductions were similar. With prosulfuron, the shaker reduced yields an average of 28%, or 17, 42, and 26%, respectively, for the first, second, and third harvest dates. For the first 2 harvest dates, the additive effects of prosulfuron and the shaker were greater than either one alone, whereas on the third harvest date, the shaker effect was the same with and without prosulfuron.

Conclusions

1. Prosulfuron applied at 30 ppm to young Valencia fruit before late May significantly reduced subsequent mature Valencia yields.
2. Mature Valencia fruit loosening by prosulfuron applied at 30 ppm significantly increased the removal efficiency of the trunk shaker only 1 in 3 harvest dates.

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