

Shaker Stroke Affects Selective Removal of Valencia Oranges

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ABSTRACT

AN experiment was conducted to determine the effect of three shaker strokes with and without an abscission chemical on the selective removal of mature Valencia oranges as measured by subsequent fruit yields. Subsequent fruit yields were reduced an average of 15% over the corresponding initial yield for all shaker strokes. The reduction in yield was less with the 15.2 and 20.3 cm strokes compared to the 25.4 cm stroke shaker treatments. The abscission chemical (RELEASE)[†] did not improve selectivity over no chemical check when the 25.4 cm shaker stroke was used.

INTRODUCTION

Mature Valencia oranges are harvested annually when the next year's young fruit crop is forming on the tree (Coppock and Hedden, 1977). This cultivar characteristics makes non-selective harvesting of mature crops with tree shakers extremely difficult because of the potential removal of next year's crop. To aid in selective removal of only mature fruit, an abscission chemical can be used to loosen the mature but not the young fruit (Wilson et al., 1977). Because of the variability of the limb structure and of the fruit loosening obtained with the abscission chemical, it is necessary that the shaking force transmitted to the tree be closely controlled. The length of the shaker stroke is a design factor which can influence the transmission of the shaking force to the limb (Lenker and Hedden, 1968). Long strokes may cause large limb displacements resulting in whipping an excessive number of young fruit from the limbs. Short strokes may not displace the limb enough to remove adequate numbers of mature fruit.

This paper discusses an experiment to determine the effect of three shaker strokes and abscission chemical on the selective removal of mature fruit as measured by fruit yields.

PROCEDURE

A harvesting experiment was designed to study the

Article was submitted for publication in January, 1985; reviewed and approved for publication by the Power and Machinery Div. of ASAE in May, 1985.

Florida Agricultural Experiment Stations Journal Series No. 6129. Cooperative research by the USDA-ARS, University of Florida, Citrus Research and Education Center, Lake Alfred, and the Florida Department of Citrus.

Trade names and company names are used in the publication solely for the purpose of providing specific information. Their mention does not constitute a guarantee or warranty of product by the U.S. Department of Agriculture, University of Florida or Florida Department of Citrus.

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effect of three shaker strokes with an abscission chemical to loosen the mature fruit, and one shaker stroke without abscission chemical, on selectivity in the removal of mature fruit as measured by subsequent year fruit yield. A 25.4 cm shaker treatment without abscission chemical was included as a check in the evaluation of the abscission chemical effect on selectivity. Also, two handpicked treatments, one with and the other without abscission chemical were included to determine the effect of the abscission chemical only on fruit yield. Five replications of 6 treatments were applied to 30 Valencia trees in a randomized block design. The trees were 65 years old with lower limbs high enough to allow unobstructed movement of the limb shaker. They were maintained under a standard cultural practice for the year before and following the application of the treatments. The treatments were as follows:

- CH - 15 chemical sprayed; 15.2 cm shaker stroke
- CH - 20 chemical sprayed; 20.3 cm shaker stroke
- CH - 25 chemical sprayed; 25.4 cm shaker stroke
- CK - 25 (check) no chemical; 25.4 cm shaker stroke
- CH - HP chemical sprayed; handpicked
- CK - HP (check) no chemical; handpicked

The chemical treated trees were sprayed with an AgTec air carrier sprayer with 38 L per tree of 300 ppm RELEASE (5-chloro-3-methyl-4-nitro-1H-pyrazole) + 0.1% surfactant (ORTHO X-77) 4 days before harvest. Previous experience had shown the above chemical concentration and application rate to be optimum for loosening the mature Valencia fruit.

A tractor mounted inertia limb shaker (Fig. 1) with an adjustable stroke slider crank was used to apply the shaking motion to the tree limbs. The shaker stroke



Fig. 1—Tractor-mounted sliding crank limb shaker used in length of stroke experiment.

TABLE 1. PERFORMANCE OF TREATMENTS

Treatments*	CH-15	CH-20	CH-25	CK-25	CH-HP	CK-HP
M.F. bonding force, N†	11.6	11.6	11.6	67.6	11.6	67.6
M.F. weight, g						204.1
Y.F. bonding force, N	---	---	---	---	---	57.8
Y.F. weight, g	---	---	---	---	---	10.2
Y.F. diameter, mm	---	---	---	---	---	28.4
Shake time, min/tree	0.77	0.60	0.81	1.77	---	---
M.F. removal, %	96.1	96.2	97.6	93.1	---	---
Y.F. removal, no./tree	265	344	352	413	---	---
PYR ‡ §	88 ^{bc}	91 ^{abc}	79 ^c	79 ^c	102 ^{ab}	108 ^a

*Average of 5 trees. Treatment code: CH-Abcission chemical applied; 15, 20, 25 represents 15.24, 20.32, 25.4 length of stroke in cm (crank throw x 2);

HP-Handpicked

†Trees sprayed 4 days before harvest. Y.F.-Young fruit, M.F.-Mature fruit is the average of 40 measurements taken from sprayed trees.

‡PYR - percent yield ratio (subsequent yield ÷ initial yield x 100)

§Means within this row followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

(crank throw x 2) was adjustable to 15.2, 20.3 and 25.4 cm. The total mass of the shaker mechanism was 558 Kg with 184 Kg of this attached to the crank. Rotation speed was held constant at 200 cycles per minute while the operator controlled the time of shaking to achieve a high mature fruit removal rate.

Shaking time, mature and young fruit bonding force, mature and young fruit weight and young fruit diameter were measured. Young fruit which was shaken off the trees was counted and that which dropped later was counted at weekly intervals for 48 days after harvest. The subsequent fruit yield data were collected the following year.

RESULTS AND DISCUSSION

The fruit condition and performance data for the treatments are given in Table 1. The experiment was conducted late in the harvest season (June 5) when selectivity was the most difficult. The young fruit weight averaged 10.2 g and the bonding force averaged 57.8 N. Mature fruit removal averaged 96.5% for the abcission chemical treated trees but was only 93.1% for those trees without abcission chemical treatment. The shake time

was greater for the trees without an abcission chemical. For all chemically treated trees, the mature fruit bonding force was reduced about 81%. The number of young fruit removed at harvest time increased as the shaker stroke was increased from 15.2 to 25.4 cm with the largest number being removed when no abcission chemical was used and the stroke was 25.4 cm.

Fig. 2 shows the accumulative number of young fruit removed at harvest plus those that dropped over 48 days after harvest, the initial mature fruit yield and the subsequent mature fruit yield for the 6 treatments. A larger number of young fruit were removed and dropped after harvest from the shaker treatments than dropped from the handpicked treatments. For the handpicked treatments, a larger number of young fruit dropped after harvest when the abcission chemical was used than when no chemical was used. This indicates that some of the young fruit drop in the shaker treatments may have been caused by the abcission chemical. Subsequent average mature fruit yields were reduced 15 percentage points over the corresponding initial yield for all shaker treatments including the no chemical treatment. Although not significant, there was less yield reduction for the 15.2 and 20.3 cm shaker strokes when compared with the 25.4 cm shaker stroke. There was little subsequent yield difference between the 25.4 cm stroke with chemical and the 25.4 cm stroke without chemical treatments indicating the abcission chemical was of little value other than to increase fruit removal rate and efficiency. For the handpicked treatment, the abcission chemical reduced the fruit yield only slightly over the no chemical check treatment. Sumner and Churchill (1980) reported evidence of Valencia yield reduction from abcission chemical RELEASE.

In conclusion, the limb shaker removal method reduced subsequent mature fruit yields over handpicked, both with and without the use of an abcission chemical. Although not significant, there is a strong indication that fruit yield reduction was less when the 15.2 and 20.3 cm shaker strokes were used and abcission chemical had little effect on selectivity when the 25.4 cm stroke was used.

If percent removal is multiplied by the PYR (Table 1) to get an indication of total recoverable fruit to expect (Whitney, 1976) then the 20.3 cm stroke with abcission chemical was the most efficient with a harvest efficiency of 87.5%.

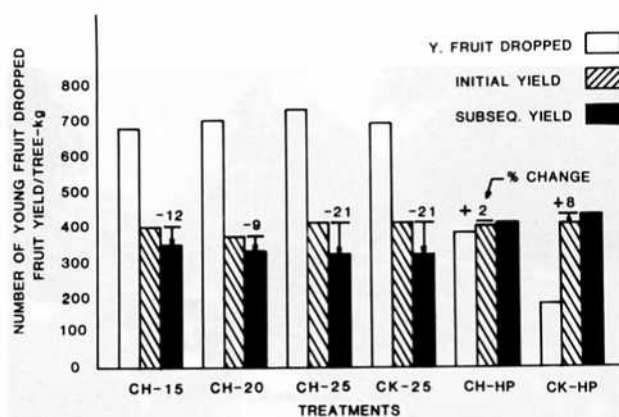


Fig. 2—The effect of 6 harvest treatments on young fruit dropped and subsequent year fruit yield. The treatments were (CH-15) abcission chemical with 15.2 cm shaker stroke; (CH-20) abcission chemical with 20.3 cm shaker stroke; (CH-25) abcission chemical with 25.4 cm shaker stroke; (CK-25) 25.4 cm shaker stroke; (CK-HP) check-handpicked. Young fruit dropped is the number of fruit removed at harvest plus any that dropped over the following 48 days. All values are the mean of 5 replications.

References

1. Coppock, G. E. and S. L. Hedden. 1977. Citrus harvesting in Florida. Proc. Int. Soc. Citriculture. 2:393-397.
2. Lenker, D. H. and S. L. Hedden. 1968. Optimum shaking action for citrus fruit harvesting. TRANSACTIONS of the ASAE 11(3):347-349.
3. Sumner, H. R. and D. B. Churchill. 1980. Subsequent yields of Valencia orange trees sprayed with abscission chemicals. Proc. Fla. State Hort. Soc. 93:53-55.
4. Sumner, H. R. and S. L. Hedden. 1982. Tractor-mounted lin shaker for harvesting citrus. TRANSACTIONS of the ASA 2(25):288-290, 296.
5. Whitney, J. D. 1976. Air shaker harvest trials in Valencia oranges with 2 rates of abscission chemical. Proc. Fla. State Hort. Soc. 89:41-43.
6. Wilson, W. C., R. E. Holm, and R. K. Clark. 1977. Abscissic chemicals - aid to citrus fruit removal. Proc. Int. Soc. Citriculture 2:404-406.