Mechanical thinning of fruits by using electro-magnetic shakers

Report: 2004/2005 – by Uriel Rosa, Jim Thompson and David Slaughter.

A testing unit was assembled and extensive field tests were performed to answer fundamental questions concerned with the implementation of this new technology for thinning of fruits. A 10 inch stroke linear motor was purchased and mounted on the arm of a restored loader used to position the shaker on the branches for the shaking actions. A 10kW tow able electric generator served as the power source to the electric system. The unit was programmed to produce an exact number of oscillations and control their stroke and acceleration. This level of control allowed the individual trees to receive just enough shaking to remove the correct amount of fruit. The precise tree limb shaker did not require clamping action to the limbs. The attachment of the shaker to the limbs did not produce any noticeable bark injury.

A high speed video camera was used to: investigate the clamp-less shaker action on the branch, to study fruit detachment and the path of removed fruits, and to evaluate the effect of horizontal versus vertical limb excitation on long hangers.

Here are the answers for some fundamental questions:

1. Can we use this technology only on "V" or also in regular orchards?

Answer: The field tests indicated this shaker technology can be used on "V" or in regular orchards. However, when the equipment is used on trees with long hangers, the unit is capable of removing fruits by shaking in the vertical direction, but positioning of the shaker is difficult.

2. Can we avoid removal of fruits from the top of the tree?

Answer: We have found two possible ways of removing more fruits from the middle of the branch without removing fruits from the top of the tree:

a) We restrained the top of the branch with a regular trunk shaker and excited the middle of the branch with our shaker. Almost no fruits were removed from the top of the tree.

b) A very hard hit was accidentally applied to the middle of a particular branch producing a big impact that removed mostly middle fruit while the top of the branch did not vibrate much (this needs to be investigated further).

3. Can the sensor detect change in fruit mass as fruits are removed?

Answer: Experimental lab and field test results on prunes indicated that the unit can actually measure the amount of fruit removed. It lightly taps a limb "measuring" its natural frequency. This is repeated after some fruit is removed and the change in natural frequency is related to the amount of fruit removed. Our goal is to come up with an automated procedure to consistently determine the proper amount of thinning on each limb.

4. Can some shaking frequencies remove smaller fruits rather than bigger ones?

Answer: At this point we did not find any conclusive indication that some frequencies would be able to remove smaller fruits rather than bigger ones. However, a good approach would be to try to thin the crop early when the fruits are not too big. Prune sizes at thinning time do not differ too much, besides fruit count has been important on prunes.

5. What is the frequency range and stroke for fruit removal during thinning?

Frequency for efficient shaking of prune limbs ranged from 12 to 14 Hz. Long stroke helps positioning the shaker on the branch. The required vibration amplitude may range from one to one and a half inches.

Extensive number of tests was performed in four different locations during the 2004/2005 season:

1) Joe Turkovich's prune orchard in Winters during mid June 05, and other cling peach and nectarine orchards in April and June at the UCDavis Pomology fields, at the Wolfskill Experimental Station in Winters, and in commercial orchards at the Garden Highway in Yuba City.

This method seemed to show particularly encouraging results for application on prune orchards where the total amount of fruit could be precisely removed with application of short time excitations. Future work is looking at controlling location of fruit removal and developing automated placement of the shaker on the limbs.