Final Report, Project No. 98-KS-o2: Reducing Shaker Injury

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Summary

Over the past few years, the Almond Board of California has supported research to determine how much water stress is needed in order to reduce barking injury, but this research has uncovered the surprising fact that water stress at harvest may not be related to barking injury at all. In 1997 and 1998, experimental plots in an almond orchard in Bakersfield, CA, were assigned to three different irrigation regimes: wet, medium and dry, with pre-harvest irrigation cutoffs of about 2, 9 and 21 days, respectively. All treatments included mature trees (about 25 years old) and a number of 4-7 year old replant trees. Most trees were normally shaker harvested, but a group of 28 trees (14 older trees, 14 replant trees) were harvested by shaking at a high pressure (2000 psi) for a long period (15 s) to attempt to actually cause damage. Surprisingly, there was no shaker damage observed in any tree regardless of tree age, irrigation treatment, or severity of shaking. These results do not support the commonly held belief that irrigation cut off is necessary to strengthen almond bark and to reduce tree susceptibility to shaker injury. It is clear that a better understanding of bark strength in almond is needed in order to develop management strategies that consistently minimize shaker injury. Research in 1999 will test these results in additional sites, and will test some alternative irrigation practices designed to reduce hull rot by withholding irrigation during the hull split period.

Introduction

Trunk shakers are used for harvesting almond trees, and even though shakers are economical, they also may cause damage to almond bark. The clamp pads compress the bark and deliver a strong jolt to the tree trunk. This combination can crush the cambium and/or remove bark. Such damage probably inhibits the tree's ability to transport nutrients to the roots. In addition, fungal and bacterial diseases such as Ceratocystis can enter the tree through the damaged bark and ultimately kill the tree. Clearly, improper shaker operation as well as improper pad design can easily damage the cambial zone.

Irrigation cut off as well as Ethephon application could be reasonable cultural practices to increase the bark strength. These cultural practices could be of long term economic value to growers. On some occasions we have experimentally increased bark strength with local application of Ethephon, but we are not yet able to test this on a commercial scale. There were three main objectives of this project: , 1) to continue testing for an effect of irrigation management on shaker injury, 2) to develop a method for measuring the strength of the bark under field conditions that will be related to the damage susceptibility of the tree, and 3) to document the effect of Ethephon application on bark strength.

Results (Objective #1):

Plots in an almond orchard in Bakersfield were assigned to three different irrigation regimes: wet, medium and dry. The wet treatment was full irrigation to within 2 days of harvest, the medium treatment was normal irrigation cut off (9 days) and the dry treatment was a 21 day cut off. All treatments included mature trees (about 25 years old) and a number of 4-7 year old replant trees. Because of the problems with the irrigation system, all treatments experienced some stress during mid-July. A total of 408 trees were included in the evaluation of shaker damage, 296 older trees and 112 replant trees. Most trees were normally shaker harvested, but a group of 28 trees (14 older trees, 14 replant trees) were harvested by shaking at a high pressure (2000 psi) for a long period (15 s) as was done in previous studies, to attempt to cause damage.

There was **no shaker damage** observed in any tree regardless of tree age, irrigation treatment, or severity of shaking. These results are in agreement with those found in 1997, and do not support the commonly held belief that irrigation cut off is necessary to strengthen almond bark and to reduce tree susceptibility to shaker injury. It is clear that a better understanding of bark strength in almond is needed in order to develop management strategies that consistently minimize shaker injury.

Results (Objective #2):

The second objective has three stages, 1) to develop a reliable laboratory method for sample preparation, 2) to measure the strength of the bark sample with a device that can be used under field conditions and compare the result with a standard engineering device (the Instron), and 3) to relate the measured bark strength to the susceptibility of the tree to barking damage under field conditions. For the first stage, a sharp cutter was used to remove the bark surrounding the section to be tested. The upper edge of the test section was cut as straight as possible so that the distribution of the test load would be uniform along the bark section. The length of the cleaned space below the bark section was at least the same length as the bark section to allow the section to move down freely when the load was applied. This was particularly important when using the field-portable device. The section size was approximately 0.4" x 0.6", but in each test the exact area was measured by a caliper to calculate the shear stress.

Shear stress = (force causing the section to fail)/section area

For some samples an "L" shaped piece of aluminum was used to support the test bark section. The aluminum matched the area of the bark section so that the width of this L shape was resting on the upper edge of the section to be tested. A fast-setting (5 minute) epoxy was used to glue the metal piece to the outside of the bark. Some tests were done with epoxy and others were done without epoxy. The epoxy was applied to the bark section for four reasons: 1) to avoid sample buckling when applying the shearing force, 2) to get a uniform shear stress along the cross section of the bark, 3) to assume the bark will behave as elastic material, and 4) to have a minimum distance between the center of shear force and the cambial sheared area so as not to create a moment (causing the section to open from the top).

For the second stage, 87 successful tests were carried out comparing the Instron to a field portable, hand device. Each sample was divided into units. Each unit had four sections to be tested. Half of the unit was assigned to be treated with the aluminum support and the other half without. Also in each half of each unit, which contained two sections, one section was sheared by Instron and the other section was sheared using the hand device.

There was a significant effect of using the aluminum support, but no difference between the hand device and the Instron (table 1). Based on the failure patterns observed when using the Instron device (data not shown) we believe that the aluminum support is necessary for the accurate measurement of bark strength, and we will use this method in future research.

Table (1) Effects of support method and measurement device on measured bark strength (data collected March 6 to March 26 1998)

Support Method	N	Measured Bark Strength (KPa)*
Aluminum "L"	(38)	597 a
No Support	(49)	529 b

Measurement Device	N	Measured Bark Strength (KPa)*
Field-Portable Hand Device	(45)	564 a
Instron	(42)	553 a

*Means with the same letter are not significantly different at P<0.05 DMRT.

(Objective #3)

Two concentrations (500 and 1000 ppm solution) of Ethephon solution were applied to almond tree trunks and in some cases large scaffold branches, in experimental plots at Davis, CA. With each two treatments of Ethephon, one control was assigned by spraying water only. After two weeks, the bark strength was measured in the field. A total of 4 comparisons were made in 1998, but only the comparison made in August (table 2) showed a significant increase in bark strength over the control. In all other dates that were later in the season (e.g., October 14, Table 2) the control bark strength had increased substantially, and there was no effect of Ethephon on bark strength. In no cases of this or earlier research, have we ever observed any of the phytotoxicity symptoms (e.g., gumming) that can occur when Ethephon is sprayed on the tree canopy. This is not surprising, since spraying Ethephon directly on the trunk would be expected to have minimal influence on the rest of the tree. Earlier research has shown Ethephon to significantly increase bark strength in almond stems, and in no cases have we found a significant negative effect (reduction) of Ethephon on bark strength. We believe that larger scale studies will be necessary to determine if Ethephon can be developed as a practical tool to increase bark strength and to reduce shaker injury, particularly on young almond trees.

Table (2) Effects of Ethephon on bark strength in trunks for two measurement dates

Date	Ethephon treatment (ppm)	(N)	Measured Bark Strength (KPa)*
Aug. 4, 1998	1000	3	597 a
	500	4	439 b
	0	3	433 b
Oct. 14, 1998			
	0	3	765 a
	500	4	706 a
	1000	4	695 a

*Means with the same letter are not significantly different at P<0.05 DMRT.