1997 Final Report, Project No. 97-KS-o2: Reducing Shaker Injury

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Introduction

Shaker damage (barking) during almond harvest can reduce tree health and productivity, and any reasonable cultural practice to increase bark strength could be of long term economic value to growers. It is widely recognized that incorrect pad design or improper shaker operation can cause barking under most conditions, but it is also believed that well irrigated trees are more susceptible to barking than water stressed trees. After a number of experimental tests since 1990 however, neither we nor other researchers have been able to document any decrease in shaker injury with irrigation cutoff, nor have we been able to measure (with force gauges) any increase in bark strength under conditions of long or short term water stress. On some occasions we have experimentally increased bark strength with local application of ethephon (to the trunk only), but this has not had a measurable influence on the degree of shaker injury. There are two main objectives of this project: 1) to continue testing for an effect of irrigation management on shaker injury, and 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.

Results (Objective #1)

In cooperation with Paramount farms, a mature, low-volume sprinkler irrigated orchard was chosen in the Shafter area, and 3 irrigation cutoff treatments (3, 5 and 15 days) were applied prior to harvest. Tree water stress was measured using the midday stem water potential method, and just after an irrigation (e.g., Table 1, August 4 measurement), the values obtained were close to those expected for fully irrigated trees. Overall water applications were well matched to the seasonal ET values obtained from a nearby CIMIS weather station, and even though on average the trees of all treatments were under some level of water stress compared to fully irrigated trees, by the planned harvest date (Aug. 19/20), trees in the three treatments were experiencing progressively more stress with longer cutoffs. There was some tree-to-tree variation in water stress within each treatment, but within the wettest treatment (3 day cutoff) some trees did exhibit the level of stem water potential expected for a well watered tree.

A large portion of the plot (3,500 trees) was unexpectedly harvested on August 18, which was only **36 hours** from the last irrigation in the late cutoff treatment. The remaining portion of the plot (500 trees) was harvested on August 20. **No shaker damage** was observed in any tree, and this included some young replant trees (approximately 7th leaf) which were part of the group that were harvested on August 18. In addition to these standard commercial harvests, a group of 33 unharvested trees were each shaken at a high pressure setting (1800 psi) for 15 seconds, as was performed in the 1995 shaker injury trial, to attempt to induce shaker injury. None of these trees were damaged. These results were surprising, particularly that relatively young trees were not damaged, even though they had been given 2.9" of water within 36h of harvest.

The level of shaker injury that had occurred in 1995 and 1996 was also evaluated in an irrigation management experiment that had been conducted since 1995 by I. Klein, G. Esparza, S. Weinbaum and T. DeJong. This experiment consisted of a Full Irrigation treatment (1.35 inches of water every five to six days), a Moderate Stress treatment (withholding two irrigations prior to harvest), and a Severe Stress treatment (withholding three to four irrigations prior to harvest and one irrigation after harvest). The level of injury was scored both as the total number of injured trees (as a percent) and for those trees showing injury, the approximate percent of the trunk area that was affected. No statistically significant differences in either measure of injury was found for the different irrigation treatments of this study (Table 2).

These results are consistent with previous findings, and suggest that if water management is related to shaker injury susceptibility, it may be related more to long-term water management than to short term, irrigation cutoff water management.

(Objective #2)

An Instron device was modified so that the shear failure patterns of sections of almond bark could be accurately determined under laboratory conditions. Previous to this, we had developed a field-portable hand operated device, but that device only registered the maximum force that occurred during the measurement. For some measurements (Fig. 1A) we have found a progressive increase to a clear maximum followed by a failure, but we have also found evidence that the separation between wood and bark may be more complex than previously assumed, because many of the measurements (Figure 1B) do not show this pattern. We will continue to develop this method so that the failure patterns of intact bark under field conditions can be determined. In addition to measuring the force during failure however, a novel method was tested in which a sensitive ultrasonic "microphone" was attached to the bark during the failure test. This technology (called Ultrasonic Acoustic Emission Detection) is used to determine when building materials such as metals or concrete begin to experience fracture when stressed, and if the fracturing between wood and bark could be detected, then this technology would be useful for an instrument to measure bark strength, and might even be applicable as part of an alarm system on shaker equipment. It has been used to measure water stress in trees (by listening to the sound of the water columns breaking), but to our knowledge has never been tested to measure bark failure. Unfortunately, the device was unable to detect any meaningful signal when the bark was failing under laboratory tests (as in Fig. 1), and so it does not show any particular promise in the area of bark failure in almond.

Table 1. Water applied to the different irrigation cutoff treatments (early, middle and late cutoff), and the resulting value of tree water stress (midday stem water potential) at various times in those treatments. A reference value for a well irrigated almond tree that would be expected for each measurement date is also shown. In Almonds, a reduction from about -0.8 to -1.8 (as on Aug. 19/20 for the difference between the well watered and the medium cutoff treatment) would correspond to about a 50% reduction in leaf stomatal opening and overall tree growth.

Date	Seasonal Crop Water Demand	Seasonal Crop Water Applied to Treatments	Midday Tree Stress, by Stem Water Potential (MPa)			
			Early Cutoff (15 days)	Medium Cutoff (5 days)	Late cutoff (3 days)	Well Watered Reference Value
Aug. 4	31"	35.2" (L, M, E)	-1.16	-1.21	-1.22	-0.94
Aug. 11			-1.97	-1.78	-1.78	-0.65
Aug. 12	32.8"	37.4" (L, M)				
Aug. 15			-2.23	-1.76	-1.73	-0.98
Aug. 16	33.7"	40.3" (L)				
Aug. 19/20 (harvest)			-2.22	-1.84	-1.48	-0.85

Table 2. Evaluation of shaker damage caused in the 1995 and 1996 seasons to trees in three contrasting irrigation regimes.

Treatment	Total # of Trees	# of Trees Showing Damage	% of Trees Showing Damage	Approximate Area of Trunk Affected (%)
Full Irrigation	170	24	14%	18%
Moderate Stress	170	15	9%	19%
Severe Stress	102	13	13%	18%

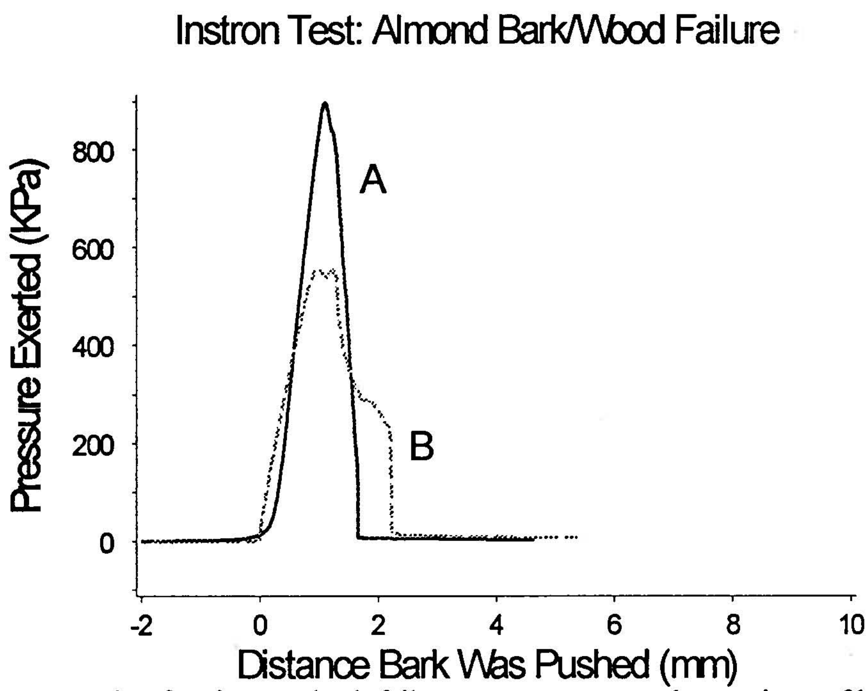

Figure 1. Example of an instron bark failure test on two nearby sections of bark (A, B) on the same section of trunk.