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Reassessment of Potassium Critical Values

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Executive Summary
In 1998, our efforts in the field concerned obtaining baseline yields for individual trees, beginning to establish differentials in tree K statuses, and a pilot thinning project to investigate the relationship between crop load and leaf potassium values. In the laboratory we analyzed samples from sequentially-excavated trees to determine the seasonal patterns of potassium uptake, distribution, and any storage mechanisms. Thus far in 1999, we have applied all treatments and commenced leaf/fruit sampling on a bi-weekly basis.

Objective 1
To reassess leaf K critical values – that is, the leaf K concentration below which yields are affected adversely; also to determine the relative sensitivity of the various yield parameters to K insufficiency.

Progress
Yield-dependent parameters include: number of flowers, number of fruit retained, and fruit weight. Current U.C. guidelines suggest that almond trees with July leaf concentrations of 1.4% K+ or above had sufficient potassium to attain maximum yield. Some members of the almond industry believe leaf concentrations above 1.8% support greater yields.

Experimental Time Frame

1998:
Establish individual tree baseline (pretreatment) yields.

1998 & 1999:
Establish a range of July leaf K concentrations between 1% and 2% by applying differential rates of potassium fertilizer to a low-K+ orchard.

1999:
Determine the relative sensitivity of yield-dependent parameters to insufficient potassium.

1999:
Relate the relative change in tree yield (i.e. between yield in 1999 and baseline yields) to leaf K+ concentrations in order to reassess the validity of the currently-accepted critical values.

Objective 2
To obtain seasonal patterns of leaf K concentration and establish early season critical values.

Progress
By sampling leaves and fruits frequently throughout the season, we can determine their patterns of accumulation/depletion of potassium (seasonal curves) on a concentration (%) and mass (weight in grams) basis. We will generate four curves based on the differential K+ application rates. We may then be able to predict July leaf K+ concentrations from early season samplings.

Potassium fertilization commenced in May of 1998, at 0, 100, 200, and 300 pounds per acre applied over a six week period. July leaf sampling of all trees revealed an average potassium concentration of 1.1% for unfertilized trees and 1.3% for fertilized trees at all three rates (concentrations ranged from 0.9% to 1.8%). This may indicate a limited tree demand for potassium between May and July, or delayed K+ availability and uptake under this application regime in this particular soil. At hull split (July 23), fruit samples were taken from unfertilized trees and trees receiving 200 pounds of K+ per acre. There were no differences in fruit potassium concentration.

Because the data above and those presented under objective 4 indicate that soil solution potassium must be available in the early spring, we began applying this year's fertilizer much earlier (two-thirds on February 26, 1999 and one-third April 29). In order to establish a broad differential in leaf potassium concentration between unfertilized (control) and fertilized trees more quickly, we have increased the application rate substantially, to 100, 300, and 500 pounds of elemental potassium per acre.

We began sampling leaves and fruits on April 6, and sampling will continue bi-weekly through the post-harvest period.

Objective 3
To assess the impact of crop load on leaf K critical values.

Progress
Expanding leaves are potassium "sinks" in the spring, meaning they accumulate potassium. They are presumed to become potassium "sources" later in the season, because some of the potassium contained in leaves may be redistributed to developing fruit. It follows, then, that a heavy crop load (higher fruit:leaf ratio) may demand more leaf potassium than a light crop load (provided that soil uptake cannot satisfy the total fruit K+ demand). This difference in fruit K+ demand would be reflected in leaf K+ contents, thus trees with heavy crops may have lower leaf potassium concentrations than trees with lighter crop loads.

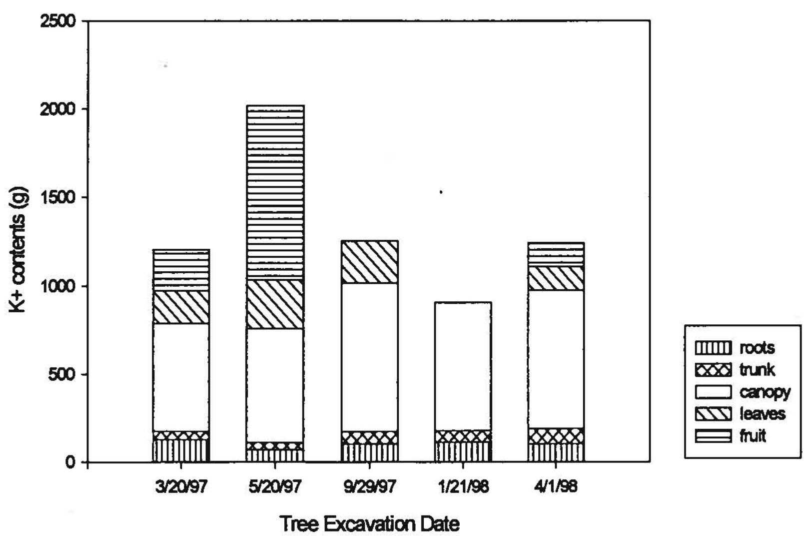
In April of 1998, we chose 10 heavily-cropped 'Monterey' trees and removed (thinned) two-thirds of the fruit from five of them. Samples taken at the time of thinning, and monthly thereafter, revealed no differences in leaf K+ concentration. Perhaps the unthinned trees had sufficient potassium supply from the soil despite the fact that fertilizer had been withheld. It is also possible that the potassium requirement of the fruit had been satisfied prior to thinning, or fruit load was not great enough to impact leaf K+ concentrations.

On April 13, 1999 we chose five pairs of 'Nonpareil' trees from unfertilized plots with similar 1998 leaf K+ concentrations. One tree from each pair was chosen at random for thinning to approximately 50% of initial crop load. On the date of thinning, the fruits were still relatively small in size, but distinguishable from fruits that would eventually abscise. With crop load either very high or moderate and with low potassium availability, we can make a better determination of the effect of crop load on leaf potassium contents.

Objective 4
To determine the seasonal patterns of K accumulation and the magnitude of K demand by fruit, leaves, and perennial tree parts.

Progress
We analyzed samples from whole tree excavations conducted by Qinglong Zhang at the Delta College's Regional Almond Variety Trial for their potassium contents. The data obtained indicate that potassium accumulation by fruit is substantial and continues throughout fruit development (figure 1). The potassium requirement of leaves, on the other hand, is smaller and is satisfied early in the growing season (figure 1). Under the record cropping conditions of 1997, leaf K+ content did not decrease during fruit development (figure 1).

Figure 1. Whole Tree Potassium Contents By Organ
(five tree averages)



Based on individual-tree harvest data, we estimated the potassium accumulation by fruits and the daily uptake rates of K+ (table 1). An estimate of the total potassium removal by fruit for this orchard is 291 pounds per acre, based on a projected yield of 4335 meat pounds per acre. The estimate is based on five healthy, mature trees in an orchard planted at 75 trees per acre during a record year for almond yield; smaller trees, diseased trees, and missing trees would reduce the yield and potassium removed in an actual acre of trees.

Table 1. Cumulative fruit potassium accumulation and daily uptake rates during three periods of fruit development (five tree averages).

Date	Fruit K+ Accumulation ($lb \cdot acre^{-1}$)	Uptake Rate ($lb \cdot acre^{-1} \cdot day^{-1}$)
budbreak --3/20	38	0.76
3/20 -- 5/20	124	2.10
5/20 -- 8/29	133	1.30

Analysis of leaves and fruits collected in 1999 (see objective 2) will allow us to refine our understanding of the seasonal patterns of K+ accumulation, distribution, and removal.

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