Avocado Tree Decline:

What's Happening to Our Trees?

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In late 2015, the California Avocado Commission (CAC) started to hear reports about fairly widespread tree decline, particularly in Ventura County and northern growing areas. Symptoms begin as wilt – maybe some tip burn – with the trees declining rapidly, often resulting in death. In an example of Mother Nature's equitability, CAC has not been spared from this issue, with a number of trees at CAC's Pine Tree Ranch demonstration grove in Santa Paula falling victim. But exactly what is happening?

In early November a number of trees in the mature block at Pine Tree Ranch were wilted. On an earlier visit in mid-October there were no signs of wilting and all the trees appeared healthy, so these symptoms had developed quite quickly. The declining trees showed symptoms of wilt, tip burn and had few, if any, healthy roots in the top few inches of soil. The endpoint of this decline was apparently death and several trees had already reached this point. To add insult to injury, the declining trees all had a good to heavy crop load.

An initial inspection of the block in November did not find any issues with the irrigation system, and it was suggested that the decline may be related to the recent pesticide trunk-injection treatments that were conducted on some of the trees. A tree-by-tree survey of the block on December 8 found that both treated and untreated trees were declining. Some of the declining trees were more than five trees and several rows away from the nearest pesticide-treated tree, ruling out the treatments as the cause of the decline.

To try to determine the cause of the decline, an initial soil sample was taken on December 8 and analyzed by Fruit Growers Lab (FGL) for electrical conductivity (EC). The results of those tests were inconclusive, but suggested that there may be elevated salinity in the soil beneath the declining trees. A more comprehensive sampling was performed by FGL on December 11, collecting leaf, soil and root samples from five pairs of healthy and declining trees across the block. These samples were submitted for comprehensive soil, leaf group plus chloride, and Phytophthora analysis. Additionally, water samples were taken from both wells on the property on January 6 and submitted to FGL for an ag water suitability test.

The leaf analysis data showed a few significant differences in nutrient content between the healthy and declining trees, but, with a couple of exceptions, all of the nutrient levels were within the optimum range for both the healthy and declining trees. Phosphorus (P) levels were low in the declining trees, but not deficient. Leaf chloride (Cl^-) levels were high in the declining trees (0.402%) compared with the healthy trees (0.208%), which is consistent with the tip burn symptoms. The Cl^- levels in declining trees are right at the threshold value of 0.5% established by David Crowley's recent work (see *From the Grove*, Fall 2015). However, leaf sodium (Na) levels were very low in all samples (0.006-0.008%).

Similar to the leaf analysis, there were some differences in the soil analysis for macronutrients between healthy and declining trees, particularly among the soluble potash (K_2O), calcium (Ca), magnesium (Mg) and Na. In all cases, the soluble forms of these nutrients are higher in the declining trees than the healthy trees. However, this may be an artifact of the poor health of the trees and their inability to take up these nutrients from the soil solution.

Among the micronutrients in the soil analysis there is little of note with the exception of Cl^- (Table 1). Although not statistically significant, Cl^- is numerically higher in the declining trees, and for both healthy and declining trees,

soil Cl^- levels are at the high end of acceptable limits.

Soil chemical properties are shown in Table 2. In both healthy and declining trees, the soil pH is slightly higher than optimal (optimal 6.0 – 7.5). Salinity is significantly higher for the declining trees, well exceeding the upper threshold limit of 2.0 dS/m. And the soil salinity of the healthy trees is also on the edge of being problematic.

The tests for *Phytophthora cinnamomi* indicate that the pathogen is present in some apparently isolated areas of the block. Four of the 10 samples collected (five healthy, five declining) were positive for *P. cinnamomi*, but of these samples two were healthy and two were declining. Thus, it does not appear that *Phytophthora* is the cause of the observed decline, but may be a contributing factor for some trees.

There are two wells on the property that water samples were taken from in early January. The large well on the upper part of the property was used to irrigate the entire grove (CAC's portion as well as Cal Poly's portion) until June 2015. In June 2015, the smaller well located nearer the front of the property was repaired and became the primary water source for CAC's portion of the grove.

The results of these water analyses show striking differences in the water quality between the two wells. The large well had an EC of 1.09 dS/m and a pH of 6.6, with 65 ppm Na and 35 ppm Cl^-. However, the small well had an EC of 2.12 dS/m and a pH of 6.9, with 85 ppm Na and 79 ppm Cl^-.

These values are interesting particularly in the context of David Crowley's Fall 2015 article in which he wrote, "Yields can be maintained at leaf nutrient analysis values as high as 0.5 percent for leaf chloride, but this becomes increasingly difficult to achieve as irrigation water chloride levels go above 80 ppm." Based on what we are seeing at Pine Tree Ranch, Crowley's analysis seems to be spot on.

Taking everything into consideration it appears that we have a pretty good picture of what has happened at Pine Tree Ranch. Starting in June 2015, the trees were being watered with poor quality water. We have now gone through four years of historic drought and the only water available to trees is what is provided by irrigation. There was a late-season heat wave that hit in mid-October with temperatures as high as 106 °F for several days. When coupled with a heavy crop load, these factors – and perhaps a little *Phytophthora* – combined to create a perfect storm that shocked the trees and caused them to rapidly decline. In early January, the ranch received more than 6 inches of rain with another 2+ inches falling later in the month. This temporarily relieved some of the stress on the trees and they seemed to perk up again. However, a dry February caused them to go back into wilt, suggesting that the damage is permanent.

The events that came together to cause the tree decline at Pine Tree Ranch may not be the same as what all growers are experiencing. However, the scenario of a prolonged drought coupled with a myriad of other stresses – *P. cinnamomi*, botryospaeria, salinity, heat, crop load, *P. mengei* and others – appears to be taking its toll on avocado trees. Each of these factors in and of itself may be manageable, but together they are dealing our trees a one-two punch. As El Niño fizzles and the drought continues, it will be imperative for growers to recognize the suite of stresses their trees are experiencing and take steps to mitigate those they can. Praying for rain wouldn't hurt either.

Table 1. Pine Tree Ranch soil micronutrient analysis for healthy and declining trees sampled on Friday December 11, 2015. Data represent the means of five samples collected from beneath five trees of each health status.

Tree Health	Zn	Mn	Fe	Cu	B	Cl^-
	-- Lbs/AF --					
Good	38.08	21.04	72.40	42.64	0.878	410.6
Poor	35.60	21.20	67.28	36.88	0.984	516.2

Table 2. Pine Tree Ranch soil chemical properties for healthy and declining trees sampled on Friday December 11, 2015. Data represent the means of five samples collected from beneath five trees of each health status.

Tree Health	CEC (meq/100g)	pH	Salinity (dS/m)
Good	14.44	7.61	2.044
Poor	17.32	7.63	2.836
	ns[z]	ns	*

[z]ns or *: Statistically non-significant or significant differences, respectively, between means of each nutrient at the 0.05 level.