
Lower Limb Dieback in Almond

Project No.: 08-PATH6-Lampinen

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Objectives:

Growers in the Sacramento and San Joaquin Valleys have been noticing increasing dieback of lower limbs on almond trees. Beginning in late April, lower canopy leaves on affected branches begin to yellow and drop off while some leaves dry and remain hanging on the affected shoots. Eventually, entire limbs dieback and by late summer significant death of lower canopy wood can occur. Necrotic brown lesions can occur under the bark, primarily on the tops of the limbs around lenticels. Frequently wedged-shaped cankers are also visible on cross sections of affected limbs. Isolations from samples of the affected tissues have, in some cases, indicated the presence of both *Botryosphaeria dothidea* and *Phomopsis* spp. These fungi have been reported to cause canker and other diseases on almond in California and in Europe, Australia, and South America. Although both fungi have been isolated at incidences up to 50 to 70%, isolations from Lower Limb Dieback-affected shoots have not been consistent among all affected orchards monitored.

Lower Limb Dieback (LLDB) seems to be most pronounced on the Butte and Padre varieties but has also been observed on Aldrich, Fritz, NePlus Ultra, Nonpareil, Sonora and other varieties to a lesser degree. Growers in Stanislaus County suggest the problem usually starts when Butte/Padre orchards reach about 7 to 8 years of age and continues to get worse as the orchard ages. Several growers have indicated that the problem is worse in heavily shaded blocks although this does not always seem to be the case, particularly in Butte County orchards.

The objectives of the current study are to investigate Lower Limb Dieback, determine the causative factors and develop methods to overcome the problem.

Interpretive Summary:

For detailed results from the 2007 season, see the annual project report, 07-PATH6-Lampinen on the 07-08 Final Report CD with this 2008 Conference Proceedings.

In 2008, three orchards in Stanislaus County and two orchards in Butte County, all with a history of Lower Limb Dieback, were monitored. All of the Stanislaus County orchards were flood irrigated Butte/Padre plantings. Stanislaus orchard #1 was the only orchard that was also studied last year. Both Butte County orchards had both microsprinkler and doubleline drip systems. The microsprinkler systems were mainly for frost protection but were also used extensively for irrigation in the Butte County orchard #2 in 2008. Butte County orchard #1 consisted of Aldrich, Butte, Nonpareil and Peerless. All four varieties were monitored in this orchard. Butte County orchard #2 consisted of Butte, Carmel, NePlus Ultra, Nonpareil and Sonora. All varieties were monitored in this orchard as well.

Midday stem water potential was measured on bagged lower canopy shaded leaves between 1:00 and 3:30 pm. Overall orchard midday light interception and light interception under the tree canopies were measured with an Accupar light bar (Decagon Devices, Pullman, WA 99163 USA) within 1 hour of the time the sun was directly overhead. Midday stem water potential and light measurements were done approximately every two to three weeks during the growing season.

All trees were rated for Lower Limb Dieback symptoms on each day water potential and midday light interception was measured. A rating of zero indicated no Lower Limb Dieback was observed, a one indicated one limb of approximately one inch in diameter was exhibiting symptoms (or a number of smaller limbs that added up to the same leaf area as a one inch diameter limb), a two indicated two limbs were impacted, etc. Ratings only indicated new occurrence of Lower Limb Dieback symptoms (i.e. branches that already had brown leaves were not counted).

Results:

Stanislaus County Orchards.

Midday stem water potentials in all three Stanislaus County orchards ran significantly wetter than the fully watered baseline during the April to June period (Fig. 1). Stanislaus County orchard #1 continued to run wetter than the baseline throughout most of the season. It also had the most severe Lower Limb Dieback symptoms of any of the orchards and they continued throughout the season until August (Fig. 1). Soil moisture readings in all three orchards show that the soil was excessively wet through the April to June period at all depths with only the shallowest sensors showing any drying between irrigation cycles (Fig. 2). All three of the Stanislaus County orchards had midday light interception near 80% which is about the point where shading related dieback usually

starts to occur in almond so there may have been a synergistic effect between shading and wet conditions (data not shown).

Butte County Orchards.

Butte County orchard #1 was excessively wet through the end of July based on soil moisture (Fig. 2) and plant water potential (Fig. 1) measurements. Below the two foot depth, the soil only began drying below field capacity during August (Fig. 2). This orchard was irrigated by double line drip with the emitters some distance out from the tree and this, combined with its relatively lower midday canopy light interception (about 70% versus 80% for the other orchards in this study) may explain why it had relatively few Lower Limb Dieback symptoms. The author has observed that orchards with double line drip placed some distance out from the tree row can be operated with relatively wet soil conditions without damaging trees, likely due to a dry area above the two drip lines down the center of the tree row where roots can access water from below but still receive adequate oxygen moving through dry soil from above. The roots in this situation would likely be concentrated in the top one foot of the soil (above all of our soil moisture sensors since the shallowest one was at the one foot depth). Butte County orchard #1 had midday light interception between 68 to 78% (data not shown).

Butte County orchard #2 was near the fully watered baseline (Fig. 1) during the period from April through early July. After June 1st, the wetting during the irrigation cycles did not reach below the one foot sensor with the 2, 3, 4, 5, 6 and 7 foot sensors successively becoming drier (in order) as the season progressed (Fig. 2). All of the varieties were moderately to severely water stressed by August based on midday stem water potential measurements (Fig. 1). Butte County orchard #2 had midday light interception between 75 and 82% (data not shown).

Overall Summary:

These results suggest a hypothesis that water management plays a role in development of Lower Limb Dieback, but confirming this relationship will require experimental verification by manipulating soil and tree water status as a treatment variable. All of the orchards could use improvement in water management since all five orchards had periods, particularly early in the season, when the trees were wetter than the fully irrigated baseline. The Stanislaus orchard #1 and Butte orchard #1 were the wettest overall based on soil moisture readings (Fig. 2). The Stanislaus orchard #1 showed the most symptoms of Lower Limb Dieback (Fig. 1) and although the Butte orchard #1 also showed symptoms (Fig. 1), the severity may have been limited by the double line drip irrigation system as describe earlier.

All five of these orchards were excessively wet at some point during the season, particularly during the April through June period (Fig. 1, 2). The excessively wet conditions early in the season likely played a role in Lower Limb Dieback. It is unusual to see orchards running substantially above the baseline as we saw in these orchards at some point during the season. It should also be noted the water potential measurements tended to be done towards the end of the irrigation cycle (particularly in

the flood irrigated orchards) so the orchards likely went through wetter periods than we recorded. The initial measurements in Stanislaus orchard #1 were done about 10 days after the first irrigation had occurred suggesting conditions would have been much wetter immediately following irrigation. It should also be noted that most of these orchards had the dead lower limbs removed throughout the season so there was likely more Lower Limb Dieback occurring than was recorded. It is also possible that shading played a role in the Dieback since levels of midday light interception were in the 70 - 80% range where problems have occurred in other orchards.

Between the three orchards investigated under this project in 2007 and the additional four orchards investigated in 2008, all of the orchards could benefit from improved water management. Six of the seven orchards were excessively wet during the April - June period and the seventh orchard had severe water management problems (excessively stressed by mid-summer with a wet soil suggesting root damage). Before spending any time looking for causes of Lower Limb Dieback, growers should first make sure that water management is not a problem with the orchard.

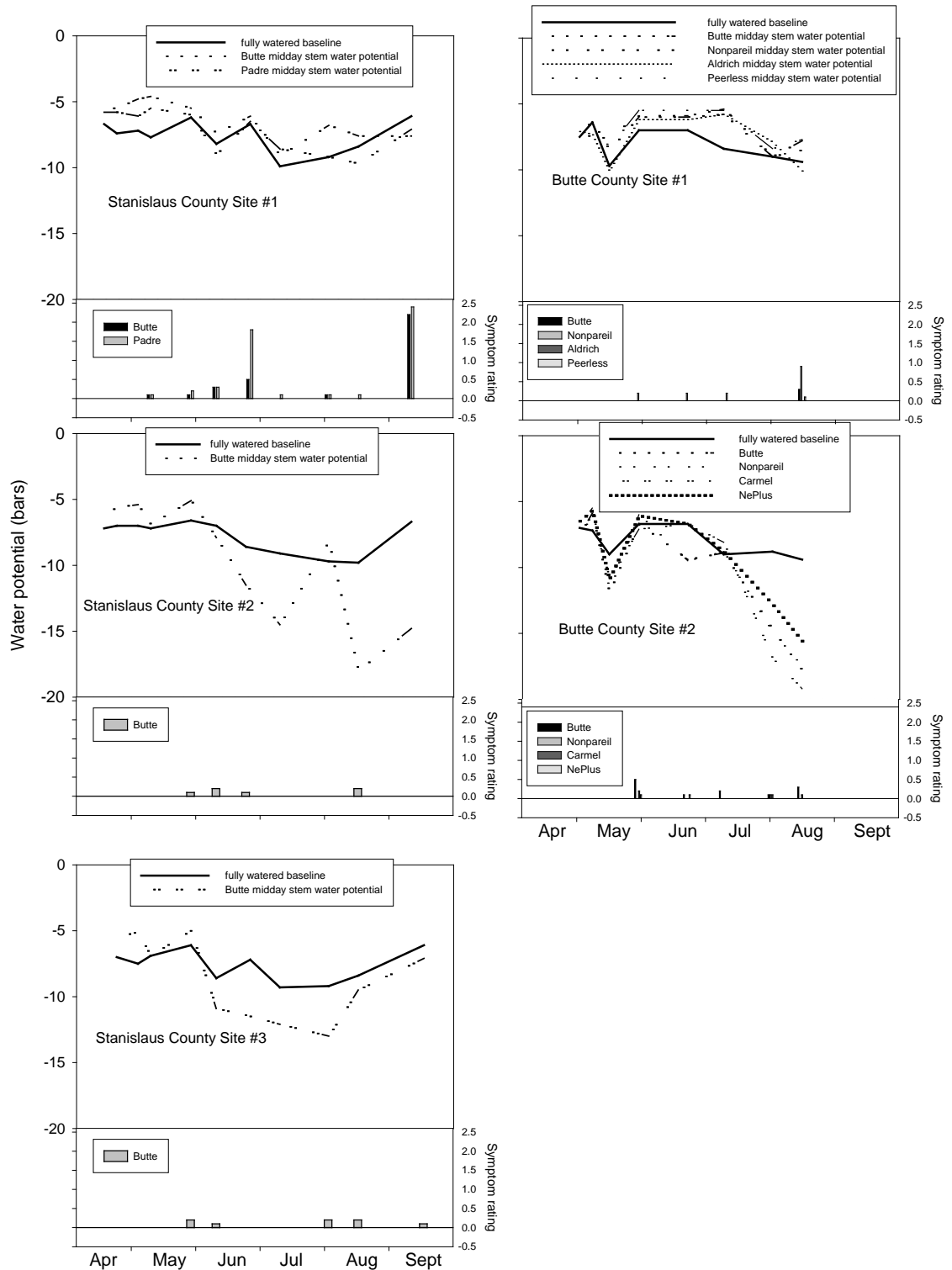


Fig. 1. Midday stem water potential and symptom ratings (bar graphs) by orchard and variety for Stanislaus and Butte County sites in 2008. The solid line is the fully watered baseline on the day of measurement.

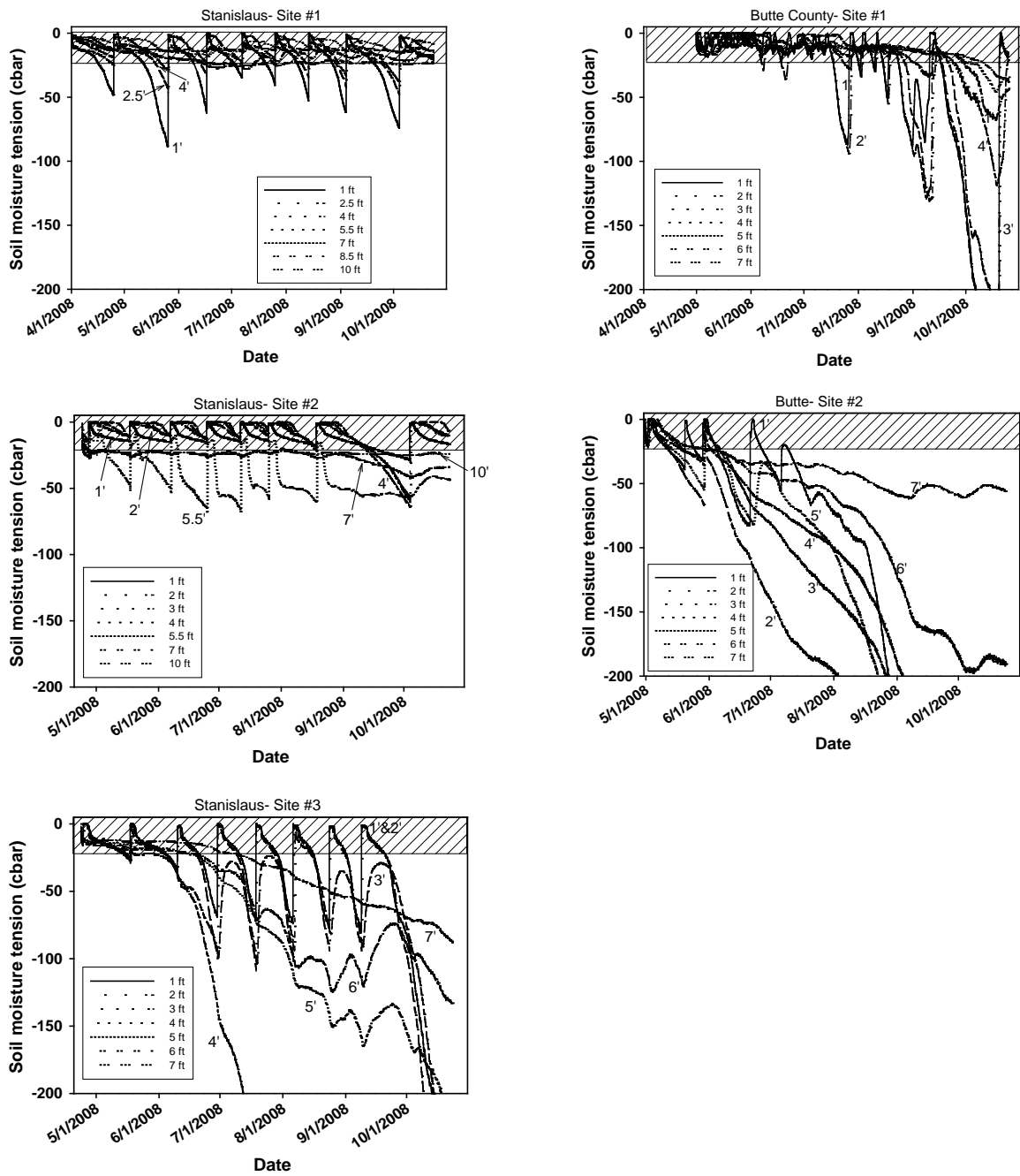


Fig. 2. Soil moisture tension (in centibars) by orchard for Stanislaus and Butte County sites in 2008. Shaded area at top of each graph indicates approximate area above field capacity.