ASSESSING IRRIGATION-RELATED PROBLEMS IN HILLSIDE ORCHARDS IN LAKE COUNTY

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ABSTRACT

Monitoring of soil moisture and plant water status was carried out on a 50-year-old Hartley orchard on a hillside site in Lake County. Large portions of the orchard were showing stunted trees with low production and little new growth for many years. Monitoring suggests that trees in the good growing part of the orchard are mining water from deep in soil profile as season progresses. Trees in poor growing part of orchard experienced overly wet conditions during much of the season and this is the likely cause of poor growth and production. These differences are likely due to soil differences. A change in irrigation practices such that the moveable sprinkler line is moved twice across the orchard on every other row during a 21 day period (rather than once across on every row) appears to have resulted in improved performance of trees in the poor growing part of the orchard.

INTRODUCTION

This study site is an approximately 50 year old Hartley on Northern California Black rootstock orchard in Lake County near Kelseyville. Large areas of the orchard showed symptoms of stunted trees with little growth and limited production during the 2004 season while other areas in the orchard had filled in their space and were quite productive. Monitoring of midday stem water potential and soil moisture were started in July 2005.

PROCEDURES

The irrigation system consists of two movable sprinkler lines which are moved across the 42 rows of the orchard over a 21 day period and then the process is restarted. In this way, it is approximately three weeks between irrigation events for any given row. This also means that irrigation commences three weeks earlier in the season in some rows and commences three weeks later in the season than in other rows. After observing the irrigation system for a month or so, the authors suggested that the grower move the sprinkler lines two rows across the orchard irrigating each odd numbered row which resulted in moving across the orchard in approximately 11 days. Then the line was moved back across on the even numbered rows for the next 11 day period.

Sites were set up in a good growing part of the orchard and in the poor growing part of the orchard. A datalogger equipped to monitor soil moisture was installed in both the good and bad areas. Watermark soil moisture sensors were installed at depths of 0.5, 1.5, 2.5, 3.5, 4.5, 5.5 and 6.5 feet at each site and attached to dataloggers. Data was logged at one hour intervals. Midday stem water potential was measured approximately weekly on nine trees surrounding the good area datalogger and nine trees surrounding the bad area datalogger.

RESULTS AND DISCUSSION

Good growth area

As the 2005 season progressed, the soil moisture dried down at the good logger site with the most dramatic drying taking place at the shallowest and deepest depths initially (Fig. 1). The irrigation event in late July was the only irrigation in which each side of the tree was irrigated on simultaneous days before the alternate row system described above was started. This irrigation only reached to the 2.5 foot depth (Fig. 1a). There were two later irrigations (one on each side of the logger at 11 day intervals) and these smaller irrigations only reached the 0.5 foot depth (Fig. 1a). Below that depth, the soil dried continuously through the season until by mid-October, all sensors at the good area logger site were registering at their minimum readings which is -200 centibars (Fig. 1). Midday stem water potential readings at the good area logger site ran from the -5 to -8 bar range through the season (mildly to moderately stressed; Fig. 1c)). Some trees in this area showed visual symptoms of water stress by late summer. The fact that the lowest water potentials reached in these trees only averaged about -8 bars while moisture sensors to 6.5 feet were very dry suggests that roots were accessing moisture below the 6.5 foot depth of moisture sensors.

Patterns of soil moisture in the good growth area in 2006 were similar to those in 2005 (Fig. 1a). However, tree water potentials tended to run somewhat more stressed in 2006 compared to in 2005 as the season progressed (Fig. 1c).

Poor growth area

In the poor growth area in 2005, soil moisture results were quite different than in the good growth area. At the beginning of the monitoring period in July, moisture sensors at all depths were showing very wet readings (Fig. 1). After each irrigation event, moisture sensors at all levels returned to near zero levels. This is generally not a healthy situation but the trees in this area tolerated this fairly well with few visual symptoms of damage by season end. The likely reason for this tolerance of these conditions is that previously, these trees had been subjected to twice as much water at each irrigation event so they were likely very shallow rooted and adapted to deal with the situation. When irrigation was ceased in preparation for harvest, the shallower depth dried down quickly while lower depths remained wet (Fig. 1). Midday stem water potentials tended to run in the -5 to -7 bar ranged which is more stressed than you would expect based on wet soil moisture conditions. This suggests either than many roots were active above the shallowest 0.5 foot sensor and/or that root function was compromised by the overly wet conditions.

In 2006 soil moisture in the poor growth area tended to be lower than during the comparable period in 2005 (Fig. 1b). Midday stem water potential also tended to run lower (more stressed) in 2006 compared to in 2005 (Fig. 1d).

Transects

In 2005, water potential transects were done twice during the season spanning across the orchard between the good and poor growing areas. . Generally, the poor growth area was slightly more stressed early in the season and less stressed later in the season compared to the good growth area (Fig. 2) The relatively high midday stem water potential in the poor growth area late in the season followed by a rapid drop as shallower soil depths dried down (Fig. 1d,) suggests that the trees were shallow rooted.

In 2006, water potential transects were done four times during the season. The orchard transects showed that midday stem water potentials were generally lower (more stressed) during the 2006 season compared to the 2005 season. Some of this is due to an extreme hot period during mid to late July in 2006. During this period, the good growth area trees tended to show less severe water stress compared to the bad growth area trees even though soil moisture tended to be wetter in the bad growth area. This suggests that trees in the good growth area are still rooting deeper than trees in the bad growth area. In 2005, excessively wet conditions at lower depths in the bad growth area (Fig. 1b in early to mid summer) likely limited deeper rooting. Hopefully, the lack of excessively wet conditions at the lower soil depths in the bad growth area during the 2006 season will result in deeper rooting and more resilient trees in the coming season.

In general, trees in the poor growth area looked better during the 2006 season. There were some visual symptoms of stress due to lack of water late in the season in both the good and poor growth parts of the orchard when midday stem water potentials reached the -10 bar range (Fig. 1). The reflected light index is a measure of kernel color with a higher number being lighter in color. In the range of seasonal average midday stem water potentials in this study (-7 to -9.5 bars), more stress was related to lighter kernel color (Fig. 3a). This same relationship was true of relative monetary return (Fig. 3d). Percent stained nuts was lower in more stressed trees (Fig. 3b). However nut size was smaller (Fig. 3c) and kernel shrivel was greater (Fig. 3e) in more stressed trees.

The plan in 2007 is to continue data collection at this site, More work will be done looking into soil and rooting differences across the orchard as well.

Acknowledgements

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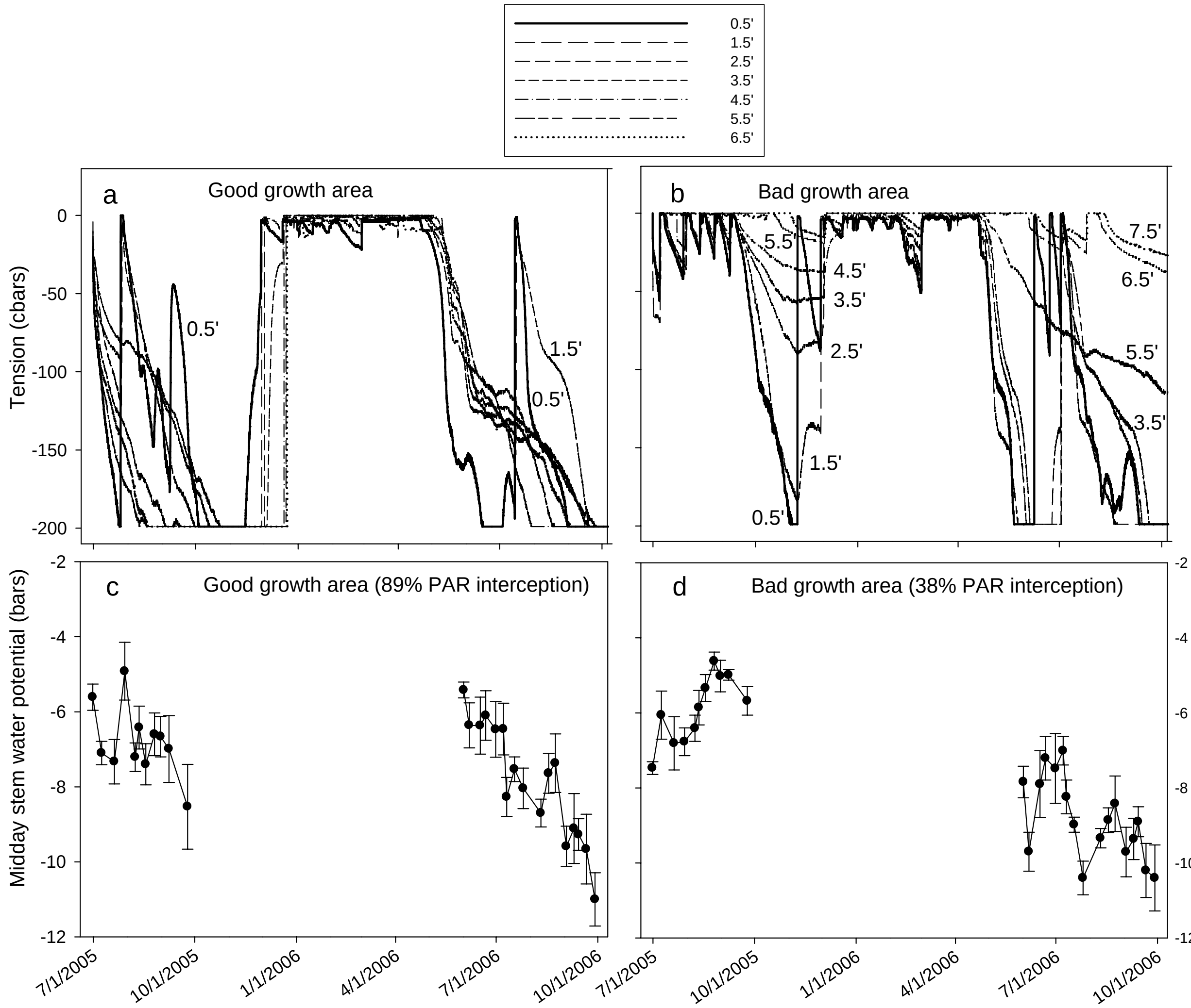

Fig. 1. Seasonal patterns of soil moisture for good growth area (a) and bad growth area (b) as well as midday stem water potentials for good growth area (c) and bad growth area (d) for the 2005 and 2006 seasons.

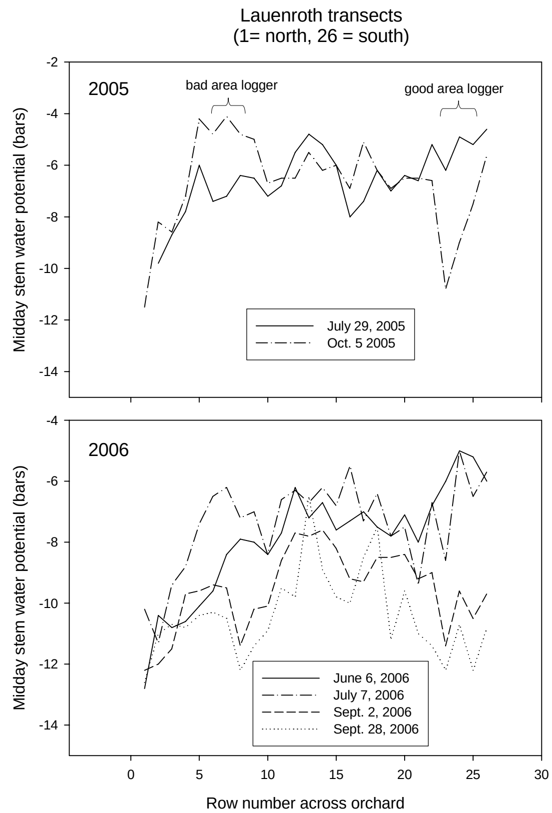

Fig. 2. Transects of midday stem water potential across the orchard on two dates in 2005 and 4 dates in 2006.

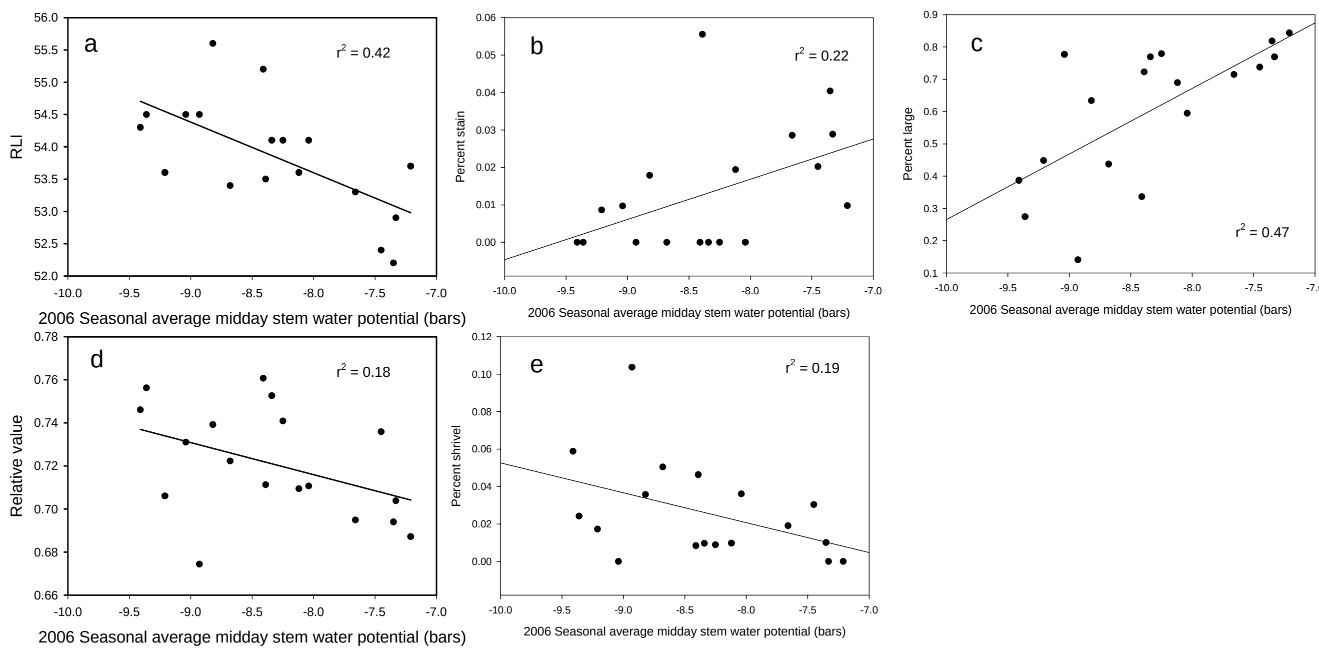

Fig. 3. Relationship between 2006 seasonal average midday stem water potential and reflected light index (a), percent stained nuts (b), percent large nuts (c), relative value (d) and percent kernel shrivel (e).