ASSESSING IRRIGATION RELATED PROBLEMS FOR A HILLSIDE ORCHARD IN LAKE COUNTY

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ABSTRACT

Monitoring of soil moisture and plant water status were carried out on a 50 year old Hartley orchard on a hillside site in Lake County from 2005 to 2007. At the start of the study in 2005, 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 the season progresses. Trees in the poor growing part of orchard experienced overly wet conditions early in the season and this is the likely cause of the 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. However, excessively wet conditions in springtime due to uncontrollable winter/spring rainfall will likely continue to limit tree performance in the poor growth area. Soil moisture monitoring can prevent irrigation starting too soon in the springtime but it is difficult to do anything about spring/winter rainfall other than installing an expensive drainage system (which would likely not be cost efficient).

INTRODUCTION

This study site is an approximately 50 year old Hartley orchard on Northern California Black rootstock 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. Dataloggers 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 throughout the year. Midday stem water potential was measured approximately weekly on nine trees surrounding the good area datalogger and nine trees surrounding the bad area datalogger. Midday light interception was measured at least once during each growing season using a Decagon Ceptometer (Decagon Devices, Pullman, WA 99163).

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. 1a). 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. 1a). 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 and 2007 were similar to those in 2005 (Fig. 1a). However, tree water potentials tended to run somewhat more stressed in 2006 and 2007 compared to 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 and 2007, 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 and 2007 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 the spring of 2006 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.

In 2007, water potential transects were done three times during the season. Patterns across the orchard were similar to the previous years with the south side of the orchard tending to be less stressed early in the season and more stressed later compared to the north side of the orchard (Fig. 2). The fact that the north side of the orchard is more stressed early in the season (Fig. 2) even though the soil tends to be wetter (Fig. 1) suggests that overly wet conditions might be impeding root function.

The change in irrigation practices led to a drying of soil moisture in the poor growth area such that conditions have been continuing to dry at an earlier period in the season each year. Although this has resulted in a slight improvement in tree health in this area, the trees are still significantly smaller with light interception levels at approximately 31% in the poor growth area versus 82% in the good growth area.

The poor area trees have been generally more stressed in late spring and less stressed later in the summer compared to the good growth area trees (Fig.1c, 1d). This is likely due to excessively wet conditions in the shallower soil profile in this area during spring and early summer resulting from winter rains. Later in the summer, the good area trees are likely rooting below the depth of the deepest Watermark sensors since the soils are very dry (Fig. 1a) while tree water status shows only moderate stress (Fig. 1c).

However, much of the problem is due to excessively wet conditions in springtime is due to uncontrollable winter/spring rainfall. This will likely continue to limit tree performance in the poor growth area of the orchard. However, this study has shown that soil moisture monitoring is still important since it can be used to prevent irrigation from starting too soon in the springtime.

There is not a good solution for the excessively wet conditions during winter/spring other than installing an expensive drainage system (which would likely not be cost effective).

Acknowledgements

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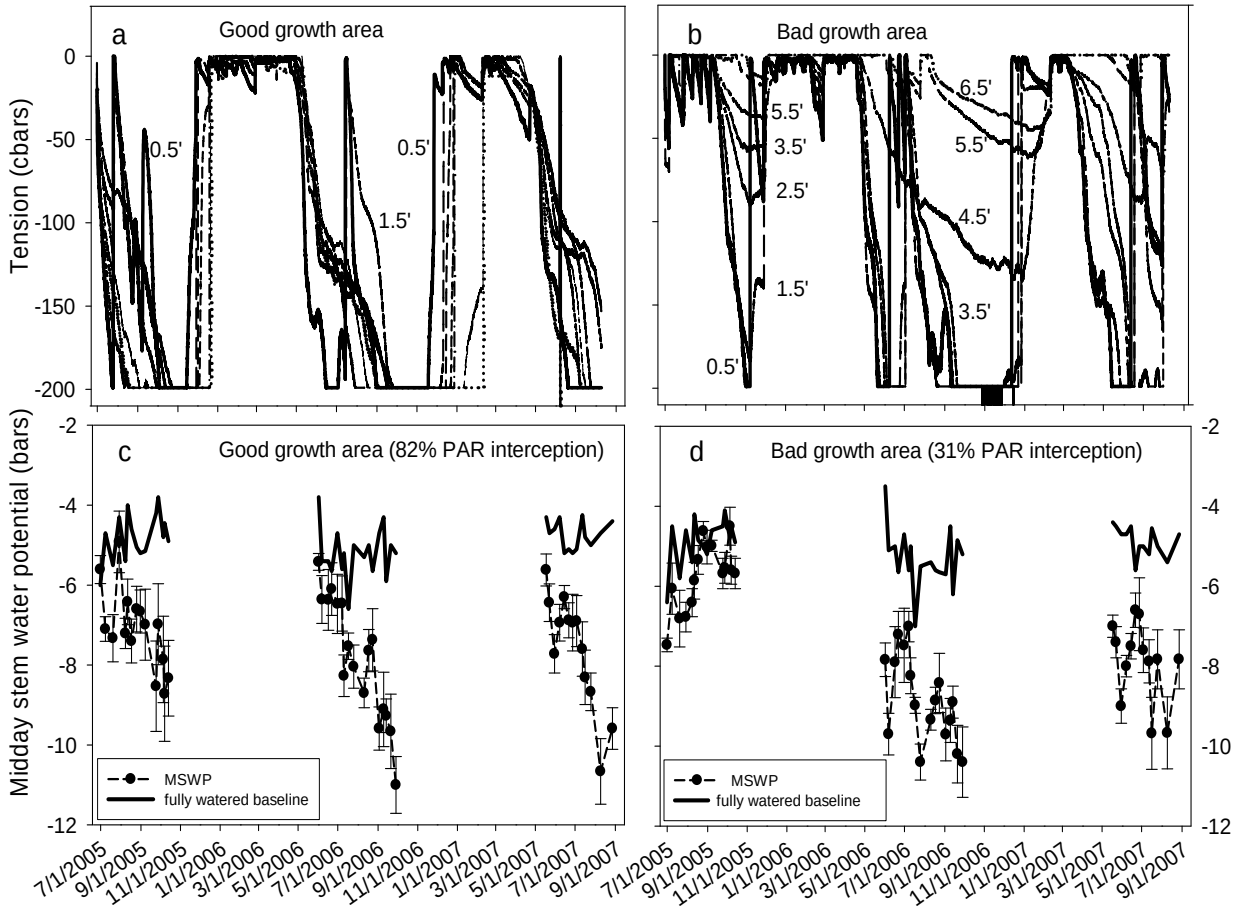

Fig. 1. Seasonal patterns of soil moisture for good growth area (a) and bad growth area (b) as well as midday stem water potentials for good growth area (c) and bad growth area (d) for the 2005-2007 seasons.

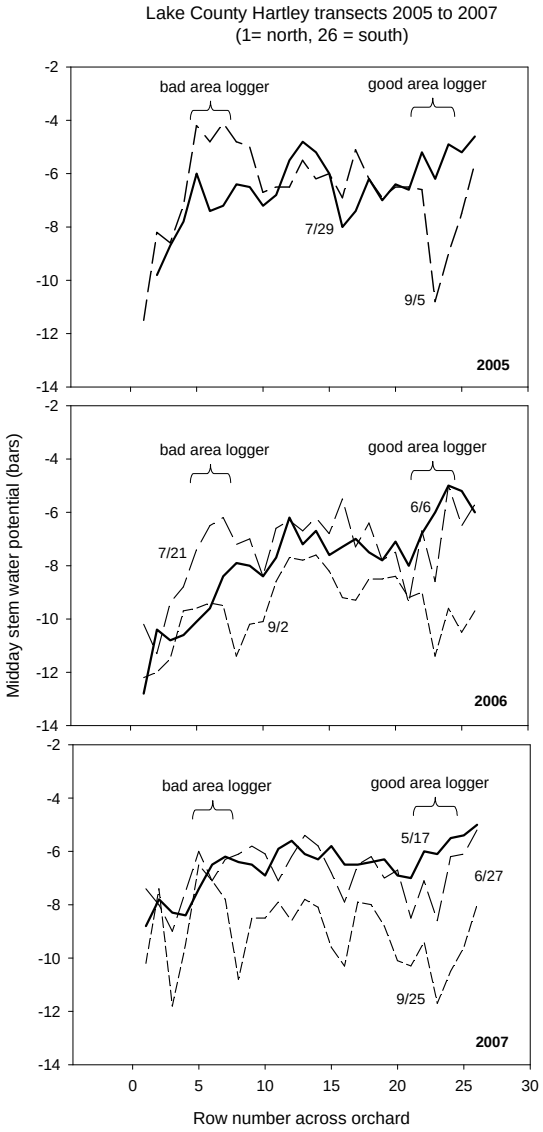

Fig. 2. Transects of midday stem water potential across the orchard on two dates in 2005, three dates in 2006 and three dates in 2007.