

IRRIGATION MANAGEMENT AS A TOOL TO STABILIZE AND REVITALIZE A DECLINING ‘CHANDLER’ ORCHARD

Bruce Lampinen, Janine Hasey, Sam Metcalf and Claudia Negrón

ABSTRACT

Leaf damage symptoms, including marginal browning and overall yellowing, were found to occur following specific irrigation events. Although the exact cause of this effect is unclear, it is likely due to the development of anaerobic conditions in the root zone following a heavy irrigation. Irrigation management using soil and plant based measurements led to a reduction in irrigation applications from 70 inches to 12 to 15 inches while maintaining trees near or within fully watered levels. After three years of improved irrigation practice, despite the setbacks that occurred following a number of specific irrigation and/or rainfall events, the orchard appearance in general is much better. Trees that were yellow and stunted in 2001 are still smaller than the average orchard tree but they look considerably better. Trees that were larger have experienced some minor stress so they have grown somewhat less. This has led to a more uniform tree size overall. It is clear that walnut orchards on soils such as this require very careful irrigation management, preferably using soil and plant based measurements, in order to thrive. This study points out the importance of an irrigation management approach that integrates soil and plant based (midday stem water potential) measurements. Using soil based measurements alone, it can be difficult to know when to begin irrigating in the springtime since you need to know where roots are in the profile to know when moisture is becoming depleted in the root zone. Stem water potential measurements let you know when the plant begins experiencing stress and hence is in need of irrigation. Using plant based measurements alone, it can be difficult to know if you are over-irrigating. Soil moisture sensors let you see if lower soil depths are drying or wetting as the season proceeds and this gives you the best overall picture of how your water applications may or may not be meeting plant water needs. If the soil has a lot of storage capacity (as it appears to in this site) it may be possible to mine much of this stored soil moisture over the season allowing lower irrigation applications thereby saving water and money while preventing potential problems resulting from over-irrigation including tree stunting, tree dieback, plant diseases etc..

INTRODUCTION

A Chandler on paradox rootstock orchard began showing leaf symptoms including marginal browning and overall yellowing when it was 5 years old in 2001. In late summer 2002, symptom expression was more severe and over a wider portion of the orchard. Approximately 20-30% of trees showed some symptoms during this episode and several trees died. At this point in time tree water potential was measured on a range of trees from healthy and tall to those showing symptoms of damage. The data indicated that the degree of symptom expression was greatest on the smallest trees which were also at the highest (least stressed) midday stem water potential (Fig. 1). At this point in time a program of more intense monitoring was started.

MATERIALS AND METHODS

Soil moisture sensors (Watermark sensors) were installed at depths of 18, 42 and 66 inches in an area of the orchard with good growth (no yellowing or marginal browning of leaves) and in an area of the orchard showing poor growth and damage symptoms. The sensors were attached to dataloggers set to log at one hour intervals starting in September 2002.

Also starting in September 2002, midday stem water potential was monitored approximately every two to three weeks during the growing season on 11 trees in a transect from the good growth area to the poor growth area. In 2003, 2004 and 2005, two trees were also monitored adjacent to the dataloggers in the good and poor growth areas.

RESULTS AND DISCUSSION

Midday stem water potential measurements in late summer 2002 indicated that trees were in the fully watered range (Fig. 3). Since leaf marginal browning and overall yellowing was most severe on trees that were the wettest, a cutback in water applications was suggested to the grower. Soil moisture sensors show the resulting dry down in soil moisture that occurred (Fig. 2). This resulted in a slight decrease in midday stem water potential (Fig. 3; last two reading dates) although the trees were still within the fully watered range.

In 2003, soil moisture in conjunction with midday stem water potential monitoring were used to advise the grower on irrigation decisions. The trees looked healthy with green leaves until an irrigation event in early summer (see Fig. 2, 3). Shortly after this irrigation event, relatively minor leaf symptoms (mainly marginal browning occurred). The trees then largely recovered and looked relatively good until early August when an irrigation event followed by an (unusual for August) one inch rainfall event once again led to onset of leaf damage symptoms (Fig. 2, 3). These symptoms were more severe and persisted through the rest of the season. By limiting water applications based on soil and plant based measurements, estimated applied water went from 70 to 15 inches suggesting that a large amount of stored soil moisture went to meet plant needs. This is confirmed by dry down of soil moisture sensors as season proceeded in all years.

In 2004, trees became moderately stressed in July (midday stem water potentials of -6 to -9 bars) when the grower cut back on irrigation in order to allow the orchard floor to dry to facilitate mowing. This did not result in any visual signs of damage to the trees. Visual appearance continued to be good until one large irrigation event in early August (Fig. 2, 3). In this case, the grower put on a double irrigation in order to give some time before the next irrigation for the soil surface to dry to allow mowing in preparation for harvest. This irrigation event caused moderate to severe leaf damage symptoms. Seasonal water application ended up at only 12 inches.

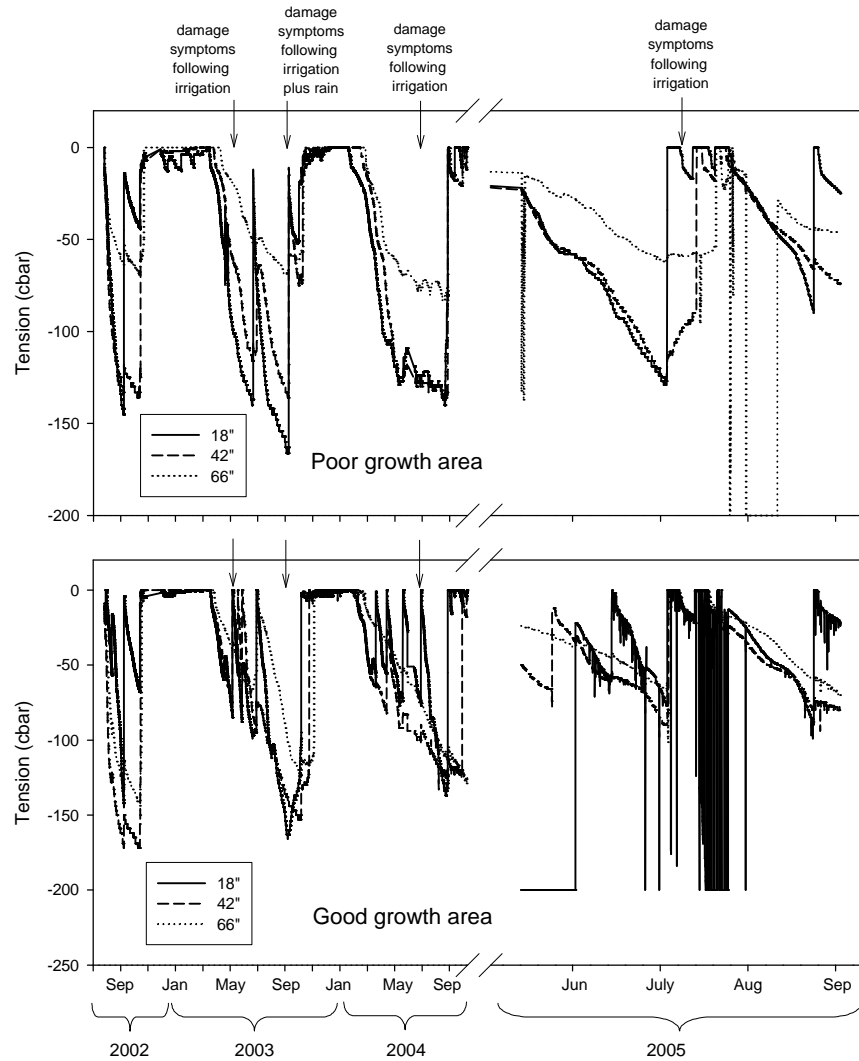
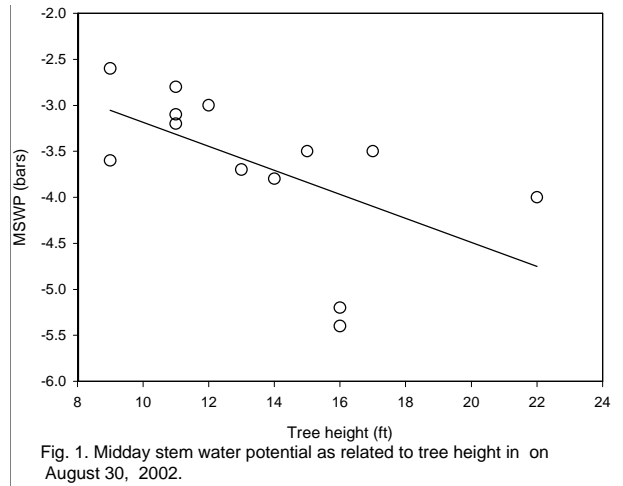
In 2005, the season was progressing well and trees looking healthy until mid-summer when a new manager took over the ranch and began irrigating at a higher rate. Starting about July 1, a series of irrigation events took place and again leaf damage symptoms occurred, as always most severely on the smallest trees that are at the highest (least negative) midday stem water potentials. After some discussion, the grower agreed to reduce irrigation amounts and symptoms improved. Before harvest a moderate stress occurred due to the grower wanted to let surface dry for ground preparation.

PRELIMINARY CONCLUSIONS

After three years of improved irrigation practice, despite the setbacks that occurred following a number of specific irrigation and/or rainfall events, the orchard appearance in general is much better. Trees that were yellow and stunted in 2001 are still smaller than the average orchard tree but they look considerably better. Larger trees have been mildly to moderately stressed at the end of some irrigation cycles (since they use more water than the smaller trees) and hence have grown somewhat slower leading to a more uniform tree size in the orchard overall. It is clear that walnut orchards on soils such as this require very careful irrigation management, preferably using soil and plant based measurements, in order to thrive.

It is worth noting that soil moisture tension is close to zero during most winter months suggesting soil is quite wet. This may be partly what leads to problems in springtime when irrigation is initiated too soon with lower soil levels still saturated and little soil reserve space to absorb moisture. This study points out the importance of an irrigation management approach that integrates soil and plant based (midday stem water potential) measurements. Using soil based measurements alone, it can be difficult to know when to begin irrigating in the springtime since you need to know where roots are in profile to know when moisture is becoming depleted in the rootzone. Stem water potential measurements let you know when the plant begins experiencing stress. Using plant based measurements alone, it can be difficult to know if you are over-irrigating. Soil moisture sensors let you see if lower soil depths are drying or wetting as season proceeds and this gives you the best overall picture of how your water applications may or may not be meeting plant water needs. If the soil has a lot of storage capacity (as it appears to in this site) it may be possible to mine much of this stored soil moisture over the season allowing lower irrigation amounts.

Using irrigation pump records, water applications in 2002, 2003, and 2004 were estimated at 70, 15 and 12 inches respectively (Fig. 1). Since the midday stem water potentials in 2003 and 2004 were mostly in the fully watered range (Fig. 1), this suggests the orchard was being over-irrigated in 2002 and this was likely the cause of the damage symptoms observed (leaf yellowing and marginal browning). This was confirmed when damage symptoms reappeared following irrigation and rainfall events in 2003, 2004 and 2005.



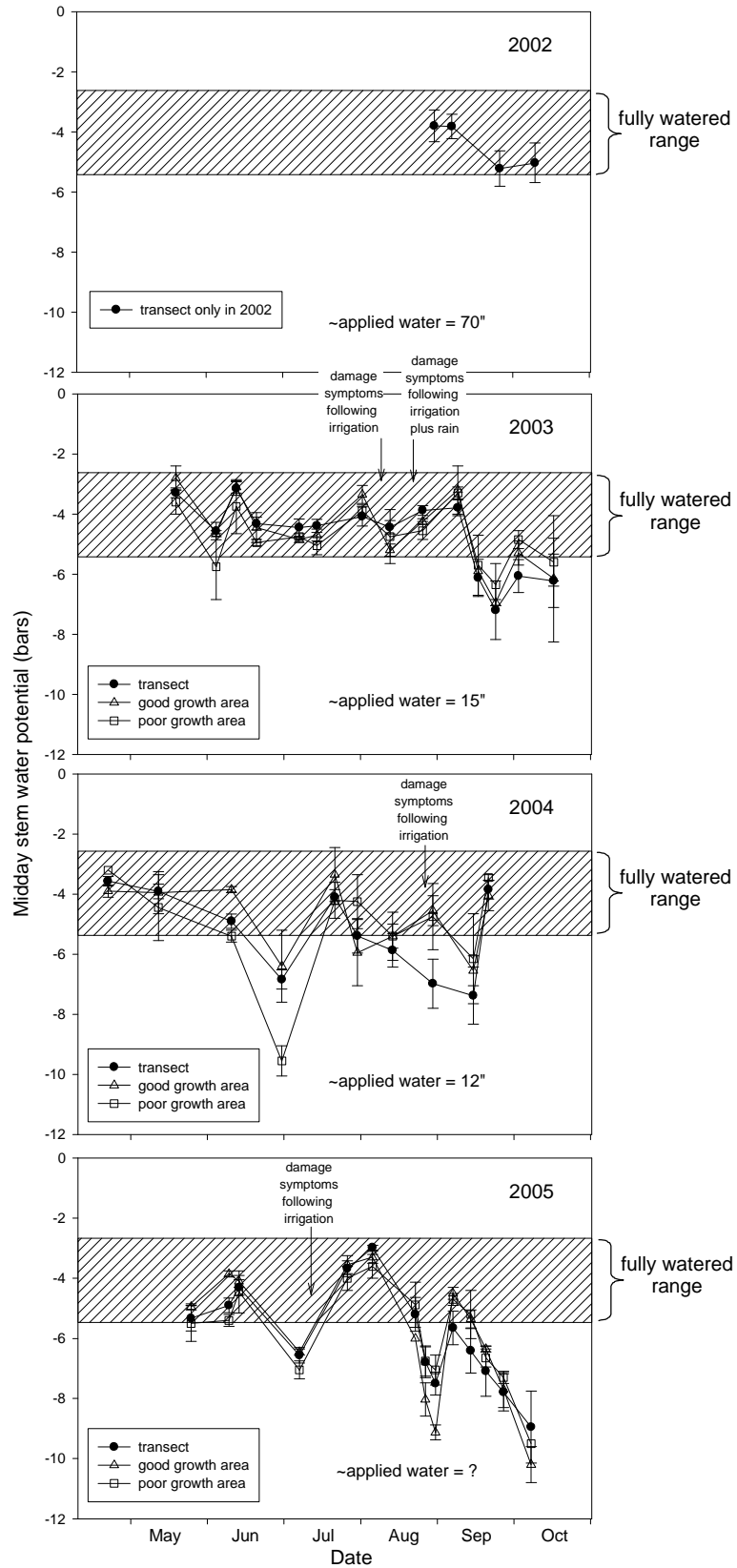


Fig. 3. Midday stem water potential and estimated applied water for 2002 through 2005 seasons