Evaluation of Regulated Deficit Irrigation in West Texas

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Deficit irrigation of grapevines has been the subject of recent research to explore its potential to conserve water, reduce vine vegetative growth, and possibly improve fruit and wine quality. Deficit irrigation strategies restrict water application to provide less than the full replacement volume of water consumed by plants, and in many cases to impose a water deficit in the vine. The regulated deficit irrigation (RDI) strategy withholds water to achieve or maintain some degree of water deficit in grapevines during a specific phenological stage, usually between fruit set and veraison. Grapevines respond to increasing water deficits by decreasing stomatal aperture and thereby reducing transpirational water loss, but with a concomitant reduction in CO_2 uptake and photosynthesis. Vine water deficits have also been observed to influence vine acclimation and possibly cold hardiness. Vineyards within the semiarid climate of the Texas High Plains could potentially utilize RDI to conserve water and manage grapevine growth, but deficit irrigation strategies have not been tested here.

Materials and Methods

RDI was evaluated over two seasons (2002-2003) in a commercial vineyard at Plains, Texas. Experiments were conducted within a four-hectare block of self-rooted Cabernet Sauvignon grapevines planted in 1986, trained to a bilateral cordon and spur pruned to twelve 2-bud spurs. The vineyard soil is Patricia loamy fine sand with approximately 3.1 to 4.6 cm sand depth, sandy clay underneath, and available water capacity ranging from 40 to 140 mm/m. The vineyard's subsurface drip irrigation system was bypassed for the duration of the RDI study and a separate drip system was installed for each treatment plot, enabling individual control of water applications.

Irrigation events were scheduled on the basis of vine water status as measured by midday leaf water potential, and varied among the treatment plots due to difference in vine water use. The RDI strategy was evaluated in an experiment that compared a deficit irrigation treatment imposed for approximately 3 weeks prior to veraision to an irrigation treatment (Control) that applied 100% of estimated ETc. Water was withheld from the RDI treatment during the treatment period to achieve and maintain midday leaf water potential between -1.1 and -1.3 MPa. During nondeficit periods, all treatment plots were irrigated equally. The total water applied for RDI and Control plots in 2002 was 1064 and 1506 L/vine and 404 and 822 L/vine in 2003, respectively.

Results and Discussion

Mild to moderate vine water deficits were induced for the period three weeks prior to veraison by limiting water applications in RDI treatment plots. Deficit conditions within RDI vines were clearly indicated by more negative midday leaf water potential of RDI-treated vines during this time period compared with the Control treatment (Figure 1).

Irrigation treatment had no significant effect on yield or yield components in this study, but RDI reduced pruning weight by 46% in 2002 (Table 1). Yield/pruning weight ratio did not differ between treatments in the two years. The deficit irrigation treatment significantly increased applied water-use efficiency up to 72% in 2003, with a similar but non-significant trend in 2002. RDI had no effect on fruit soluble solids (brix), titratable acidity, and pH (Table 2).

Earlier and more rapid vine acclimation, indicated by periderm development on shoots, was consistently associated with the RDI treatment (Figure 2). Although RDI vines began the acclimation process earlier and developed periderm more quickly, there was no measurable improvement in bud cold hardiness when compared with Control vines.

Figure 1. Vine water status in 2003 of Cabernet Sauvignon receiving RDI or a Control (no-deficit) treatment.

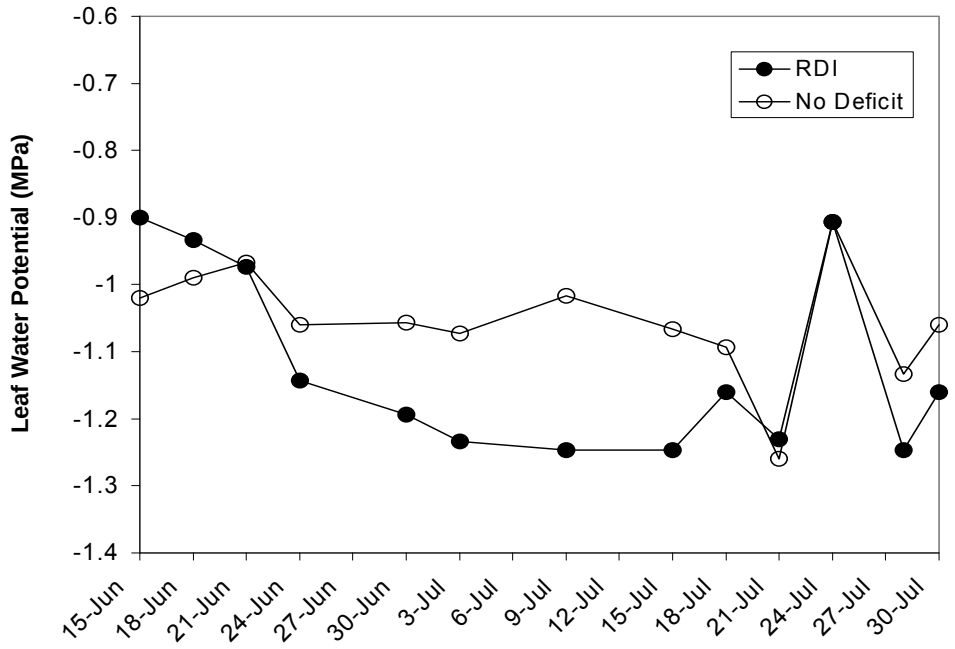


Table 1. Effect of RDI and a non-deficit irrigation treatment on yield components, vine size, and applied water use efficiency of Cabernet Sauvignon grapevines.

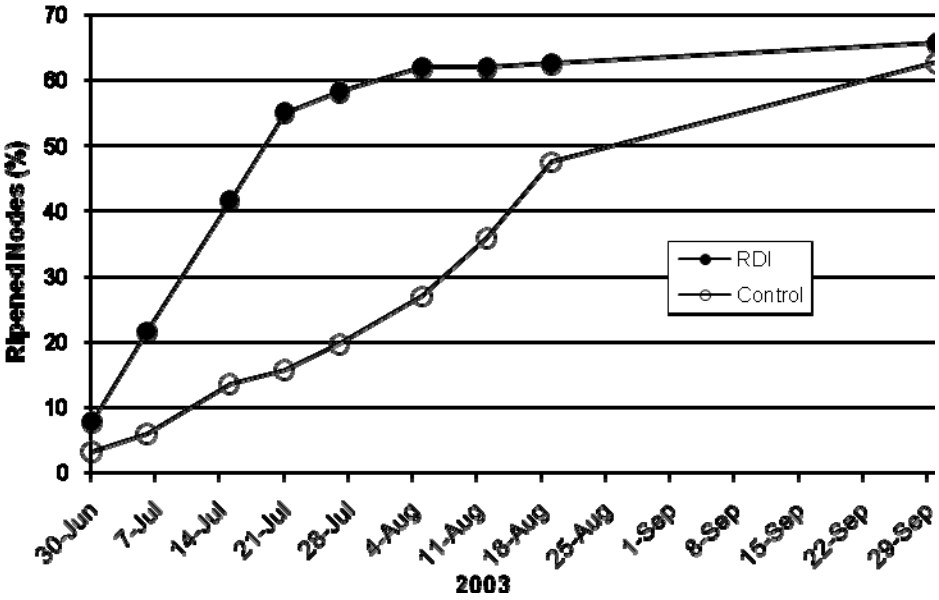
Irrigation Treatment	Yield (kg/vine)	Cluster Wt. (g)	Berry Wt. (g)	Pruning Wt. (kg/vine)	Yield / Pruning Wt.	Applied Water Use Efficiency[a] (g/L)
2002						
RDI	4.53	88.43	1.17	0.56*	9.99	4.8
Control	5.43	97.76	1.25	1.02	5.76	3.7
2003						
RDI	2.76	41.10	-	0.40	7.39	6.8**
Control	3.26	46.96	-	0.50	7.83	4.0

[a]Applied water use efficiency is the ratio of fruit yield (g) per unit of applied water (L).
*Treatments significantly different by ANOVA at α=.05.
**Treatments significantly different by ANOVA at α=.01.

Table 2. Effect of RDI and a non-deficit irrigation treatment on fruit composition of Cabernet Sauvignon grapevines.

Irrigation Treatment	Soluble Solids (Brix)	Titratable Acidity (g/L)	pH
2002			
RDI	24.55	4.23	3.88
No Deficit	23.85	4.50	3.87
2003			
RDI	23.54	5.14	3.59
No Deficit	23.63	4.35	3.65

Figure 2. Percent ripened nodes during the acclimation period in 2003 of Cabernet Sauvignon shoots receiving RDI or a control irrigation treatment.



Applications of Research

Regulated deficit irrigation, properly implemented, can be utilized in west Texas to improve efficiency of applied water use without negatively affecting crop yield or fruit composition. Deficit irrigation can also promote earlier shoot acclimation, These benefits have been attained with mild to moderate levels of vine water stress, with midday leaf water potential ranging from -1.1 to -1.3 MPa. Producers interested in utilizing deficit irrigation are encouraged to proceed with caution since excessive water deficits or ill-timed deficits may result in negative impacts on crop yields, fruit composition, and vine health.

Acknowledgements

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A complete report of this research has been published and is available online at: http://winegrapes.tamu.edu/research/Hellman_Irrigation.pdf