Deficit Irrigation Strategies and interactions with Alfalfa Varieties

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Introduction: If the drought of the past 5 years has taught us anything, it's that full water allocations may be uncertain in the future. Further, there is an ongoing need to move water from one crop to another, or perhaps to transfer water to other users for payment.

Alfalfa is well suited to short-term drydown (droughts), in fact may be the best crop to have in a drought due to its ability to survive stress periods.

This research was instituted to see if 1) Drip irrigation would improve the ability to deficit irrigate alfalfa, and 2) Discover the interactions between irrigation deficits and variety performance.

Experiments. Fifteen commercial or newly-released alfalfa varieties to be potentially grown in the Southwest US (Arizona, California, and New Mexico) were established Fall, 2014 using a split plot design with four replications. We used sprinkler irrigation for stand establishment and the soil profile was filled by sprinkler irrigation during early season growth in 2014-15, and the trials were irrigated by SDI starting April 20, 2015, for the entire season, with 40-in spaced driplines installed 10-12-in deep The driplines are of commercial type (Netafim Typhon 875 series) with inner diameter of 0.875 inches and regularly spaced (14") emitters with nominal flow rate of 0.18 gph at 10 psi.

Irrigation treatments. The irrigation treatments (Figure 1) included 1) full irrigation at 100% of crop ETc , 2) 75% of full water with sudden water cutoff on August 13, 3) 75% of seasonal water supply (full irrigation until 50% of

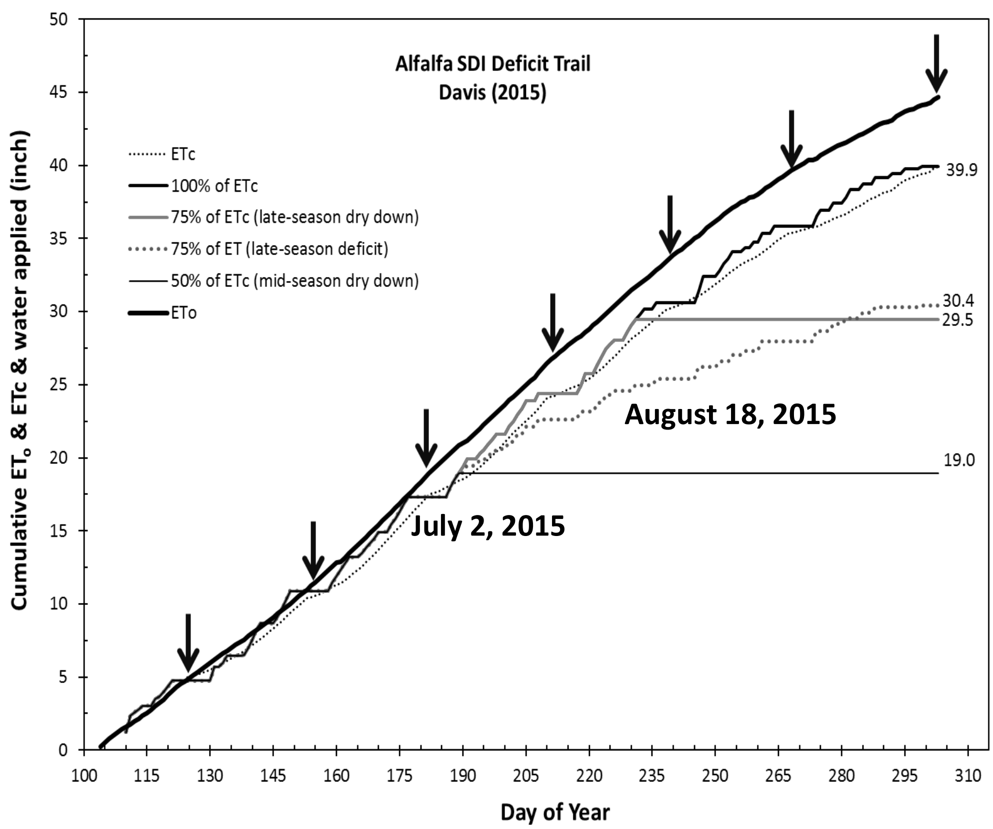

Figure 1. Cumulative alfalfa ET and applied water at the different irrigation treatments over the season 2015

seasonal ET occurred July 2nd, and then ½ normal irrigation for the rest of the season, and 4) 50% of ET (sudden cutoff on July 2nd).

The full alfalfa ET was measured with Eddy Covariance instruments established nearby at Davis – the daily crop coefficient (Kc) values were adjusted based upon the changes observed during each cutting schedule – with the summed Kc values totaled approximately 0.85 of ETo directly from our Eddy Covariance readings for the fully irrigated treatment. No irrigation occurred over the first cycle up to the first cutting. The crop water use of the first cut was estimated utilizing an average Kc value of 0.85 and total ETo between February 1st and March 30th when the first crop cycle and cutting were realized. Totally 4.6 in. as crop water use from soil moisture residue was estimated over this period.

Alfalfa dry matter

The average alfalfa DM of 15 varieties over eight cutting events at the irrigation treatments of I-1, I-2, I-3, and I-4 were 10.1, 9.7, 9.6, and 8.1 ton ac^{-1}, respectively (Figure 2). Although yield reductions occurred right after irrigation was cut off (treatment IV) by early July, only a reduction of 5.5% occurred at the 6th cut. This indicates that some plant growth continues even

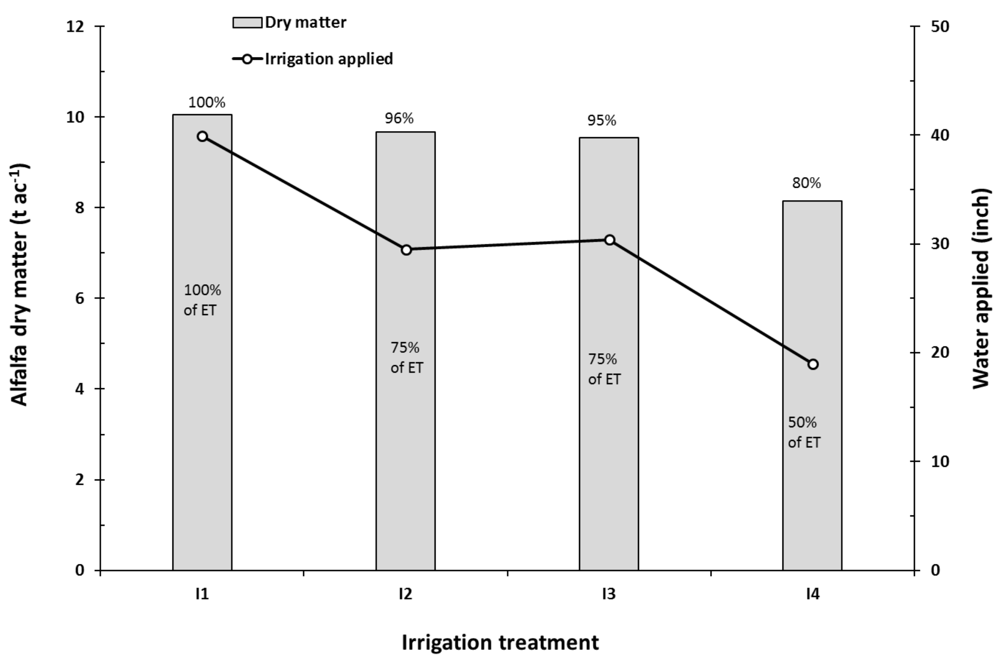

Figure 2. The average alfalfa DM of 15 varieties over the growing season and water applied for different irrigation treatments

after severe irrigation cutbacks thanks to residual soil moisture. No difference in terms of yield reduction at the end of the year was found for the 75% irrigation scenarios, where reduction were 4% at treatment II and 5.0% at treatment III were observed. A 20% yield reduction was observed for the 50% deficit irrigation scenario over the year, mostly from the last four cuttings of the growing season, which were affected by severe water limitations.

The alfalfa cumulative yield percentage values (averaged over 15 alfalfa varieties) over the seasonal cuttings for each irrigation treatment are illustrated in Figure 3. A total of 74.1% of seasonal dry matter was obtained over the first five cuts until the end of July; and 12.1% in the 6th cut, 7.7% in the 7th cut, and 6.2% in the 8th cut. Figure 3 clearly shows that spring and early-summer cuttings result in higher alfalfa yields. The cumulative yield percentages match pretty well the results obtained from other studies conducted on alfalfa fields under conventional flood and sprinkler irrigation.

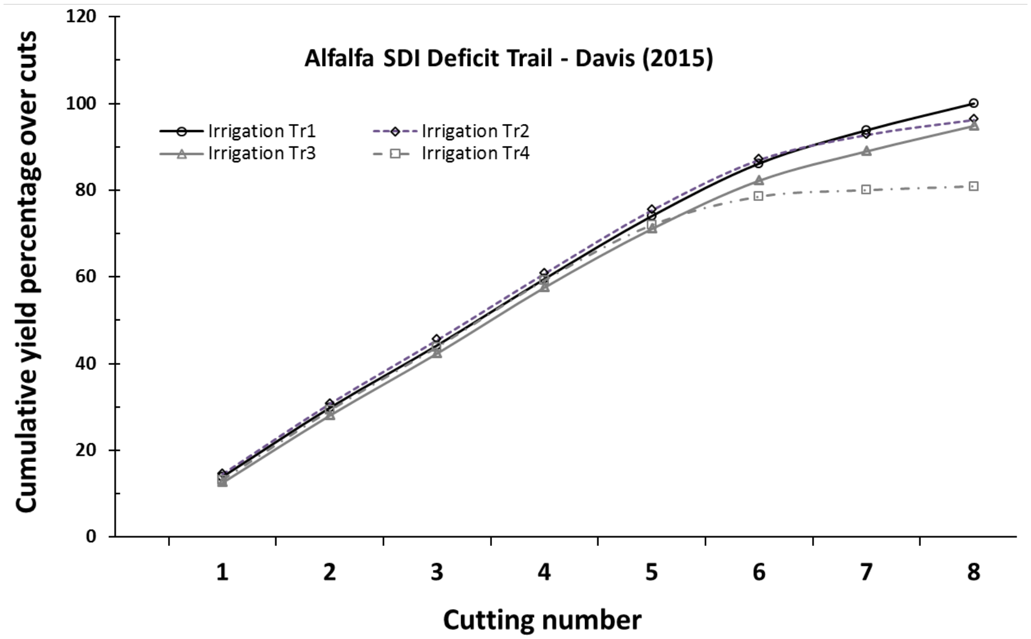

Figure 3. Alfalfa cumulative yield percentage at different irrigation treatments over the seasonal cuttings

Conclusion

In California, it is important to develop improved strategies to maximize water use efficiency under variable water supplies. Alfalfa appears to be highly conducive to deficit irrigation strategies during low water years due to its deep rooted characteristics, flexibility, high yields under partial irrigation, and drought tolerance compared with many crops. Overall, the mid-summer deficit irrigation strategy can keep the relatively high hay yields of the first part of growing season when alfalfa water use efficiency is higher and reduce water applications during the summer when yield is lower and hay quality is poorer. In this one-year study, yields were about 80% of normal when applied irrigation water was cut to ½ of full ET requirements. This strategy may increase alfalfa water use efficiency under SDI as a result of greater water application efficiency, higher distribution uniformity over time and space, and yield production utilizing the more productive early growth periods. While these results were positive for SDI in alfalfa, multiple-year studies are necessary to evaluate the deficit irrigations strategies and multi-year effects.