Using Saline Groundwater for Large-Scale Irrigation of Pistachios Interplanted with Cotton

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Irrigation districts in the San Joaquin Valley (SJV) have seen water costs increase 3 to 5 fold in the last ten years, while dependable supplies have decreased. Growers of low value field crops like cotton are looking for alternative crops and water supplies. Some marginally saline drain and groundwaters associated with over 250,000 acres of the westside SJV can be used to increase water supply and decrease costs for irrigating salt tolerant crops. This study is testing the economic and cultural viability of establishing a large, commercial-scale pistachio orchard interplanted with cotton using saline irrigation water.

Earlier studies: Work in Iran, a 2001 salt tank study at the USDA Salinity Lab, Riverside, and a small plot, 9-year study (ending 2002) in the southern San Joaquin Valley indicate pistachios may tolerate as much soil salinity as cotton (9 dS/m), but this has not been proven over the long-term on a commercial scale in California.

Experimental / Field setup: In 2004, twelve 19.5 acre test plots were set up in two adjacent 155 acre fields to test the use of saline water for commercial-scale cotton production and development of a new pistachio orchard using shallow sub-surface drip tape. The fields were well reclaimed (salinity averaged 1.57 dS/m to 3 feet) and had good drainage. We used fresh (Aqueduct), blended (Blend) and saline Well water treatments (average EC of 0.5, 3.0 and 5.4 dS/m and boron @ 0.3, 6 and 11 ppm, respectively). The highest salinity treatment is more than 4 times as saline as almost all irrigation waters currently used in the SJV. The field was planted to solid pima cotton in 2004. In 2005, pistachio rootstocks (PG1) were planted in March, 17 feet apart on a 22 foot row spacing and interplanted with four 38 inch rows of pima cotton. Pistachios were budded with a Kerman scion in July. Every winter/early spring all treatments receive 8 to 12 inches of fresh water for leaching/preirrigation and cotton germination, followed by 21 to 26 inches of treatment water, depending on seasonal demand. Pistachios receive about 18 inches total based on a 9.5 foot wide area (7.8 inches for the 22 foot row spacing). Cotton was not interplanted for 2007 or 2008 as the grower stopped all his Westside cotton production due to severe shortage of canal water.

Plant / yield data: Plant tissue analysis showed a significant 0.5 to 3 fold increase in chloride and boron levels in both cotton and pistachio tissues, but produced no toxicity symptoms. Pima cotton lint yields were nearly 4 bale/acre in 2004, but crashed to about 2 bale/acre in 2005 due to very cool spring conditions that made for poor stand establishment. Yields and plant height were unaffected by salinity. Spring 2006 provided excellent conditions for cotton growth, but excessive salts accumulated in the top 4 inches of the Well treatment beds reduced cotton emergence by 14% (statistically insignificant). Plant height under saline irrigation was significantly reduced early in the season, but this difference was insignificant by the end of July. Comparing aerial imagery and the Normalized Difference Vegetation Index (NDVI) for August 2004 and 2006 also showed no treatment impacts. But lint yield from the saline Well treatment was reduced by 275 lb/ac compared to the Aqueduct water. However, the Well treatment yield was still excellent at 3.12 bale/ac. Increase in pistachio rootstock di-

ameter and general tree development was unaffected by salinity after three years. By the end of the fourth year the PG1 rootstock diameter in the Well treatment was reduced by 7% compared to the Aqueduct treatment (P=0.04). The UCB rootstock was not affected by salinity.

Salinity and sustainability: At the end of 2006, after three seasons of cotton irrigation this program has applied about 6600, 32500 and 54000 lb/ac of salt in the Aqueduct, Blend and Well treatments, respectively. Average rootzone salinity to 5 feet has remained surprisingly stable at about an EC_e of 2.5 dS/m for the Aqueduct and 4.6 dS/m for the Well treatment. However, in-season EC_e in the top three feet can be as high as 11 dS/m. Without 6 to 10 inches of effective rainfall or fresh water winter irrigation for efficient leaching this system may not be sustainable. Due to the decrease in cotton yield in 2006, combined with a 50% increase in the Well water EC over the last four years, we reduced the salinity of the Well treatment (by blending with Aqueduct water) down to 4.5 dS/m starting July 2007. This is about the salinity of the Well treatment at the start of the test in 2004. Even with the decreased lint yield for the Well treatment in 2006, an economic analysis of cotton yield return to the project shows a net return of $2,249/ac using the $45/ac-ft Well water compared to $2,120/ac for the $120/ac-ft Aqueduct water. But after five years the Well water adds 73,800 lb/ac salt in the wetted zone of the pistachios compared to about 8,000 lb/ac for the Aqueduct water.

Publications

Sanden, B.L., L. Ferguson, C. Kallsen, D. Corwin. 2007. Large-Scale Utilization of Saline Groundwater for Development and Irrigation of Pistachios (P. integerrima) Interplanted with Cotton (G. barbadense) Proceedings of the Vth International Symposium on Irrigation of Horticultural Crops, Eds: I. Goodwin and M.G. O'Connel, Acta Horticulturae, ISHS 792:551-558.

Sanden, B., L. Ferguson, C. Kallsen, D. Corwin, B. Marsh, B. Hutmacher. 2007. Using saline groundwater for large-scale development and irrigation of pistachios interplanted with cotton. Proceedings 28th Annual International Irrigation Show, 12/9-11/07, San Diego, CA. Irrigation Assoc. 6540 Arlington Blvd, Falls Church, VA 22042. pp.779-785

Professional Presentations

Sanden, B.L., L. Ferguson, C. Kallsen, D. Corwin. 2007. Correlation of geo-referenced normalized differential vegetative index (NDVI) for pistachios and cotton with plant data and soil salinity. CalGIS 2007, Ag Symposium. Oakland, CA 4/5/07

Sanden, B.L., L. Ferguson, C. Kallsen, D. Corwin. 2007. Using saline groundwater for large-scale development and irrigation of pistachios interplanted with cotton. Water Resources Continuing Conference. Woodland, CA 4/19/07.

Sanden, B., L. Ferguson, C. Kallsen, D. Corwin, B. Marsh, B. Hutmacher. 2007. Using saline groundwater for large-scale development and irrigation of pistachios interplanted with cotton. Proceedings 28th Annual International Irrigation Show, 12/9-11/07, San Diego, CA.

Collaborative Efforts

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