



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.

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.

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 as the grower stopped all his Westside cotton production due to severe shortage of canal water.

Plant tissue analysis showed a significant 0.5 to 3 fold increase in chloride and boron levels in both cotton and pistachio tissues (Table 1), 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, however, 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. Lint yield, however, was reduced by 275 lb/ac compared to the Aqueduct water, but still excellent at 3.12 bale/ac. Increase in pistachio rootstock diameter and general tree development has been unaffected by salinity.

Salinity and sustainability: At the end of 2006, after three seasons of cotton irrigation, this program has applied about 6,900, 32,500 and 54,000 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 is much higher. Without 6 to 10 inches of effective rainfall or fresh water winter irrigation for efficient leaching this system may not be sustainable. The other uncertainty is the long-term fate of currently adsorbed boron. This soil has a huge fixation capacity, with a native total B content of 22 ppm. Current levels of soluble B, however, are only 2.5 ppm in our Well treatment. This concern, plus the decrease in cotton yield in 2006, combined with a nearly 20% increase in the Well water EC over the last four years has prompted the grower to insist that salinity treatments be cut in half of current levels as he is concerned for this long-term 310 acre investment. We will report on these changes next year.

Publications

Sanden, B.L., L. Ferguson, C. Kallsen, D. Corwin. 2006. Large-Scale Utilization of Saline Groundwater for Development and Irrigation of Pistachios Interplanted with Cotton. Proceedings of the Vth International Symposium on Irrigation of Horticultural Crops, *Acta Horticulturae* (accepted).

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

Table 1. Plant tissue nutrients, selected salts, growth characteristics, yield and applied salts for cotton and pistachio.

| | Cl (%) | B (ppm) | Root-zone EC _e to 5 ft (dS/m) | ¹ Cotton Ht, Pistachio Circum (inch) | Cotton Lint Yield (lb/ac) | ² Total Salts Applied in Irrigation (lb/ac) |
|-------------|--------------------|---------|--|---|---------------------------|--|
| 2004 | Cotn Petioles 8/27 | | 10/6/04 | 9/14/04 | 10/6/04 | Cotton'04 |
| Aque | 2.58 | 34 | 2.71 | 42.2 | 1933 | 2,343 |
| 50/50 | **3.23 | 37 | *4.08 | *35.8 | 1928 | 11,390 |
| Well | *3.00 | 37 | *4.68 | 38.8 | 2016 | 21,444 |
| 2005 | Cotn Petioles 9/15 | | 10/18/05 | 9/15/05 | 10/19/05 | Cotton'05 |
| Aque | 2.71 | 42 | 1.42 | 41.6 | 954 | 2,305 |
| 50/50 | *3.13 | 46 | 3.71 | 43.1 | 1129 | 10,144 |
| Well | **3.38 | **50 | *4.74 | 42.1 | 999 | 16,975 |
| | Pist Leaves 9/15 | | 10/18/05 | 10/19/05 | | Pistach'05 |
| Aque | 0.27 | 194 | 2.87 | 2.31 | | 1,742 |
| 50/50 | 0.27 | **492 | 4.12 | 2.17 | | 8,570 |
| Well | **0.38 | **673 | *4.44 | 2.18 | | 14,782 |
| 2006 | Cotn Petioles 9/21 | | 10/30/06 | 9/21/06 | 10/27/06 | Cotton'06 |
| Aque | 1.95 | 48 | 1.01 | 44.9 | 1835 | 1,967 |
| 50/50 | 1.91 | 55 | *3.61 | 45.0 | 1615 | 11,046 |
| Well | 2.21 | *56 | **4.63 | 40.9 | *1560 | 15,832 |
| | Pist Leaves 10/31 | | 10/30/06 | 10/19/06 | | Pistach'06 |
| Aque | 0.52 | 531 | 2.65 | 2.58 | | 1,022 |
| 50/50 | *0.58 | **954 | 4.34 | 2.55 | | 8,994 |
| Well | *0.62 | **1096 | *4.61 | 2.49 | | 11,104 |
| 2007 | Pist Leaves 6/19 | | | 4/27/07 | | Pistach'07 |
| Aque | 0.24 | 167 | | 2.68 | | |
| 50/50 | 0.28 | **315 | | 2.66 | | |
| Well | 0.30 | **384 | | 2.61 | | |

*Significantly different from Aqueduct @ 0.05, **Significant @ 0.01

¹Cotton height @ irrigation cutoff.

²Cotton cover = 12.7 feet/tree row

Pistachios = 9.3 feet/tree row

large-scale development and irrigation of pistachios interplanted with cotton. Water Resources Coordinating Conference. Woodland, CA 4/19/07.

Collaborative Efforts

USDA Salinity Lab: Dennis Corwin – Aerial and ground GIS data analysis; Patrick Taber, Don Suarez – modeling rootzone salinity.

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