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

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Irrigation districts across the state have seen water costs increase 3 to 5 fold in the last ten years. Growers of low value field crops like cotton are struggling to remain profitable. Some marginally saline drain and groundwater associated with over 250,000 acres of the Westside of the San Joaquin Valley (SJV) can be used to increase water supply and decrease costs for irrigating salt tolerant crops. An earlier 9 year study with pistachios indicates that they are about as salt tolerant as cotton. This study is testing the economic and cultural viability of a large, commercial-scale interplanting of cotton and pistachios using saline irrigation water.

Cotton has long been known as a salt tolerant crop, but despite many small-scale field trials over 30 years almost no marginally saline water in the San Joaquin Valley of California is used for long-term production. Over the same period, water costs have increased four to tenfold while cotton prices have stagnated. In 1990, State Water Project allocations to Westside irrigation districts went to zero; unleashing California's infant water market with the establishment of "Emergency Pool" water that could be bought for $100/ac-ft. Given the salt tolerance of cotton and other rotation crops on the Westside (such as processing tomatoes), some studies investigated utilizing fresh water blended with drainage from tile systems as a means of boosting available water supplies for furrow irrigation. This approach generated some interest since yields were maintained at similar levels to fresh water irrigations, but required a high degree of management with the possibility of long-term residual salinity problems that growers did not want to deal with. Farmers are looking for less expensive, more secure water supplies and more profitable crops. Work in Iran, salt tank studies at the USDA Salinity Lab, Riverside, and a small plot, 9-year study 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 subsurface drip tape. The fields have been farmed for more than 30 years, were well reclaimed (salinity averaged 1.57 dS/m to 3 feet) and had good drainage. We used fresh, blended 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, with excellent yields near 4 bale/acre.

In 2005, pistachio rootstocks were planted in March on a 22 foot row spacing interplanted with four 38 inch rows of pima cotton. Pistachios were budded with a Kerman scion in July. All cotton yields were disappointing at around 2 bale/acre, but increase in pistachio trunk circumference was excellent. Plant tissue analysis showed a significant 0.5 to 3 fold increase in

	NO3-N (ppm)	NH4-N (ppm)	PO4-P (ppm)	K (%)	Na (ppm)	Cl (%)	B (ppm)	[1]Cotton Ht, ΔPistachio Circum (inch)	Cotton Lint Yield (lb/ac)	Total Salts Applied in Irrigation (lb/ac)
	Petioles 8/27/04				**Cotton 2004**			**9/14/04**	**10/6/04**	**Cotton'04**
Aque	170	75	368	1.84	570	2.58	34	42.2	1933	2,343
Blend	273	95	463	1.73	712	**3.23	37	*35.8	1928	11,390
Well	548	108	413	1.72	574	*3.00	37	38.8	2016	21,444
	Petioles 9/15/05				**Cotton 2005**			**9/15/05**	**10/19/05**	**Cotton'05**
Aque	403	53	760	2.06	605	2.71	42	41.6	954	2,305
Blend	158	40	573	1.79	539	*3.13	46	43.1	1129	10,144
Well	288	85	593	1.91	546	**3.38	**50	42.1	999	16,975
	Rootstock Leaves 9/15/05				**Pistachio 2005**			**10/19/05**		**Pistach'05**
Aque	63	160	580	1.02	222	0.27	194	1.06		1,742
Blend	55	128	545	1.06	220	0.27	**492	0.94		8,570
Well	65	148	500	1.08	314	**0.38	**673	0.94		14,782

*Significant @ 0.05 **Significant @ 0.01

[1]Cotton height @ irrigation cuttoff and increased pistachio trunk circumference from 6/2 - 10/19/05.

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

chloride and boron levels in both cotton and pistachio (Table 1), but produced no toxicity symptoms. In spring 2006, cotton emergence was reduced by 14% (statistically insignificant) in the Well treatment compared to fresh water, and plant height was reduced earlier in the season. By the end of July, however, plant heights were about equal. Comparison of digital aerial analysis of the Normalized Difference Vegetation Index (NDVI) for August 2004 and 2006 also showed no treatment impacts. Thus, as of late summer 2006 there is no detriment to pistachio or cotton development due to salinity.

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 based on a 9.5 foot wide area (7.8 inches for the 22 foot row spacing). After three seasons of cotton irrigation this program results in about 6,900 lb/ac applied salt in the Aqueduct treatment and about 54,000 lb/ac in the Well treatment. Cotton will be grown one more season, and, with the continued help of the CA Pistachio Commission, the pistachios will be monitored at least until 10 years of age (2014).

Professional Presentations

Sanden, Blake, Louise Ferguson, Craig Kallsen and Dennis Corwin. 2006. Large-Scale Utilization of Saline Groundwater for Development and Irrigation of Pistachios Interplanted with Cotton. Vth International Symposium on Irrigation of Horticultural Crops, Mildura, Australia, August 2006.

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).

Collaborative Efforts

Aerial and ground GIS data are being analyzed in collaboration with Dennis Corwin of the USDA Salinity Lab, Riverside, CA and the majority of funding required for the next two years is provided by the CA Pistachio Commission in addition to funds from the UC Water Resources Center.

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