Use of drainage water for irrigation of melons and tomatoes

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Reuse of saline drainage water for irrigation is one management practice growers on the West Side of the San Joaquin Valley are considering to reduce its volume. This practice alone will not solve the long-term drainage problem in the valley; it must be coupled with a means of salt removal from the valley.

Reuse has been successfully tested on salt-tolerant field crops, but has not been extensively tested on vegetable crops, which occupy a significant acreage on the West Side. These crops are more sensitive to salinity than field crops are, and use of saline drainage water to irrigate them may require different management practices. Furthermore, since drainage water in this valley has been found to contain high amounts of selenium, the feasibility of reuse depends, in part, on the extent to which selenium is accumulated and distributed within the plant.

Reuse of saline drainage water to irrigate melons and tomatoes caused no loss of yield and no health hazards.

We designed and conducted four short-term (one season) studies in 1985 and 1986 at two locations on the West Side of the San Joaquin Valley to evaluate the effects of saline drainage water reuse on yield, fruit quality, and selenium accumulation in several melon varieties and processing tomatoes. Both are important crops in the area.

Field studies

Two of the four studies, one with melons the other with tomatoes, were carried out at the University of California West Side Field Station at Five Points, where the selenium concentration of the drainage water was 30 to 40 micrograms per liter (μg/L [=parts per billion, or ppb]) (table 1). Two similar experiments were done at Murrieta Farms in Mendota, where the selenium concentration in the drainage water was 250 to 350 μg/L. The locations were comparable with respect to soil type (Panoche clay loam) and salinity in terms of both electrical conductivity (EC) and ionic composition. The California Aqueduct water used for the controls was low in salts (EC 0.2 decisiemens per meter [dS/m]) and selenium (<5 μg/L) (table 1).

Plots in all studies were irrigated with California Aqueduct water until first flower, since most annual crops are more sensitive to salinity during early vegetative growth than at maturity. From first flower onwards, crops were irrigated with saline drainage water. Water was applied weekly to each plot by furrow irrigation in quantities sufficient to replace estimated losses by evapotranspiration (table 1). The saline and control treatments were replicated 4 to 12 times, depending on the study. Yield and soluble solids were determined at harvest and plant samples were taken for selenium analysis.

TABLE 1. Irrigation water quality and quantity used in the field studies

Location	Water quality: EC	Water quality: Selenium
	dS/m	*μg/L*
Saline drainage water		
Five Points	7.7 - 8.1	30 - 40
Mendota	7.7 - 8.1	250 - 350
Control*		
Five Points	0.2	<5
Mendota	0.2	<5

	Water applied: Before 1st flower		After 1st flower	
	Aqueduct	Drain	Control*	Drain
	inches			
Melons				
Five Points	3.0	—	9.2	9.6
Mendota	5.0	—	12.8	12.0
Tomatoes				
Five Points	5.0	—	18.9	18.9
Mendota	8.0	—	12.8	14.7

NOTE: μg/L (micrograms per liter) = ppb
* California Aqueduct water

Processing tomatoes irrigated with saline drainage water at the UC West Side Field Station in the summer of 1986.

Fruit yield

Irrigation of melons and tomatoes with saline drainage water from first flower to harvest did not significantly reduce yields at either location (table 2). Although average yields from melon plots irrigated with saline drainage water were less than those irrigated with aqueduct water (with the exception of casaba) the differences were not statistically significant. The yields reported here are similar to those commonly found in the San Joaquin Valley.

Soluble solids

Soluble solids (°Brix) in tomatoes at both locations and cantaloupes at Mendota were significantly increased by irrigation with drainage water (table 3). The °Brix values in melon fruit were highly variable within a given treatment, and consequently large differences between treatments were needed to be significant. The increase in soluble solids for tomatoes appears to be related to an increase in the soluble organic fraction rather than the accumulation of salts within the fruit. Fruit samples are currently being analyzed to test this theory.

Selenium content

The analytical procedure for selenium determination was tested and refined until an acceptable level of accuracy and reproducibility was obtained using National Bureau of Standards as reference material.

Irrigation with saline drainage water significantly increased the selenium concentration in melons and tomatoes in most cases (fig. 1). This effect, however, was not significant for honeydew fruit at Mendota or tomato fruit at Five Points.

Melons irrigated with saline drainage water at the West Side Field Station had only insignificantly lower yields than those irrigated with high-quality aqueduct water.

TABLE 2. Yields from field experiments using saline drainage water and nonsaline (control) water for irrigation

Crop	Fruit yield			
	Five Points		Mendota	
	Drain	Control	Drain	Control
TOMATOES:				
Processing (tons/ac)	41	41	39	40
MELONS:				
Honeydew (boxes/ac)	1,514	1,635	1,530	1,580
PMR-45 cantaloupe (boxes/ac)	704	826	879	897
Topmark cantaloupe* (boxes/ac)	785	805	—	—
Casaba* (tons/ac)	31	30	—	—

* These varieties grown only at UC West Side Field Station, Five Points.

TABLE 3. Soluble solids (°Brix) in melons and tomatoes irrigated with saline (drainage) and nonsaline (control) water

Crop	Soluble solids			
	Five Points		Mendota	
	Drain	Control	Drain	Control
	°Brix			
TOMATOES:				
Processing†	5.0*	4.6	5.9**	5.4
MELONS				
Honeydew	15.0	14.4	13.7	13.3
PMR-45 cantaloupe	11.3	11.1	12.5*	11.5
Topmark - cantaloupe‡	12.4	12.3	—	—
Casaba‡	10.0	9.4	—	—

*,** Indicates statistical significance at 5% and 1% confidence levels, respectively.
† Variety at Five Points was 'UC82B'; at Mendota, 'Murrieta'.
‡ Grown only at Five Points.

The data on plant selenium content indicate that:

☐ Melon and tomato fruits from plots irrigated with California Aqueduct water contained more selenium when grown at Mendota than at Five Points. This difference is probably related to the higher soil-selenium concentrations at Mendota than at Five Points.

☐ Melon and tomato fruits from plots irrigated with saline drainage water contained more selenium when grown at Mendota than at Five Points. The increased accumulation was not unexpected, since the selenium concentration in the drainage water at Mendota was eight to ten times higher than at the West Side Field Station.

☐ Selenium concentrations in tomato plants at Mendota were greater than those in melon plants grown under the same conditions in adjacent plots. This finding could be due to differences in the plants' ability to absorb and translocate selenium or differences in root distribution among species.

☐ Distribution of selenium within the shoot was similar for both melons and tomatoes. The concentration of selenium was highest in the leaves, intermediate in the stems, and lowest in the fruit.

Selenium levels were also determined in casaba and 'Topmark' cantaloupe grown at Five Points but were not reported in figure 1. Respective concentrations were 25 and 33 μg/kg dry weight in plants irrigated with a high-quality aqueduct water and 52 and 87 μg/kg dry weight in plants treated with drainage water.

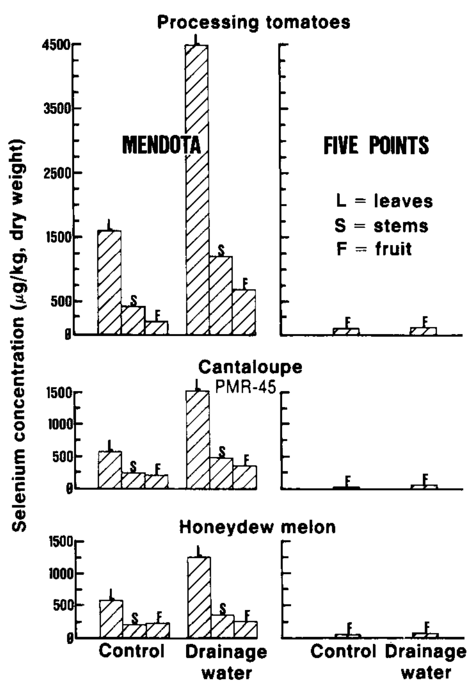

Fig. 1. Selenium was significantly higher in most fruit irrigated with saline drainage water rather than California Aqueduct water.

Conclusion

Melons and tomatoes accumulate selenium when irrigated with selenium-containing drainage water and when grown in soils high in selenium. Although the values are higher than those previously reported in the literature, the estimated daily intake of selenium would still be relatively low (6 to 8 μg selenium) and was not considered a health hazard by Dr. Anna Fan, Staff Toxicologist, California State Department of Health Services.

These findings seem to suggest that saline drainage water could be reused for irrigation of melons and tomatoes without incurring any loss of yield or health hazard. However, this interpretation is subject to obtaining more information on the practice of reuse over time: (1) its effects on the physical structure of the soil and on water infiltration; (2) influence on the buildup of soil salinity and accumulation of boron; (3) effects on accumulation of selenium and other toxic elements in the soil; and (4) methods of management to maximize plant performance and minimize adverse environmental effects. A long-term rotation study was initiated in 1986 at the West Side Field Station to address many of these concerns.

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