Use of greywater and brackish groundwater for cotton production

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Outline

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Introduction

Water conservation and waste disposal are increasing challenges in Texas

Increase in demands on both potable water and irrigation water for landscapes

Irrigation with degraded water often destroys soil structure and reduces water infiltration with a harmful impact on crop yields (Yaron et al., 1973)

Long-term irrigation with greywater rich in surfactants might cause their accumulation in the soil and form water repellent soils (Shafran A., 2005)
Objectives

Evaluate impacts of greywater and brackish water irrigation on cotton production and soil salinity

Evaluate the effectiveness of co-utilization of an organic mulch with marginal water in conditioning soils to maintain soil tilth and prevent aggregate instability
Materials and Methods

Site Characterization

Rogelio Sanchez, Texas State Prison in El Paso, TX, (on a desert mesa)

The soil was loamy sand underlain by shallow to deep layers of caliche (calcium carbonate)

Each of 4 blocks were split into ½ with a separate base between them; one with mulch/one without
Materials and Methods

Experiment site
Materials and Methods

Source water and irrigation

Laundry water (Greywater)
- About 11 loads of laundry washing per day at the prison
- 2 wash, 2 rinse cycles & 1 sour bath; rinse water recycled → 3,500 gal
- Remaining greywater → subsurface trap → wastewater system

Brackish groundwater
- Well adjacent to the prison property
Materials and Methods

Source water and irrigation

- Blocks were irrigated twice a week with either 250 or 500 Gallons/plot (567 sq.ft) (0.005 or 0.01 in/acre) 5/12 – 9/29

- A total of 33 in. of laundry water or well water were applied to plots

- El Paso rainfall is typically < 10 in. during growing season
  - Total rainfall was 18.14 in.

- Annual pan evaporation is approximately 100 in.
  - over 70 inches is during the growing season
Materials and Methods

Cotton Planting

The cotton is from Delta & Pine

- West Texas, Oklahoma, Kansas & New Mexico

Cotton seeds were planted manually

- May 12; surface soil @ 70°F.
Materials and Methods

**Sampling and data collection**

- **Echo™** soil moisture sensors placed 6, 12, and 18 in.
  - Data collected at an interval of 15 min.

- **Prior planting:**
  - Soil samples were collected from the top 6 in.
  - Laundry and well waters - characterize salts, nutrients, & metal concentrations

- **After planting:**
  - Soil & water samples → 6-21, 7-21, 8-11, 9-15, 10-19 & 11-10
  - Soil samples from 6 to 12 in. depth → 11-10
Materials and Methods

**Sampling and data collection**

- **Plants heights**
  - June 13, July 14, August 4 & September 21

- **Boll weevil and pinky bollworm traps**
  - Texas Boll Weevil Eradication Program West Texas Office staff

- **Seed cotton and lint yields**
  - Each sample - 5 cotton plants on Nov. 10
# Results

## Laundry and brackish water quality

<table>
<thead>
<tr>
<th>Chemical Parameter</th>
<th>Field Experiment</th>
<th>El Paso Water Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laundry Water</td>
<td>Brackish Water</td>
</tr>
<tr>
<td>pH</td>
<td>8.19 (0.41)</td>
<td>7.72 (0.19)</td>
</tr>
<tr>
<td>EC(^1) (dS m(^{-1}))</td>
<td>1.54 (0.28)</td>
<td>2.61 (0.12)</td>
</tr>
<tr>
<td>Available Ca (mg L(^{-1}))</td>
<td>20.4 (4.68)</td>
<td>120 (7.45)</td>
</tr>
<tr>
<td>Available Mg (mg L(^{-1}))</td>
<td>5.72 (0.35)</td>
<td>25.3 (0.94)</td>
</tr>
<tr>
<td>Available Na (mg L(^{-1}))</td>
<td>320 (50.96)</td>
<td>438 (33.03)</td>
</tr>
<tr>
<td>SAR (mmol(^{1/2}) L(^{-1/2}))(^2)</td>
<td>16.0 (2.06)</td>
<td>9.44 (0.45)</td>
</tr>
<tr>
<td>Cl (mg L(^{-1}))</td>
<td>139 (6.17)</td>
<td>420 (57.07)</td>
</tr>
<tr>
<td>NO(_3) (mg L(^{-1}))</td>
<td>3.44 (1.89)</td>
<td>4.37 (1.15)</td>
</tr>
<tr>
<td>PO(_4) (mg L(^{-1}))</td>
<td>8.29 (0.03)</td>
<td>0.00 (0.00)</td>
</tr>
<tr>
<td>SO(_4) (mg L(^{-1}))</td>
<td>151 (7.87)</td>
<td>675 (92.4)</td>
</tr>
</tbody>
</table>

\(^1\) EC, Electrical Conductivity  
\(^2\) SAR, Sodium Adsorption Ratio  

Values provided in parentheses, represent standard deviations of mean.
Results

Irrigation and soil moisture

- Soil moisture < 20% on a volumetric basis
- The effective root zone (6-in. moisture) was dry → deeper soil

- Mulch may help to retain higher moisture
- Surface soil moisture was also slightly variable among blocks
- Soil moisture changes from sensors at the 18-in depth
  - Groundwater contamination from greywater irrigation was minimal due to high evapotranspiration and deep groundwater levels.
Results

Soil salinity

SAR
- Reduced from 10 - 2 by heavy rainfall in summer & end of growing season
- Mulching increased it w/laundry water by 40%
- Mulching decreased it w/well water by 30%
- Decreased w/depth, below mulch, except W/No mulch & well water

EC
- High at the beginning of the season & low after heavy rain
- EC increased with depth, because caliche (CaCO3) in deeper zones

In general, the soil was moderately alkaline

Salts accumulated at the soil surfaces regardless of irrigation water, not detrimental
Results

Soil salinity (CONT)

Changes in SAR EC for all treatments and water types during field experiment.
Results

Soil salinity (CONT)

Changes in SAR and EC with depth for all treatments and water types at the end of experiment
Results

Growth of cotton

- Soil conditioning improved growth rate of cotton - earlier growth periods
- Cotton plants irrigated with laundry water grow better → brackish water
- W/N mulch & laundry water - height 5 in. higher → brackish water
- Mulch improved growth of cotton plants for both irrigation waters
- Soil conditioning effects were greater for cottons W/brackish well water → laundry water
- Soil conditioning could lessen impacts of water salinity
Results

Growth of cotton (CONT)

Growth patterns of cotton under different conditions
Results

Seed cotton and lint yield

- The lint turnout: 42% laundry water & 43% well water

- Laundry water irrigation produced:
  - 77% more seed cotton
  - 70% more lint → brackish well water W/N mulch

- With soil conditioning:
  - Laundry water produced 65% more lint → W/N mulch
  - Brackish groundwater produced cotton/lint 1.5 times higher → W/N mulch
  - Laundry water produced 14% more seed or 10% more lint → brackish water

- Brackish well water could be used more efficiently with appropriate soil conditioning
Conclusions

- Cottons irrigated with laundry water:
  - Grow higher
  - Produce more lint

- With mulch conditioning:
  - Cottons grew almost at the same rate regardless irrigation water
  - Brackish groundwater could be used more efficiently
  - Altered distribution of salinity & sodicity

- Salts accumulated at the soil surfaces regardless of irrigation water source, but not detrimental

- Recommend to conduct additional experiment study on long term impacts.
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