Alfalfa Management For Saline Soils

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Alforex Seed is proud to be a co-sponsor of this Alfalfa U with New Holland and the High Plains Journal.
CAL/WEST SEEDS & DAIRYLAND SEEDS

One of Largest Forage Breeding Companies in North America
Saline/Marginal Soils

In Broad terms the differences between marginal soils are based on:

- Dissolved salts
- Variations in pH
- Sodium (Na) content
Saline and/or Marginal Soils

Soil Types:

Saline
Alkaline
Alkali

Are these the same?
Saline Soil
– High in dissolved salts EC>4
  (Can vary as to pH)

Alkaline Soil
– pH above 8.5

Alkali Soil
– high levels of Sodium(Na)> 15%
Factors Affecting Soil Structure And Water Infiltration

Sodium Absorption Ratio (SAR): Ratio of soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with soil.

*SAR>13 -> poor soil structure -> poor water infiltration and percolation -> less leaching of salts out of soil profile and root zone
Saline Soils

- **Saline soil** is defined as one with enough salts in soil solutions to interfere with crop growth.
- ECe > 4dS/m.
- Alfalfa ECe > 2 (7.5% yield reduction per point above 2 (non saline Tolerant alfalfa varieties)
- **Salts:** most common sodium sulfate (Na2SO4) and sodium chloride (NaCl)… chlorides, sulfate, or bicarbonates of sodium, calcium, magnesium, and potassium.
Salinity Overview

Problem Salt Areas in U.S. & Can

• Dry Environments or Irrigated farm land
• Saline Seeps, High water tables
Water Quality

Good quality water
TDS < 300 mg/L or EC 0.5 dS/m

Poor quality water
TDS > 300-800 mg/L or EC of 0.5 => 1.2 dS/m
California Aqueduct Irrigation water deposits 600-700 lbs of salt per acre foot of water applied.

A full irrigation season of 4 acre feet deposits 1.2 tons of salt per acre
Manure high in salts
Saline Seep Problems
Very Wet Years

Long Term Problem
# Measuring Soil & Water Salinity

## Conversion Chart

<table>
<thead>
<tr>
<th>%</th>
<th>g/L</th>
<th>Mpa</th>
<th>bars</th>
<th>EC or dS/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>5</td>
<td>-0.28</td>
<td>-0.3</td>
<td>7.8</td>
</tr>
<tr>
<td>0.75</td>
<td>7.5</td>
<td>-0.42</td>
<td>-4.2</td>
<td>11.7</td>
</tr>
<tr>
<td>1.00</td>
<td>10</td>
<td>-0.56</td>
<td>-5.6</td>
<td>15.6</td>
</tr>
<tr>
<td>1.25</td>
<td>12.5</td>
<td>-0.70</td>
<td>-7.0</td>
<td>19.4</td>
</tr>
<tr>
<td>1.50</td>
<td>15</td>
<td>-0.84</td>
<td>-8.4</td>
<td>23.3</td>
</tr>
<tr>
<td>1.75</td>
<td>17.5</td>
<td>-0.98</td>
<td>-9.8</td>
<td>27.2</td>
</tr>
<tr>
<td>2.00</td>
<td>20</td>
<td>-1.12</td>
<td>-11.2</td>
<td>31.1</td>
</tr>
</tbody>
</table>
Relative Salt Tolerance of Agricultural Crops*
(Yield Reduction Estimates**)

<table>
<thead>
<tr>
<th>Crop</th>
<th>0% ECE</th>
<th>0% ECw</th>
<th>10% ECE</th>
<th>10% ECw</th>
<th>25% ECE</th>
<th>25% ECw</th>
<th>50% ECE</th>
<th>50% ECw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>2</td>
<td>1.3</td>
<td>3.4</td>
<td>2.2</td>
<td>5.4</td>
<td>3.6</td>
<td>8.8</td>
<td>5.9</td>
</tr>
<tr>
<td>Barley</td>
<td>8</td>
<td>5.3</td>
<td>10</td>
<td>6.7</td>
<td>13</td>
<td>8.7</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>Bermuda Grass</td>
<td>6.9</td>
<td>4.6</td>
<td>8.5</td>
<td>5.6</td>
<td>11</td>
<td>7.2</td>
<td>15</td>
<td>9.8</td>
</tr>
<tr>
<td>Corn</td>
<td>1.7</td>
<td>1.1</td>
<td>2.5</td>
<td>1.7</td>
<td>3.8</td>
<td>2.5</td>
<td>5.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Sorghum</td>
<td>6.8</td>
<td>4.5</td>
<td>7.4</td>
<td>5</td>
<td>8.4</td>
<td>5.6</td>
<td>9.9</td>
<td>6.7</td>
</tr>
<tr>
<td>Sudangrass</td>
<td>2.8</td>
<td>1.9</td>
<td>5.1</td>
<td>3.4</td>
<td>8.6</td>
<td>5.7</td>
<td>14</td>
<td>9.6</td>
</tr>
<tr>
<td>Wheat</td>
<td>6</td>
<td>4</td>
<td>7.4</td>
<td>4.9</td>
<td>9.5</td>
<td>6.3</td>
<td>13</td>
<td>8.7</td>
</tr>
</tbody>
</table>
\( EC_e = \text{Means average root zone salinity as measures by electrical conductivity of the saturation soil extract} \)

\( EC_w = \text{electrical conductivity of the irrigation water} \)

\( EC_e = 1.5 \cdot EC_w \)
Soil and Water Management

ALFALFA MANAGEMENT FOR SALINE SOILS

A Guide for Producers, Extension, and Seedsmen
Soil Amendments

• Improves Soil Structure
• Follow Soil Lab Recommendations
Soil Amendments

- **Sodic soils**
  (poor soil structure and water infiltration)

- **Gypsum**
  (provides calcium in high pH soils)

- **Sulfur**
  (lowers pH to free up calcium)

- **Manure or Organic matter**
Remediation of Saline Soils

Crop Rotation and Crop Selection

- Crop Species
  - Tolerant to level of salinity
  - As soil improves with integrated soil and water management, move to higher value tolerant crops
Plant Breeding Solution ?? ?? Alfalfa
Salinity Affect On Alfalfa Plant Growth
## Alfalfa Germination

<table>
<thead>
<tr>
<th>Reduction</th>
<th>ECe</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Limitations</td>
<td>&lt; 1.0</td>
</tr>
<tr>
<td>5-10% seedling mortality</td>
<td>1.0-2.0</td>
</tr>
<tr>
<td>10-35 % seedling mortality</td>
<td>2.0-4.0</td>
</tr>
<tr>
<td>35-75% seedling mortality</td>
<td>4.0-8.0</td>
</tr>
</tbody>
</table>

Data from USDA Soil Salinity Lab, Riverside, CA
# Alfalfa Yield

<table>
<thead>
<tr>
<th>Reduction</th>
<th>PPM</th>
<th>EC&lt;sub&gt;e&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa “Threshold”</td>
<td>1286</td>
<td>2.0</td>
</tr>
<tr>
<td>Alfalfa 10% Yield Loss</td>
<td>2186</td>
<td>3.4</td>
</tr>
<tr>
<td>Alfalfa 25% Yield Loss</td>
<td>3472</td>
<td>5.4</td>
</tr>
<tr>
<td>Alfalfa Stops Growth</td>
<td>10228</td>
<td>16.0</td>
</tr>
</tbody>
</table>

Data from USDA Soil Salinity Lab, Riverside, CA
Alfalfa Breeding Objective

- Increase Alfalfa’s establishment rate in Saline Soils *(Germination)*
- Increase Alfalfa’s Salinity “Threshold” *(Mature Plant)*
- Reduce Yield loss due to Salinity

**Maintain Yield on Non-Saline Soils**
Salinity Tolerant Alfalfa

Multiple Cycles

Original Population

EC = 20
Yield Salt Screening in Containers
Survival
Salt Tolerant Alfalfa Selection
Salinity Tolerance: Conventional Breeding (Non-GMO)

Combined Resistance Testing
Salt Trials
Dickinson Research Extension Center

North Dakota State University

Alfalfa Variety Trial

Salt Tolerance

Cooperator:
Golden Valley County Conservation District

Sponsored By:
Golden Valley Extension Service
Target Seeds
Cal West Seeds
<table>
<thead>
<tr>
<th>Crop</th>
<th>Salinity Index*</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Saltlander</td>
<td>12.51</td>
</tr>
<tr>
<td>Tall Wheatgrass</td>
<td>11.73</td>
</tr>
<tr>
<td>Barley</td>
<td>8.29</td>
</tr>
<tr>
<td>Improved Saline Tolerant Alfalfa</td>
<td>8.27⁺</td>
</tr>
<tr>
<td>Canola</td>
<td>8.00</td>
</tr>
<tr>
<td>Slender Wheatgrass</td>
<td>7.84</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>6.79</td>
</tr>
<tr>
<td>Durum Wheat</td>
<td>5.20</td>
</tr>
</tbody>
</table>
Salt Hot Spot in Alfalfa Field

EC = 4-8 (75% seedling mortality)

Each EC point above 2 = 7.5% yield loss
Salinity Tolerant Variety:

Provides increased revenue on marginal land

PGI 427
# North Dakota Saline site

(4 yrs. Forage Yield)

<table>
<thead>
<tr>
<th>Variety</th>
<th>% Vernal</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGI 427</td>
<td>128</td>
</tr>
<tr>
<td>Rugged</td>
<td>128</td>
</tr>
<tr>
<td>Vernal</td>
<td>100</td>
</tr>
</tbody>
</table>
Cisco II Alfalfa
Saline Ground (dairy)
Roswell, NM
Maximizing your Profit in Saline Soils: New Saline Tolerant Forage Varieties
Salinity Tolerant Varieties

- Varieties are now available with improved germination and forage production under saline stress.

- **Common misconception:** Saline tolerant alfalfa’s are only for use on saline soils. *Good for all alfalfa production!! Just has additional beneficial trait, just like pest resistance.*
Varieties

- Rugged
- PGI 427
- AFX 457
- Magnum Salt
- Cisco II

Alfalfa

Grass

AC Saltlander
Alfalfa Management with Low to High Salt Levels

• Conduct a soil and water test to determine extent and severity of salinity
• pH: optimal 6.5-7.5 (6-8.4)
• SAR < 13
• EC range 4-8 (soluble salts)
• EC Above 8 consider other species
Saline Soils

pH: Saline soils can vary as to pH

- Salinity tolerance is independent of pH tolerance.

Alfalfa optimal pH 6.5-7.5 (6 - 8.4)

- Lime for acid soils
- Alkaline soils
  - sulfur, acid fertilizers, gypsum
Planting Considerations For Saline Tolerant Varieties

• Realistic expectations!!
• Improved varieties can provide improved stand establishment and yield on marginal soils.
• Integrated approach to salinity
Planting Considerations

- **Seeding Rates**
  (Plant on high end of recommended rates for irrigated or dryland)

- **Seed Mixtures**
  (Two or more species can provide broader adaptation in variable soils)
Planting Considerations

- Planting Time
  - Moisture
  - Crusting
Planting Considerations

- Seed placement /depth  
  (seed to soil contact)

- No-till drill
Planting Considerations

Check Soil Fertility

Healthy plants tolerate more stress
Summary

1. Salinity problem requires an integrated approach
Summary

2. Improved saline tolerant varieties help reduce size of salt hot spots in field (more productive acres on farm)

3. Saline tolerant varieties are also top yielders in non saline fields
Managing Saline Seeps
Long Term Integrated Approach

Reduce the water table of saline seeps by utilizing salt tolerant alfalfa with tolerant grass species
Alfalfa Saline Seep Control

Salt Tolerant Grass
(AC Saltlander)
Alfalfa Extracting water from soil Profile

Wet Low Ground

Soil

Water Table

Water
Recharge Zone Planted to Alfalfa

Flooded Low Ground
Be sure to cash in on the Grower Rewards inside your Registration Packet.

Enjoy this afternoons program.

Thank You!