Evaluation of adaptability, yield, and boron tolerance of Agretti (Salsola soda L.) grown on poor quality soils of the San Joaquin Valley in Central California

Elizabeth G. Mosqueda
California State University, Fresno

Duration of Project: January 2015-May 2015
Advisor: Dr. Gary Bañuelos, USDA-ARS
Report Submitted: December 31, 2015
# Table of Contents

Acknowledgments .................................................................................................................. 2

Executive Summary .................................................................................................................. 3

Project Objective .................................................................................................................... 3-4

Project Approach ................................................................................................................... 5-6

Project Outcomes .................................................................................................................. 6-7

Conclusions ............................................................................................................................ 7

Appendices .............................................................................................................................. 8-12
Acknowledgements

This project was supported by Hispanic-Serving Institution’s Education Program Grant no. 2015-38422-24058 from the USDA National Institute of Food and Agriculture.

I would like to thank the USDA-ARS of Parlier, Ca. and Dr. Gary Bañuelos for being a great mentor during the duration of this process, as well as his research team for their assistance throughout the project. Last, I would like to thank California State University, Fresno and California State University, San Bernardino for allowing me to participate in this internship.
Executive Summary

Drought and reduced availability of good quality water for soils high in salts and boron has affected irrigated agriculture in the Westside soils of California. One of the most promising ideas to manage saline soils and drainage water produced on such soils is to plant alternative drought, salt and boron tolerant crops. During the summer of 2015, a study was conducted to evaluate how well Salsola soda, more commonly known as “Agretti,” can tolerate high levels of salt and B present in soils and irrigation water. The study gave promising results, as Agretti not only grew, but thrived in these conditions. These results could potentially lead to the planting of Agretti, which may aid growers by producing a crop of economical value that can also manage salts and boron in soils and in drainage water by plant accumulation.

Project Objectives

California entered its fourth year in one of the state’s worst droughts in reported history, making high quality irrigation water for crops a scarce commodity. Drought-limited irrigation has impacted California growers in various ways. One of the most detrimental problems arises when growers in the Westside of Central California saturate their fields to try and flush excessive salts from the saline soil. They employ this strategy so that crops can grow in the saline soil. When they leach these soils, the result is the production of drainage water of poor quality (high in salts and B), or water not taken up by crops or absorbed into the water table. Consequently, soils with high amounts of salts and B produce poor quality drainage water. There have been many efforts in trying to figure out what to do with this drainage water, since the San Luis Drain (used to transport drainage water into the Delta and eventually into the ocean) was closed.
One of the most promising ideas to manage saline soils and drainage water is being researched at the USDA-ARS in Parlier, California. Dr. Bañuelos is trying to identify and plant alternative salt and boron tolerant crops that will allow growers to grow crops, which can be used as recipients for poor water quality in their saline soil.

The proposed crop, *Salsola soda*, more commonly known as “agretti,” is a halophyte native to the Mediterranean Basin. *Salsoda* L. generally grows in coastal regions and is known as a “biodesalination companion plant” of tomatoes and peppers in saline soils to reduce salinity by taking up salt-related ions and thereby increase yield of the companion vegetables. To our knowledge, this is the first study to evaluate the potential of growing *S.soda* as a salt and B tolerant alternative crop when irrigated with drainage water in the Westside of the SJV.

The aim of this study is to evaluate adaptability, salt resistance, and B accumulation by *S. Soda* grown on saline soils collected from Five-Points, in the Westside of the Central California. We hypothesized the following: a) *S. soda* will tolerate the salts and B present in the soil and/or in irrigation saline water; and b) *S. soda* will accumulate and remove B from the soil irrigated with drainage water.

As a student of Plant Science at California State University, Fresno, this opportunity exposed me to the field of “agriculture research” and potentially opened many doors of opportunity for my future career. My goals during this internship were to become a better rounded and more knowledgeable researcher, which I believe I have acquired from this research opportunity. With this hands on research experience, I can certainly now see myself pursuing a career with the USDA-ARS, preferably in a field of water-related issues, as I have learned from my mentor, Dr. Bañuelos.
**Project Approach**

On each day of March 24, April 01, and April 07, 2015, three trays with 24x8 cells were planted with Agretti seeds purchased from a distributer in Italy. Each cell was carefully filled two thirds of the way with Sungro Professional Growing Mix seeding soil, as to not compact the soil. One Agretti seed was placed within each cell, and then covered with the seeding soil. The seeding trays were then saturated with tap water using a mister nozzle. The seeding trays were kept in a greenhouse, which was maintained at temperatures ranging from 76 - 82°F. Following seeding, each tray was watered daily by lightly misting with tap water. Plant germination was exhibited approximately 7 to 15 days prior to seeding. On April 22, 2015, the Agretti plants were transplanted into sterilized 1 gallon pots filled with 2.8 kg of a clay loam soil, which had a salinity level ranging from 2-4 ds/m and were saturated with 700 mL of tap water the day prior. A total of 24 pots containing 4 Agretti plants were kept in the same greenhouse conditions and the seedlings were irrigated daily with tap water. On May 21, 2015, each pot was given 1 gm of Miracle Grow fertilizer.

When it came to treating the plants, the experimental design was a Randomized Complete Block design with 5 irrigation treatments as follows: 1) tap water, which served as our control; 2) 5mg B /L solution; 3) 10 mg B /L solution; 4) 15 mg B /L solution, and 5) 25 mg B /L solution. The selected B concentrations represent typical high B levels found in drainage water produced on excessively saline and B laden soils. 4 pots were randomly assigned as the Control pots, and each of the B treatments were randomly assigned 5 pots. Each pot was appropriately labeled with label tape indicating which treatment it belonged to. On May 5, 2015, small plastic cups with small perforations at the bottom were added to the center of each pot, which served as a slow release percolation method for irrigation and B solution. Treatments
began on May 22, 2015 by irrigating each pot with 50-200 mL of its respective treatment solution depending on water needs of the plants.

On June 26, 2015, two plants from each pot were randomly chosen and cut at the base of the plant at the soil surface. Roots of these cut plants were not collected to ensure the remaining two plants were not damaged. Each plant was weighed, then placed into labeled paper bags, and then placed into a drying oven kept at 65°F. After two days of drying, the plants were then each weighed.

On July 22, 2015, irrigation of treatments stopped and on July 23, 2015 the remaining two plants were cut at the base of the plant at the soil surface, weighed, measured, placed into appropriately labeled paper bags, and placed into a freezer kept at -80°F. Roots from these two plants were also collected, cleaned as best as possible, weighed, and also placed into the same freezer.

**Project Outcomes**

There was no significant difference between fresh or dry weight among treatments from the data collected on June 26, 2015. Fresh weight averages for each treatment were: 1) 94.9 g.; 2) 98.54 g.; 3) 98.82 g.; 4) 85.84 g., and 5) 93.08 g. (Figure 1). Dry weight averages for each treatment were: 1) 22.075 g.; 2) 22.44 g.; 3) 21.14 g. ; 4) 18.4 g., and 5) 19.84 g. (Figure 2).

Plant weight and height data collected on July 22, 2015 showed no significant differences among treatments. Fresh weight averages for each treatment were: 1) 116.3 g.; 2) 99.64 g.; 3) 111.12 g.; 4) 120.96 g., and 5) 102.66 g. (Figure 3), and plant height averages were: 1) 78.25 cm.; 2) 77.5 cm.; 3) 76.8 cm.; 4) 78.2 cm., and 5) 75.1 cm. (Figure 4).

Our findings indicate Agretti has a high level of tolerance for both high saline soil conditions, as well as high levels of B in irrigation water. No differences were observed between
both sampling dates. Also, no toxicity symptoms were observed on any of the plants within this study at any time, which indicated Agretti may accumulate and tolerate high levels of B and salts, or that Agretti has a very effective method to excrete or eliminate these salts and/or B.

**Conclusions**

Agretti, (*Salsola soda*), was evaluated to see if it could tolerate high levels of salt and B present in soils and irrigation water. The study indicated that Agretti could not only grow, but thrive in these normally harmful conditions. Because no symptoms of salt or B toxicity were exhibited on the Agretti plants throughout the project’s duration, it is assumed that most of these elements are being accumulated and tolerated in the above ground tissue, and perhaps in below ground plant material. Further chemical analysis should take place with the collected samples to indicate if this hypothesis is correct. If this trial is repeated, higher rates of B solutions should be tried to determine the threshold of B and salt accumulation for this plant.

During the duration of this internship, I have gained valuable insight as to how to properly run and maintain a scientific experiment. I have worked in both field and lab conditions, which have expanded not only my knowledge, but also my research skills as well. This learning opportunity has helped me realize that positions with the USDA-ARS, specifically within the field of water management, are very desirable to me. Because of this internship, I now know I have what it takes to obtain a technician position with the USDA-ARS.
Appendices

Figure 1

6/26/2015
Agretti Fresh Weight Average

<table>
<thead>
<tr>
<th>Weight in grams</th>
<th>Control</th>
<th>5 mg B/L</th>
<th>10 mg B/L</th>
<th>15 mg B/L</th>
<th>25 mg B/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2

6/26/2015
Agretti Dry Weight Average

<table>
<thead>
<tr>
<th>Weight in grams</th>
<th>Control</th>
<th>5 mg B/L</th>
<th>10 mg B/L</th>
<th>15 mg B/L</th>
<th>25 mg B/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pic. 1 - Transplanting Agretti.

Pic. 2 – Transplanted Agretti.

Pic. 3 – Overview of Agretti and its watering cup.

Pic. 4 – Side view of Agretti.
Pic. 5 – Agretti trial.

Pic. 6 – Irrigating Agretti.

Pic. 7 – Trial solution treatments.
Pic. 8 – Example of Agretti with no B treatment at harvest.

Pic. 9 – Example of Agretti with highest B treatment at harvest.

Pic. 10 – Harvesting Agretti plant samples.

Pic. 11 – Measuring Agretti plant sample.