Validation of Vetiver System for the improvement of irrigation water in Arica Province, Chile

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- **Implemented by Tarapacá University**
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OBJECTIVES

- To validate the remediation efficacy of vetiver in waters contaminated with boron, arsenic and heavy metals.

- To introduce new crops sensitive to boron in the Lluta valley (irrigated with remediated water)

VALLEYS IN ARICA PROVINCE

- The valleys of Arica Parinacota Province in Northern Chile present outstanding climatic conditions that allows crop production all year long, **the province is the supplier of fresh vegetables for both central and southern Chile** during winter, placing Arica´s valleys as one of the key factors in food security, specially Azapa valley which has excellent water quality producing 3,2% of the national total for horticulture.

The valleys on Arica are inserted in a desert region where salinity, boron and arsenic are in high concentrations in rivers, as well as in soil, as in the Lluta Valley

soil can reach 40 mg boron/L, while the Lluta River can reach 23 mg boron/L

Only crops to grow: Corn var. Lluteño (ecotype), Alfalfa var. alta sierra, beets, brocoli and onios

Vetiver growing on a Boron contaminated soil (35 mg/l) and irrigated with water high in B (16 mg/l), Arica Province

Boron toxicity for crops

- Very sensitive (< 0,5 mg/l): lemon;
- sensitive (0,50 - 0,75 mg/l): avocado, grapefruit, orange, apricot, peach, onion;
- moderadatly sensitive (1,00 - 2,00 mg/l): garlic, wheat, strawberry, bean;

- moderatly tolerants (2,00 - 4,00 mg/l): lettuce, cabage, corn, artichoke;
- tolerants (4,00 - 6,00 mg/l): tomato, alfalfa, beets;
- very tolerants (6,00 - 15,00 mg/l): cotton, aspargus.

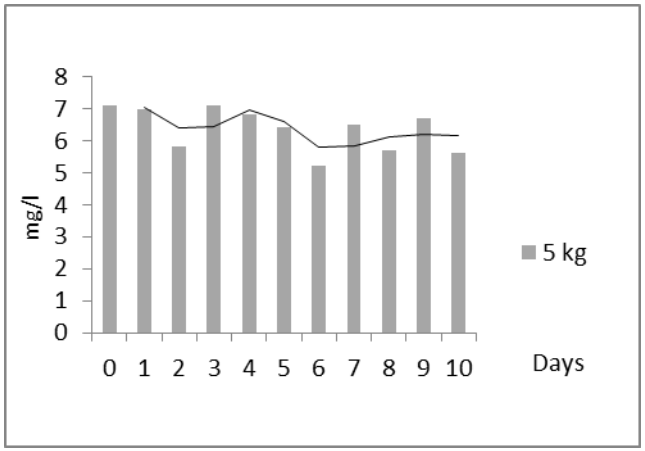
A field experiment was established to introduce 4 new crops and irrigated with Vetiver remediated water, the boron level decreased by 1.5 to 2.5 mg/L.

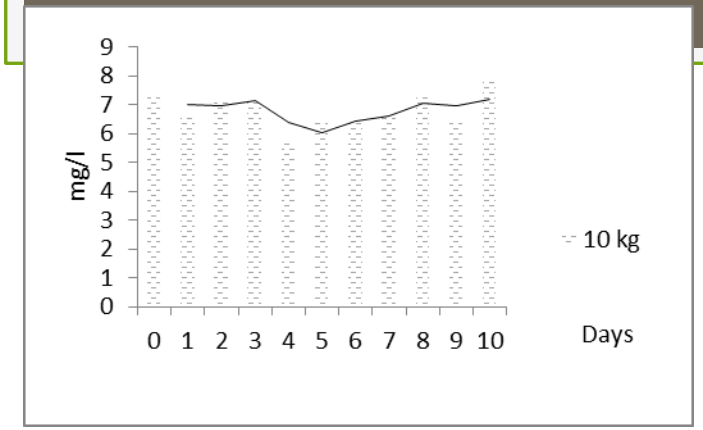
- Melons
- Lettuce
- Sweet corn
- Chilli pepper var. Cristal
- **None of this crops are able to grow in soil high in boron**

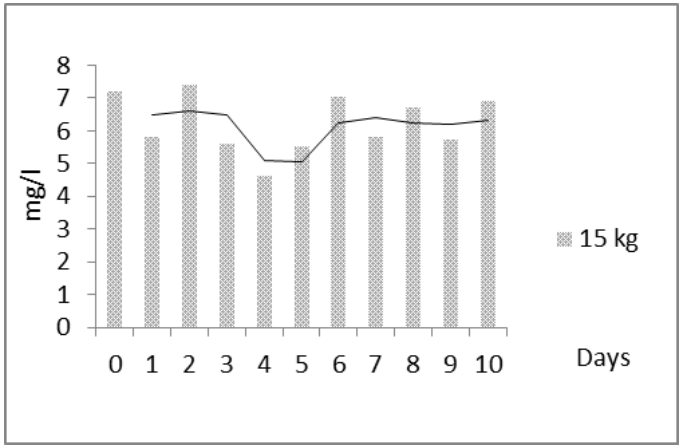
BORON IN IRRIGATION WATER

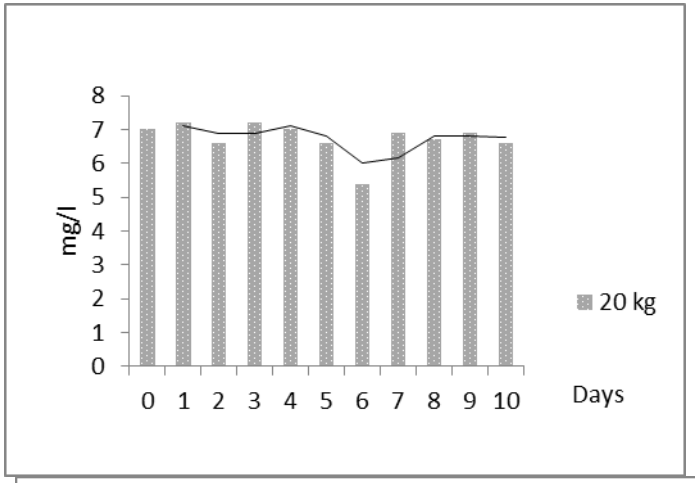
Boron decreased 21.5% average (7 a 5.5 mg/L per 2-4 days)

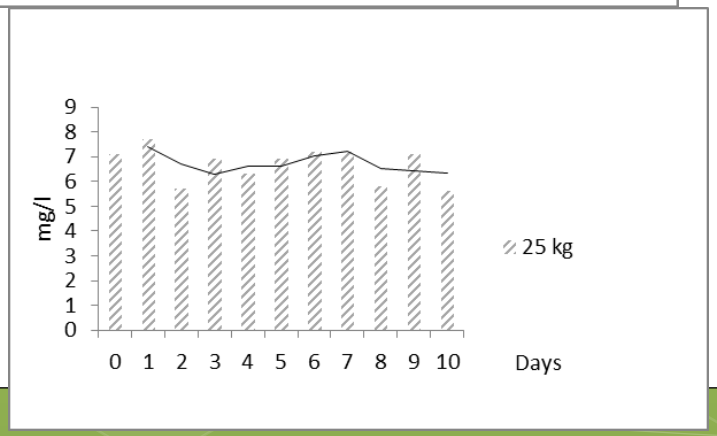
Tendency of Boron Phytoremediation in Water with Different Biomass











Sweet corn

Lower boron in irrigation water allowed the crops to grow with high to good yields

All corn was extra quality in this trial.
While the Azapa valley has only first and second quality

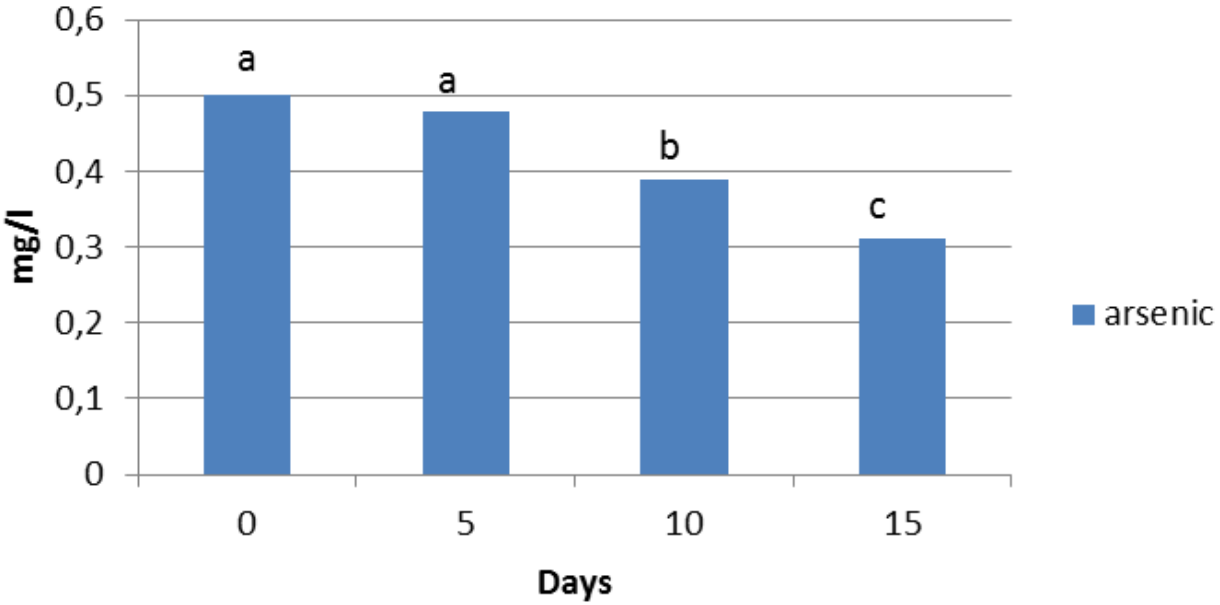
Lettuce; first quality

Yields were equal to others valleys (Azapa valley) in the Province where there is no boron contamination

Melon; second quality

Chilli peppers; extra and first quality

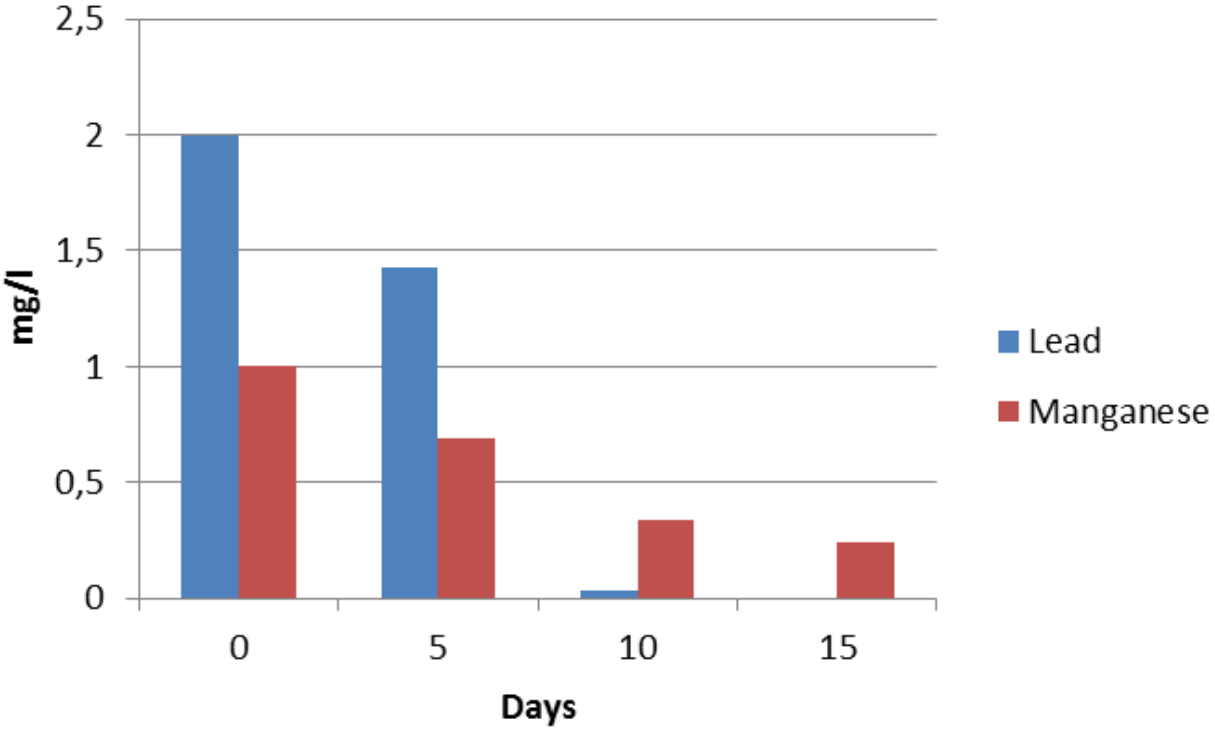
Residual As concentration in water (mg/L) at different sampling periods (n=6). T1 (600 g biomass), T2 (1000 g biomass).



+Mean values within the same column denoted by different letters are significantly different ($P < 0.05$) according to Duncan´s range test. * P < 0.05, **P <0.01. NS; not significant

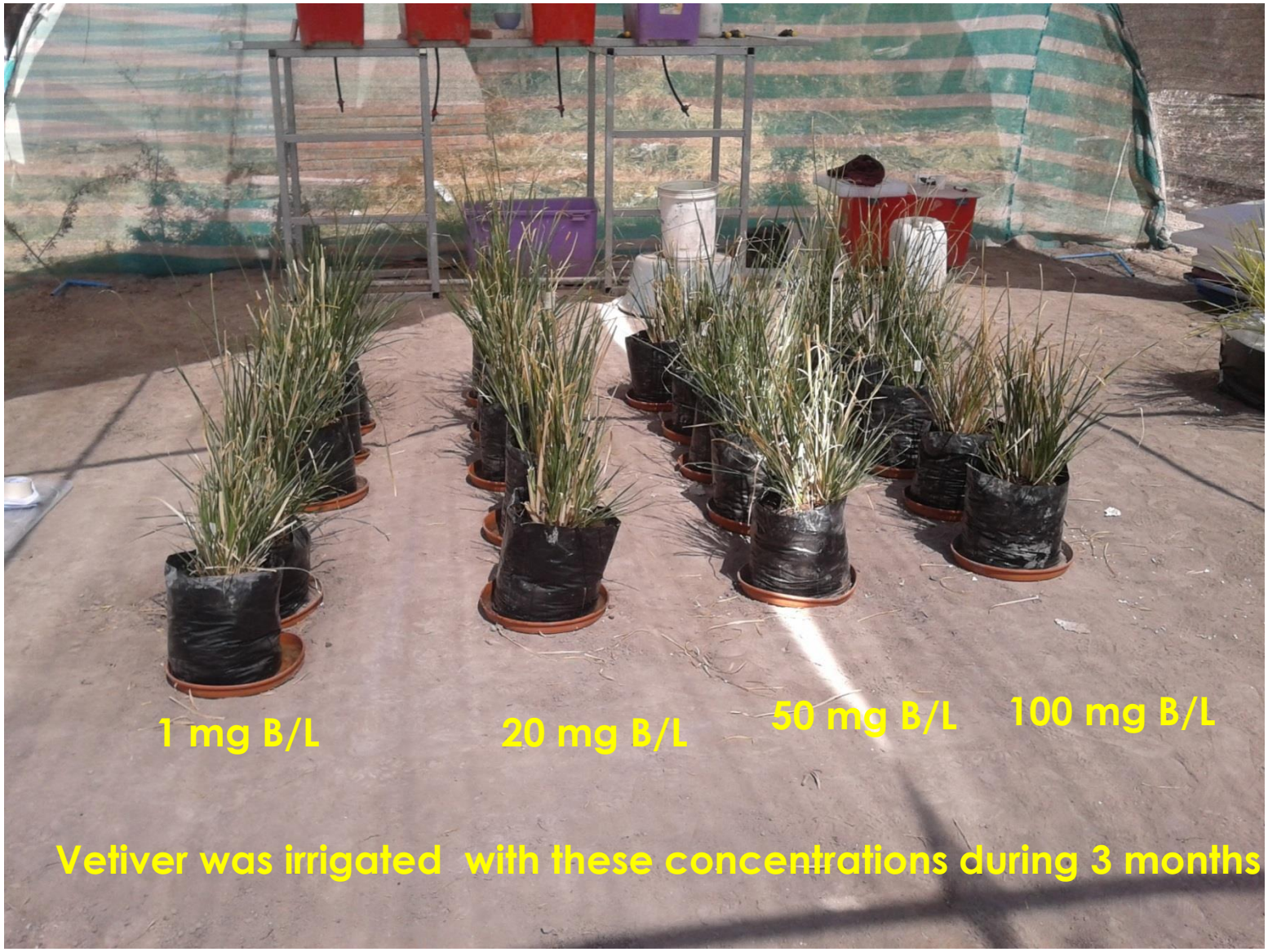
Bore water from Lluta valley;
Arsenic level reduced from 0.33 mg/L to 0.06 mg /L after 5 days

Residual lead and manganese concentration in water (mg/L) at different sampling periods (n=6)



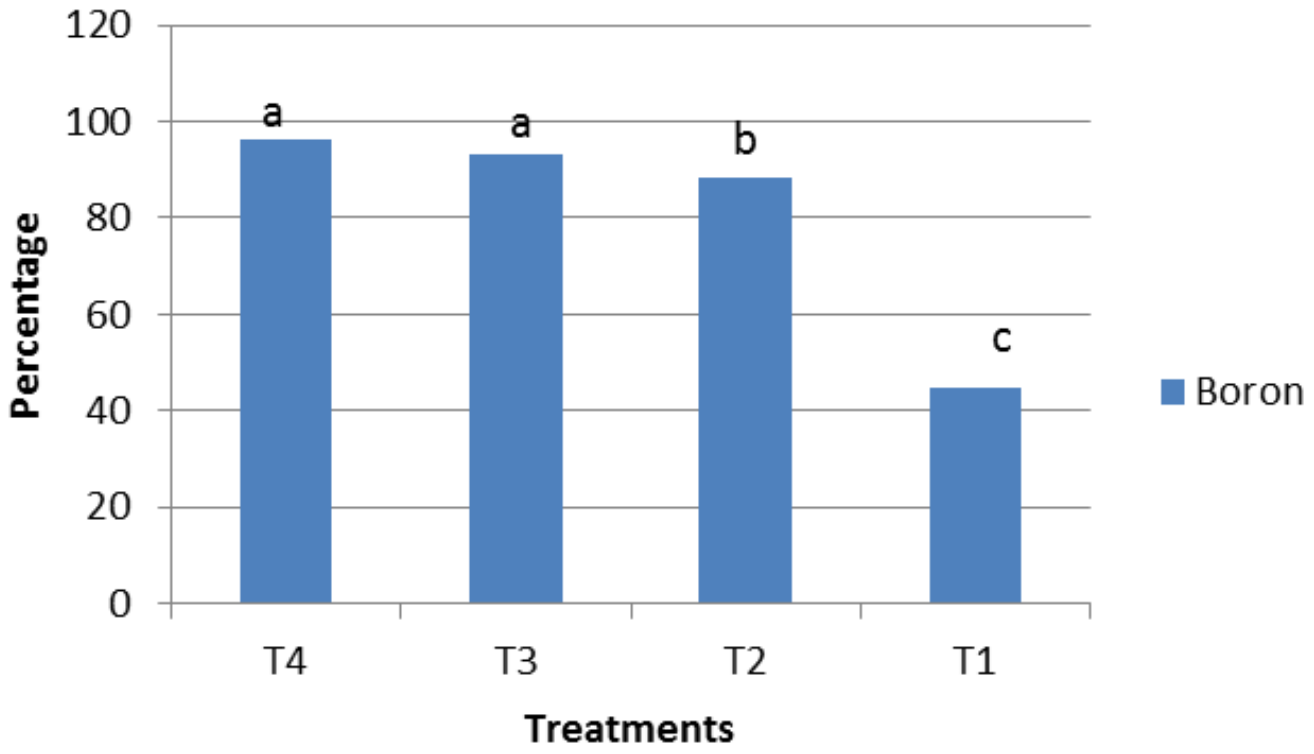
+Mean values denoted by different letters are significantly different ($P < 0.05$) according to Dunnett *t* test. ** $P < 0.01$; * $P < 0.05$; ND: not detectable

Test in Soil


1 mg B/L
20 mg B/L
50 mg B/L
100 mg B/L
Vetiver was irrigated with these concentrations during 3 months

100 mg B/L

Removal Efficiency Percentage in Boron at different sampling periods after planting. T1, 1 mg/L; T2, 20 mg/L; T3, 50 mg/L and T4,100mg/L.



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Translocation Factor for Boron (mg/kg)

	T1	T2	T3	T4
Leave	187,4	267,7	312,9	350,3
Root	19,8	81,7	117,3	175,5
TF	9,48	3,28	2,67	2,00

T1, 1 mg/L; T2, 20 mg/L; T3, 50 mg/L and T4,100mg/L.

CONCLUSION

- Vetiver can improve agriculture production in the Arica Province by remediating soil and water from Boron toxocity. This results in the development of 3.000 ha that are currently not being used due to boron toxicity.

- Also will contribute to the increase in yields of existing crops in the Lluta Valley