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Different strategies to tolerate salinity involving water relations

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Abstract and keywords

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Abstract: Salinity is one of the main limiting factors in agriculture, which can affect plants growth and development, as a result of a disruption of homeostasis. Therefore, the understanding of the mechanism of the plants for tolerate salinity stress is essential in order to develop new techniques that may improve tolerance for optimizing crop yields. In this paper, we compare the response of Cucumber (*Cucumis sativus* L.) and tomato (*Solanum lycopersicum* L.), grown by hydroponic culture, to a moderate salinity of NaCl 60 mM. For that, root hydraulic conductance, relative water content of leaves (RWC), stomatal conductance, fresh weight and dry weight ratio, and Na concentration in shoot and root were measured. The results showed a significant decrease of root hydraulic conductance in both species treated with NaCl, revealing a higher resistance to water passage from root to shoot, probably influenced by the increase of Na content after the treatment. In addition, stomatal conductance in cucumber was reduced, accompanied by a decrease of fresh/dry weight ratio in the root. Conversely, neither of those parameters changed in tomato. These experiments confirm the evidence that cucumber and tomato follow different strategies in the adaptation to salinity, being tomato more resistant probably due to the role of membrane water transporters. Despite that, more specific studies would be needed in order to support this conclusion.

Keywords: salinity resistance; water relations; water transport; aquaporins; cucumber; tomato.

Introduction

Introduction

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Salinity

↓

Osmotic Stress

- Inhibition of growth and development.
- Metabolism alteration.
- **Water deficit**

Introduction

Salinity resistance strategies

Salt avoidance

Salt exclusion

Osmotic adjustment

- Accumulation of organic solutes.
- Control ions transport pathways.
- **Membrane transporters:** maintain water flow.

Introduction

Cucumber

Salt sensitive

Tomato

Salt tolerant

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Objectives

The objective of this study is to **determine the effects of salinity in the water relations** in cucumber and tomato and to determine the **possible mechanisms involved in the stress tolerance caused by salinity** in these plants.

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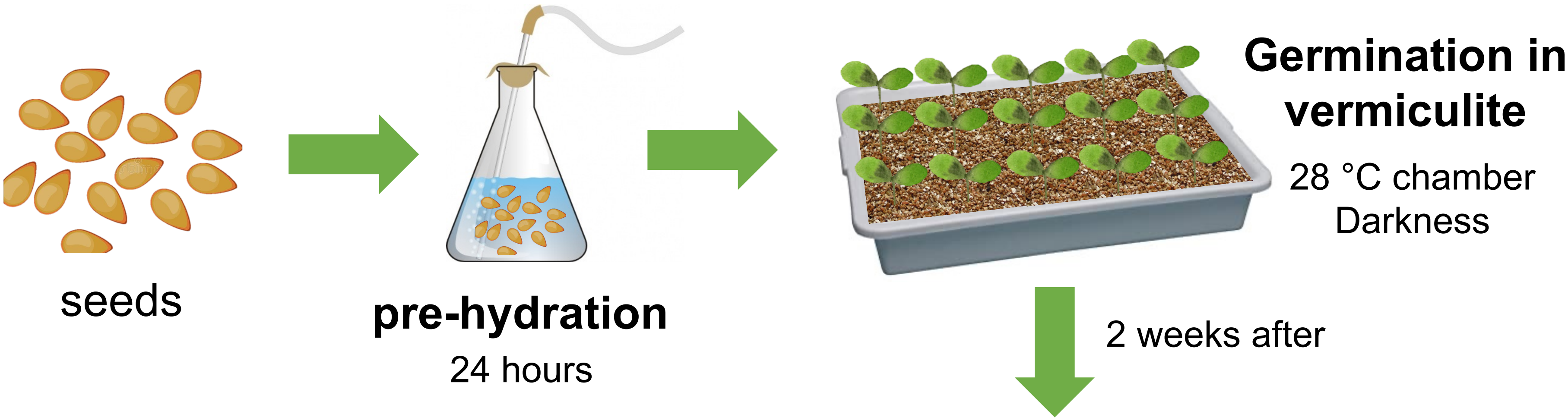
Materials and methods

Materials and methods

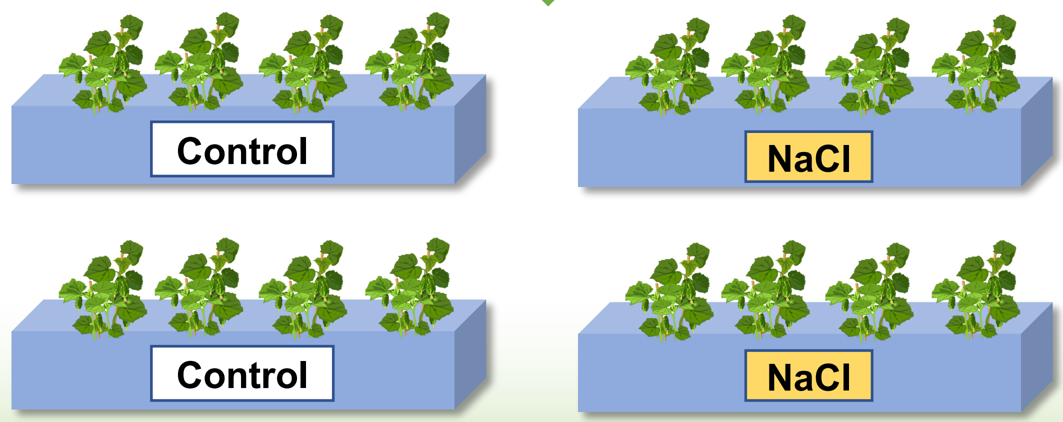
Plant materials and growth conditions



Hoagland's solution

Every week replaced

Growth time: **12 days**



Hydroponic culture

Materials and methods

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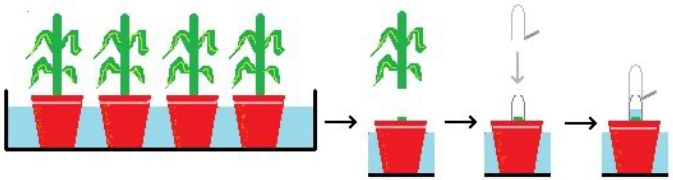
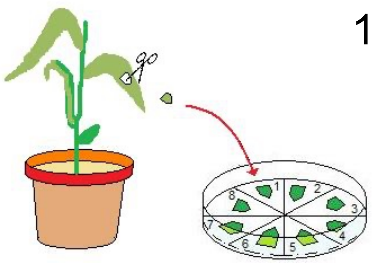
Root hydraulic conductance (L_0)



Root exudate

Relative water content (RWC)



1 cm^2 leaf fragment

Fresh weight
Turgor weight
Dry weight

Stomatal conductance

TPS-2 Portable Photosynthesis System

2nd, 3rd and 4th fully expanded leaves

Fresh weight (FW) / dry weight (DW) ratio

Shoot
Root

Ions concentration

Shoot
Root

Inductively coupled plasma (ICP) analysis

Results and discussion

Results and discussion

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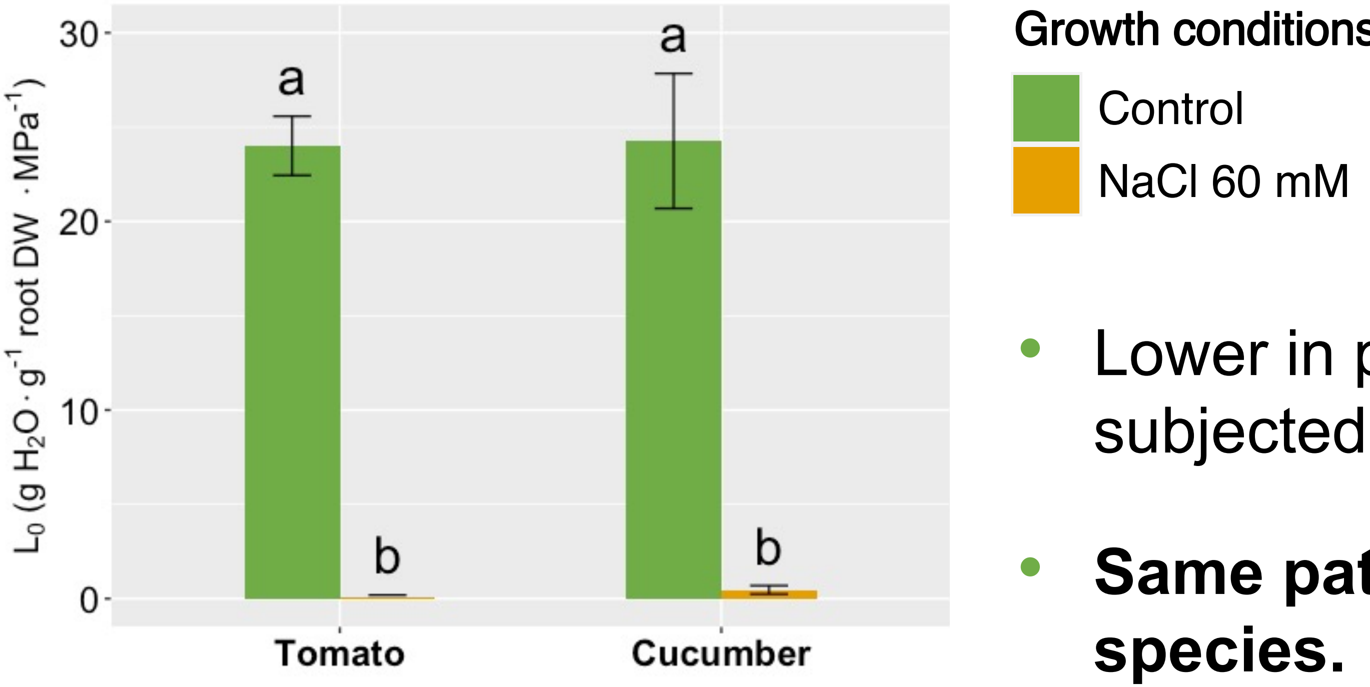
Root hydraulic conductance (L_0)



- Lower in plants subjected to salinity.
- **Same pattern in both species.**

Results and discussion

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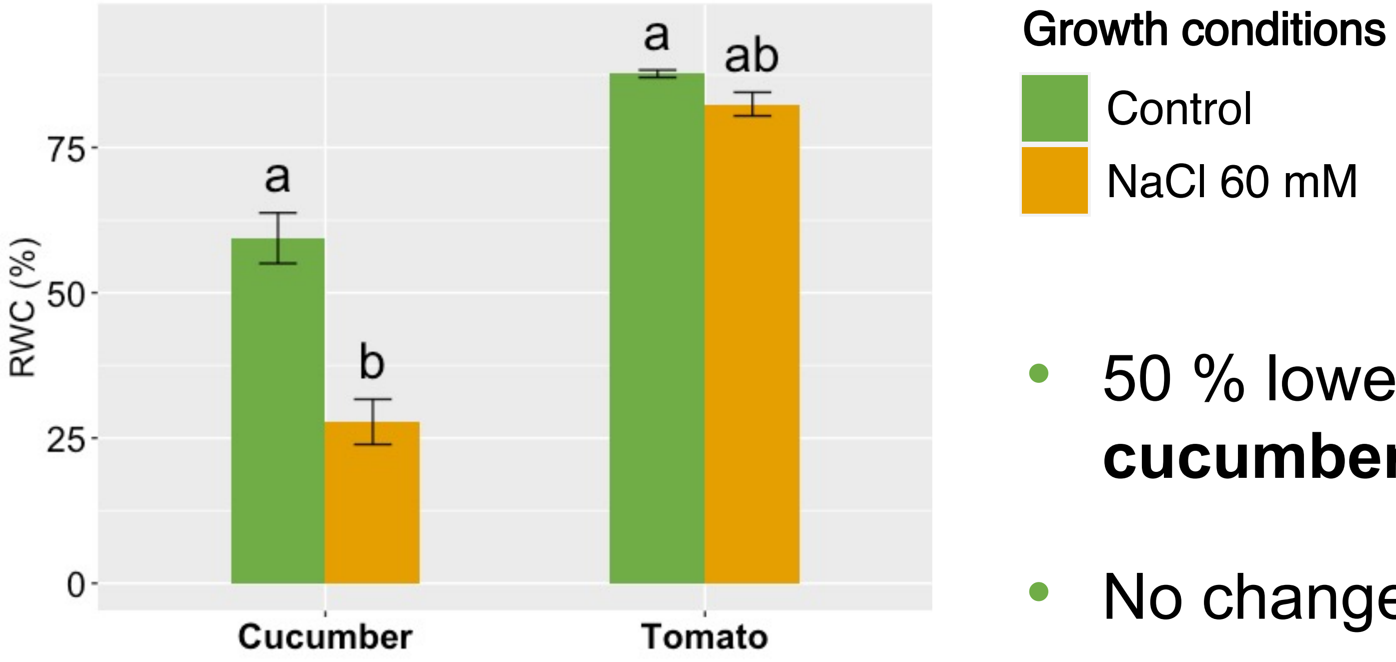
Relative water content (RWC)



- 50 % lower in **cucumber**.
- No changes in **tomato.**

Results and discussion

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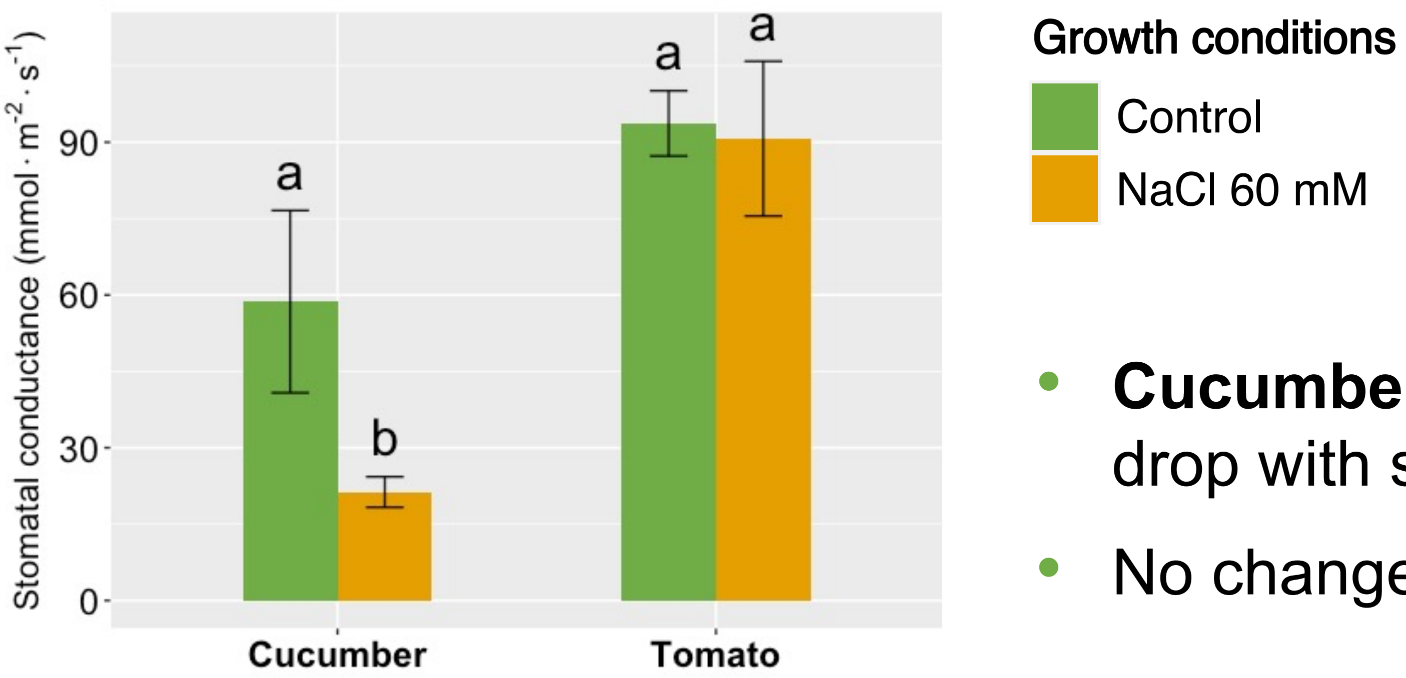
Stomatal conductance



- **Cucumber**: significative drop with salinity.
- No changes in **tomato**

Results and discussion

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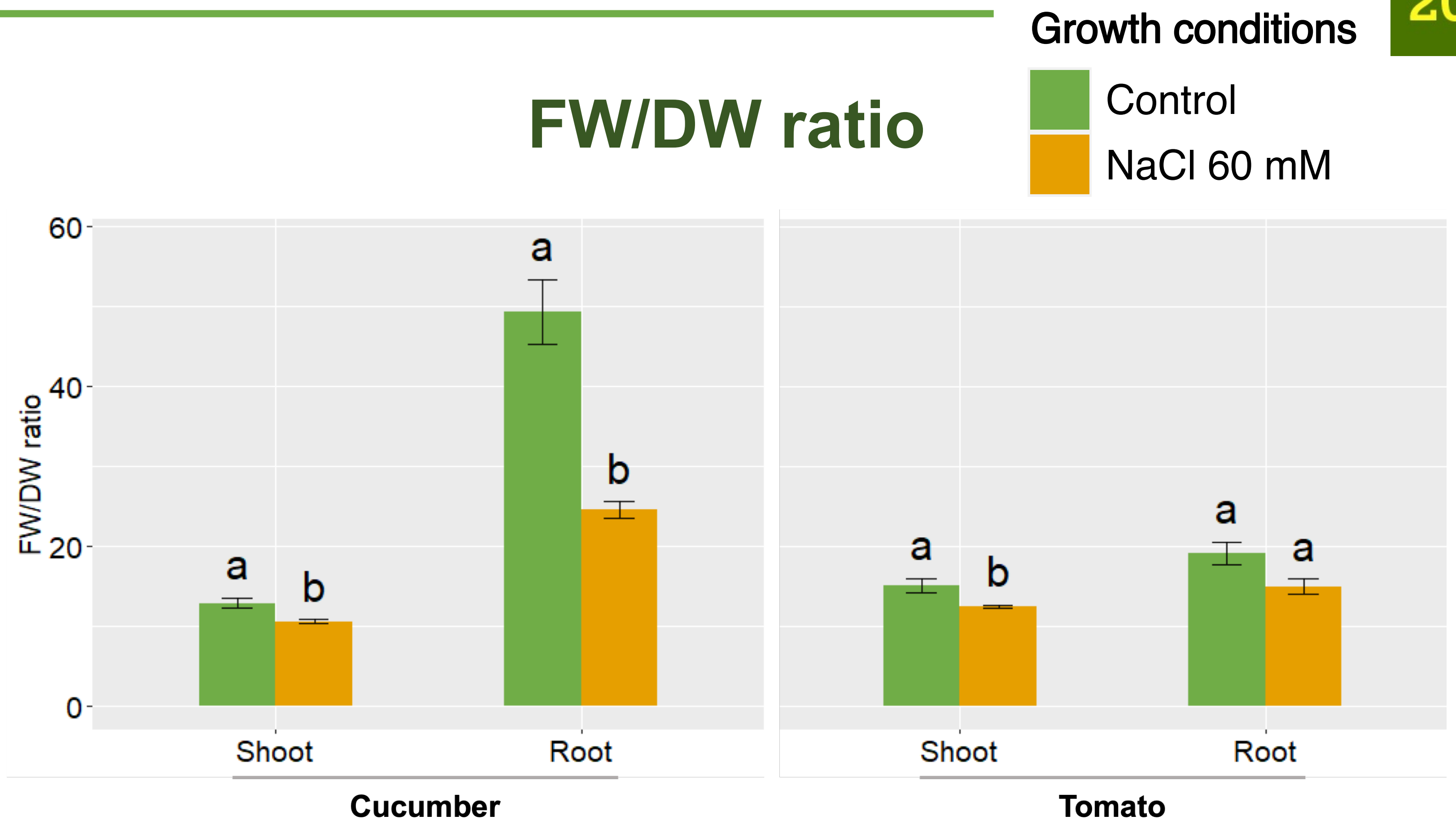

- **Cucumber:** FW/DW ratio decreased in both organs with NaCl.
- **Tomato:** decreased only in shoots under salinity.

Results and discussion

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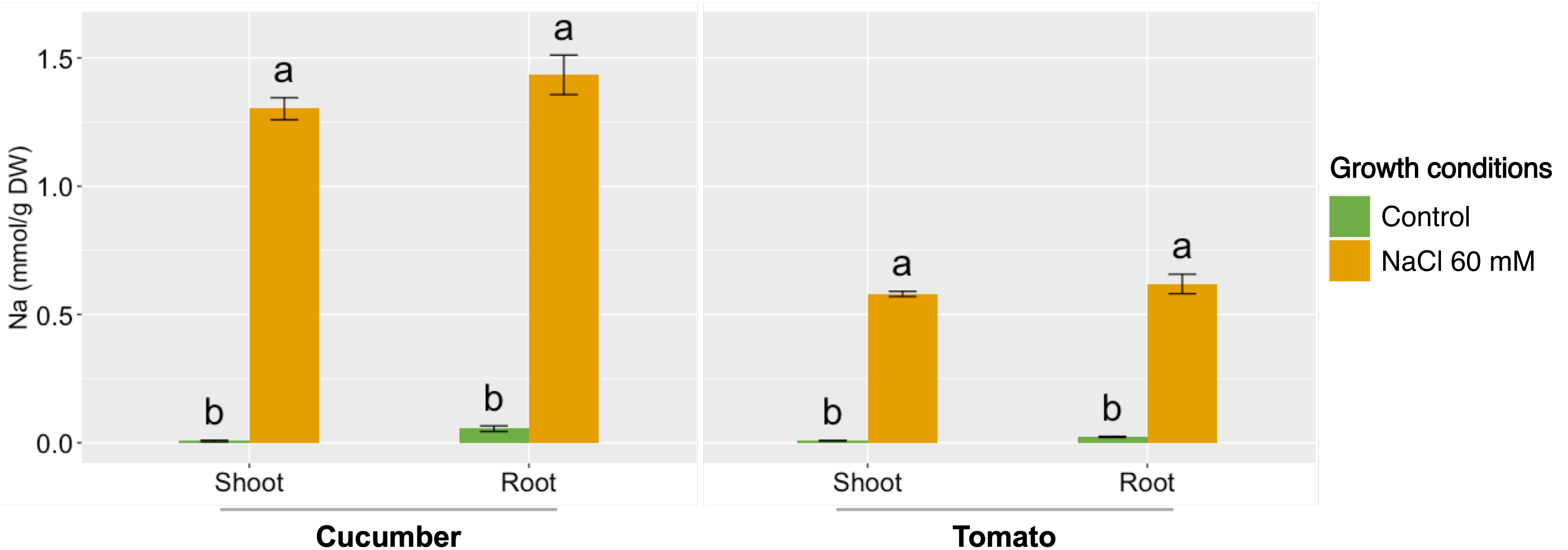
Sodium (Na) concentration



- Na concentration was considerably higher after salinity treatment in both species.
- Na concentration in **tomato** was nearly 50% lower than in **cucumber** plants under salinity stress.

Results and discussion

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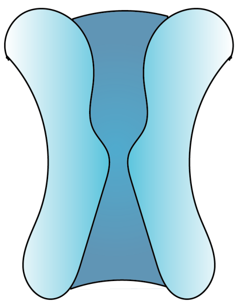
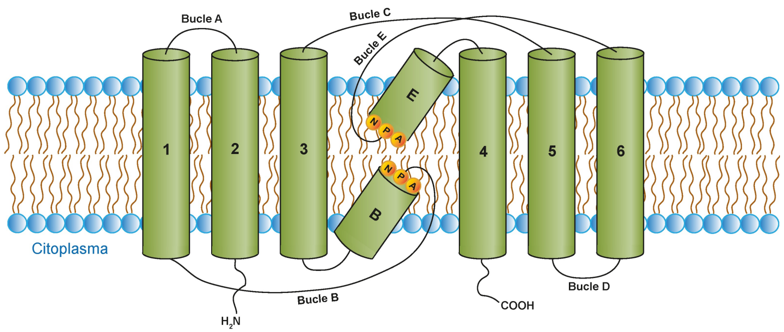
Membrane water transporters could have a significant influence on salinity adaptation.

Aquaporins (AQPs)





- Transmembrane proteins.
- Water selective transport and other solutes.
- Some AQPs can transport some ions to the vacuole.

Conclusions

Conclusions

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In light of all these results, the main conclusions of this study are:

1. **The maintenance of the water balance in the plant has a considerable influence on the adaptation to salinity stress.**

2. **Tomato is able to resist salinity better than cucumber, as most of the water relations in the plant have not been altered.**

3. **Membrane water transporters, like aquaporins, could have a key role in relieving the harmful effects of salinity in the plant, although more in-depth studies will be needed in order to confirm this fact.**

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