Different strategies to tolerate salinity involving water relations

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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

Salinity

Osmotic Stress

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

Salinity resistance strategies

Salt avoidance

Osmotic adjustment

• Accumulation of organic solutes.

• Control ions transport pathways.

• **Membrane transporters:** maintain water flow.

Salt exclusion
Introduction

Cucumber
Salt sensitive

Tomato
Salt tolerant
Introduction

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.
Materials and methods
Materials and methods

Plant materials and growth conditions

seeds → pre-hydration for 24 hours → Germination in vermiculite

Hoagland’s solution
Every week replaced
Growth time: **12 days**

2 weeks after

Germination in vermiculite @ 28 °C chamber
Darkness

Hydroponic culture
Materials and methods

Root hydraulic conductance ($L_0$)

Stomatal conductance

$TPS-2$ Portable Photosynthesis System

2nd, 3rd and 4th fully expanded leaves

Relative water content (RWC)

1 cm² leaf fragment

Fresh weight
Turgor weight
Dry weight

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

Shoot
Root

Ions concentration

Shoot
Root

Inductively coupled plasma (ICP) analysis
Results and discussion
Results and discussion

Root hydraulic conductance ($L_0$)

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

Growth conditions
- Control
- NaCl 60 mM
Results and discussion

Relative water content (RWC)

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

Growth conditions
- **Control**
- **NaCl 60 mM**

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<thead>
<tr>
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<th>Cucumber</th>
<th>Tomato</th>
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<tr>
<td>RWC (%)</td>
<td>a</td>
<td>ab</td>
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- 50% lower in cucumber.
- No changes in tomato.
Results and discussion

Stomatal conductance

- **Cucumber**: significative drop with salinity.
- **Tomato**: no changes.

Growth conditions
- **Control**
- **NaCl 60 mM**

**Cucumber**: significative drop with salinity.

**No changes in tomato**
Results and discussion

**FW/DW ratio**

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

**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.
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

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.
Acknowledgments

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