Salinity Tolerance of Guava (*Psidium guajava* L.) and the Implications for its Adaptation into Saline Environments

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1) Introduction

Water scarcity and salinity increasingly aggravate agricultural production so that natural boundaries imposed by soil salinity also limit the caloric and nutritional potential of crops. It is therefore important to determine salt-tolerance threshold of crops so as to identify well-adapted genotypes. Common guava (*Psidium guajava* L.) is highly valued for its delicious fruits, which are good source of vitamin C, minerals such as P, Ca and K, and natural antioxidants. However, guava production has been facing with salinity challenges in many producing countries, such as Brazil, Mexico, Australia, India, Sudan, and Kenya.

The objective of this study was therefore to determine the salinity tolerance level of guava based on dry matter production, gas exchange and production of phytochemicals under salt stress.

2) Material and Methods

In a six-week greenhouse experiment, 36 guava plants were subjected to salinity levels of 0 mM (control), 10 mM (low), 20 mM (medium), and 40 mM (high) of sodium chloride (NaCl) to test their level of salt tolerance. After three weeks the salinity levels were doubled. Parameters like plant height, leaf number and SPAD values were weekly determined. The plant's physiological reaction under different salt treatments was determined based on the concentration of sugar and proline. Additionally, photosynthetic parameters were recorded. At the end of the experiment the individual plant parts were weighed to determine the fresh and dry matter. From these results, the root/shoot ratio could also be calculated. The minerals within the leaves, such as sodium (Na) and chloride (Cl) were analysed for control and high salinity level treatments.

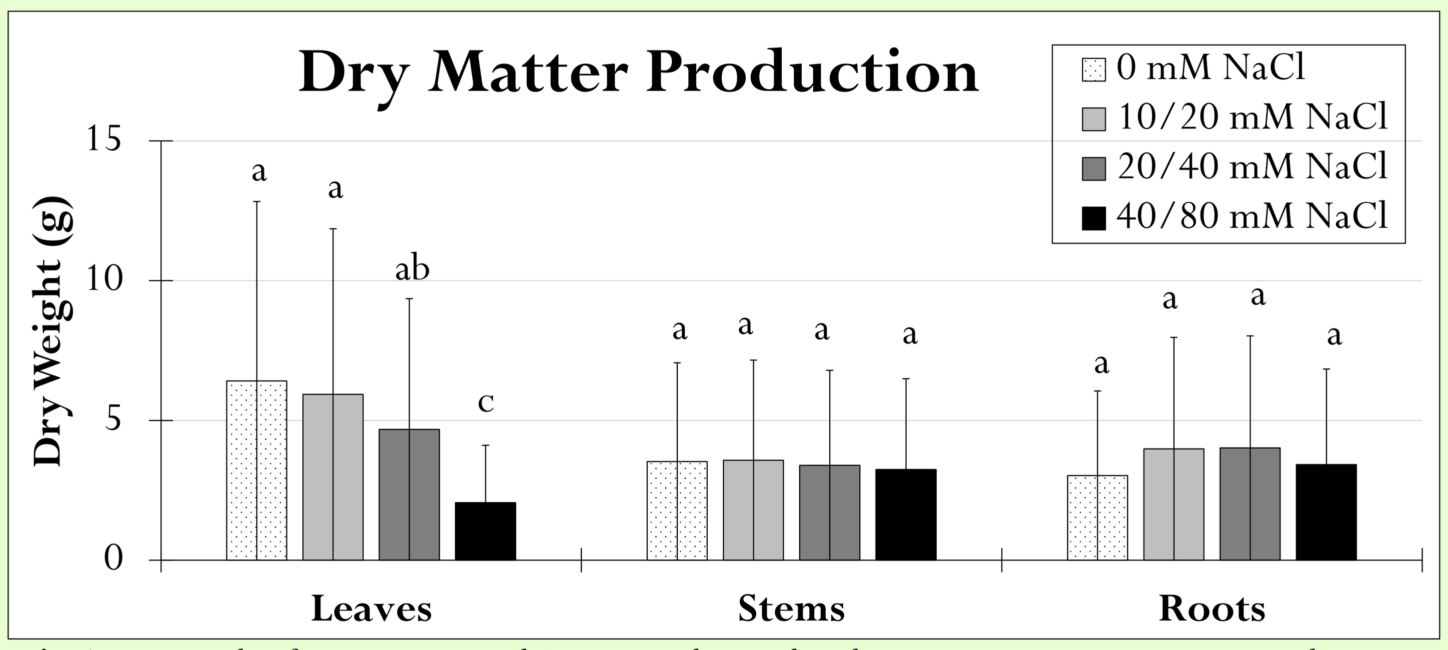

Fig. 1 : Dry Weight of Leaves, Stems and Roots according to the salt treatment (n=9 per treatment). Values are means ± standard deviation. Different letters indicate significant differences at p≤0.05 between treatments per plant part.

Tab. 1: Dry Matter of Roots and Shoots (g) and calculated Root/Shoot Ratio.

NaCl (mM)	Dry Matter (g) Root	Dry Matter (g) Shoot	Root/Shoot Ratio*
0	3.03^{a}	9.95^{a}	0.30^{a}
10/20	3.98^{a}	9.5^{a}	0.41^{a}
20/40	4.01^{a}	8.08^{a}	0.49^{a}
40/80	3.42^{a}	5.31^{b}	0.64^{b}

*mean values of fresh and dry masses of the individual plant parts were used for calculation.

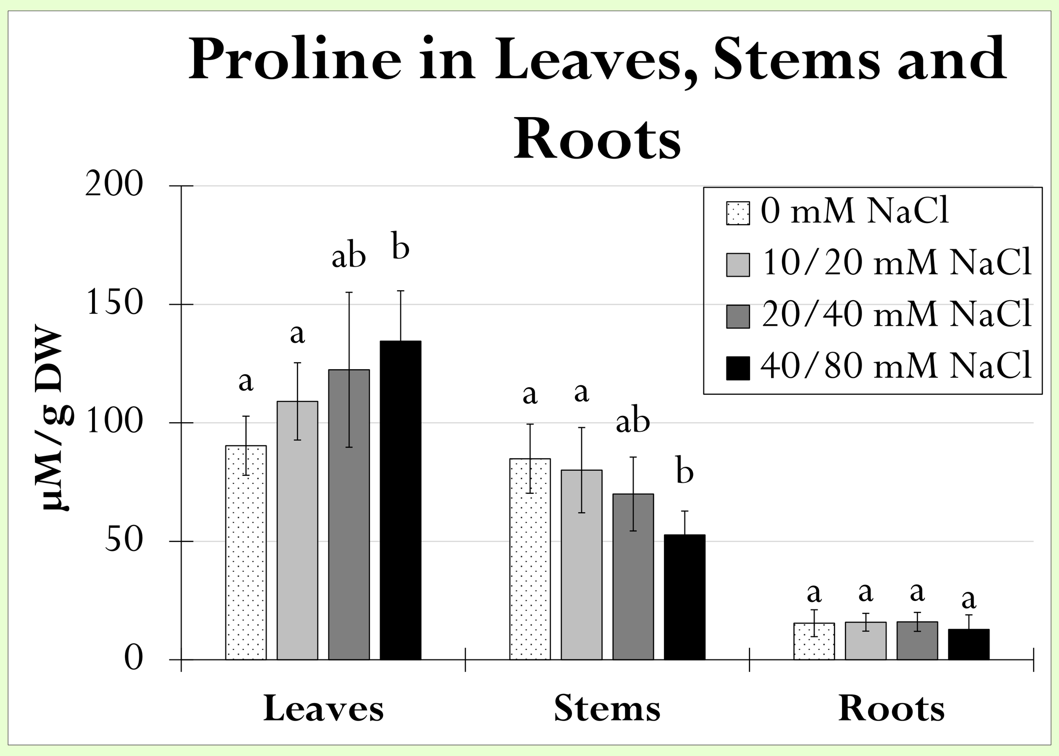

Fig. 2: Proline concentration in guava leaves under varying salinity treatments at the end of experiment (n=9 per treatment). Values are means ± standard deviation. Different letters indicate significant differences between treatments.

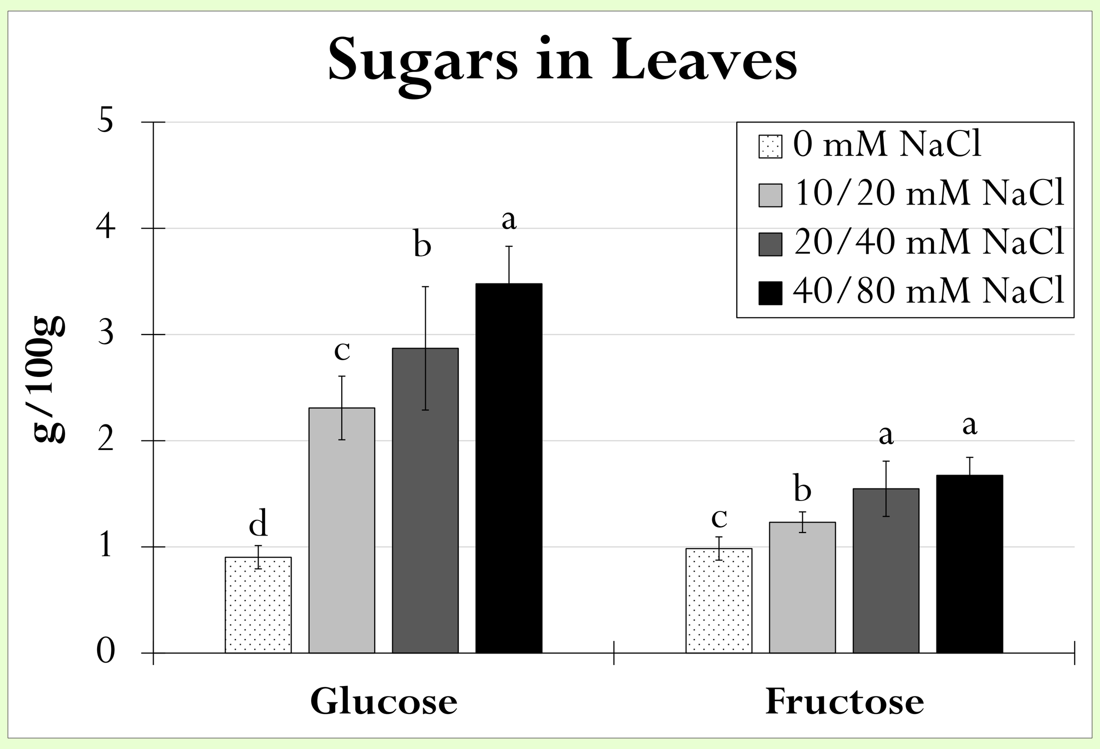

Fig. 3: Glucose and fructose concentrations in g/100 g in the leaves of guava plants under varying salt levels (n=9 per treatment). Values are means ± standard deviation. Different letters indicate significant differences at p≤0.05 between treatments.

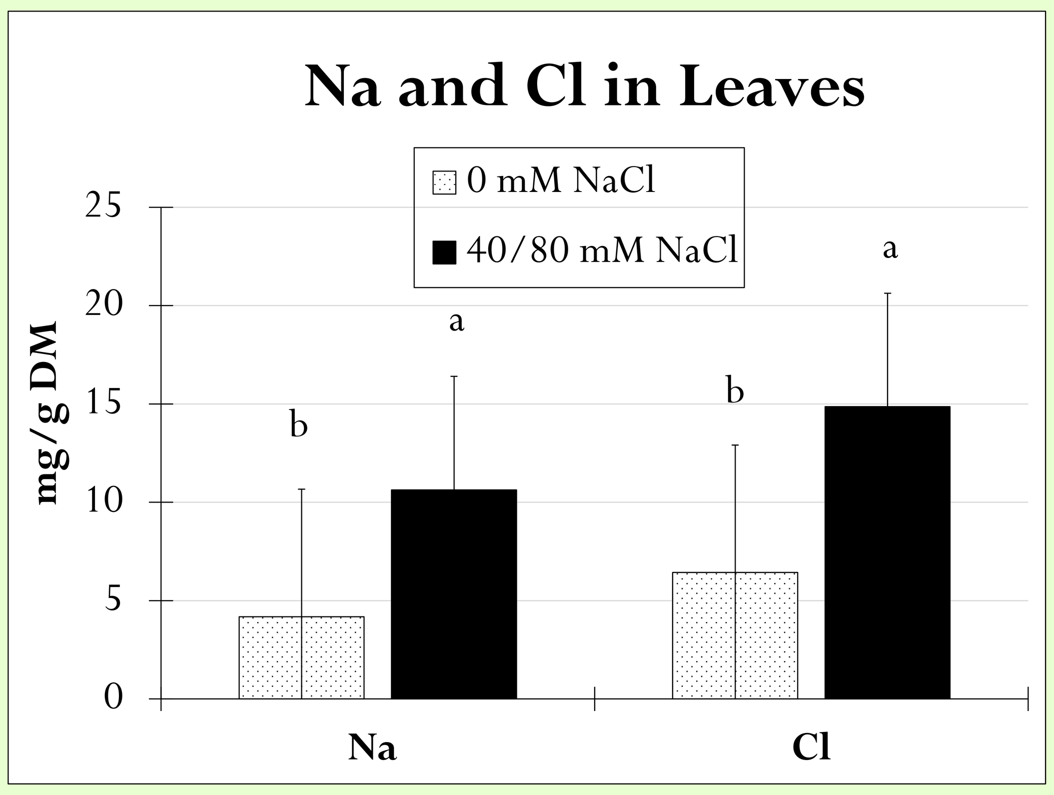

Fig. 4: Na and Cl concentrations in guava leaves under varying salt levels (n=9 per treatment). Values are means ± standard deviation. Different letters indicate significant differences at p≤0.05 between treatments.

Tab. 2: Net Photosynthesis Rate (Assimilation) and Water Consumption (g) of guava leaves under different salinity treatments.

NaCl (mM)	Assimilation (µmol CO_2 $m^{-2}s^{-1}$)	Water Consumption* (g)
0	$2.56^{a} \pm 0.92$	$3.77^{a} \pm 0.09$
10/20	$1.51^{b} \pm 0.78$	$3.66^{ab} \pm 0.07$
20/40	$1.53^{b} \pm 0.75$	$3.60^{b} \pm 0.1$
40/80	$1.38^{b} \pm 0.87$	$3.54^{b} \pm 0.12$

Values are means ± standard deviation. Different letters indicate significant differences at p≤0.05 between treatments. *Water Consumption was calculated as mean values per treatment over the whole period.

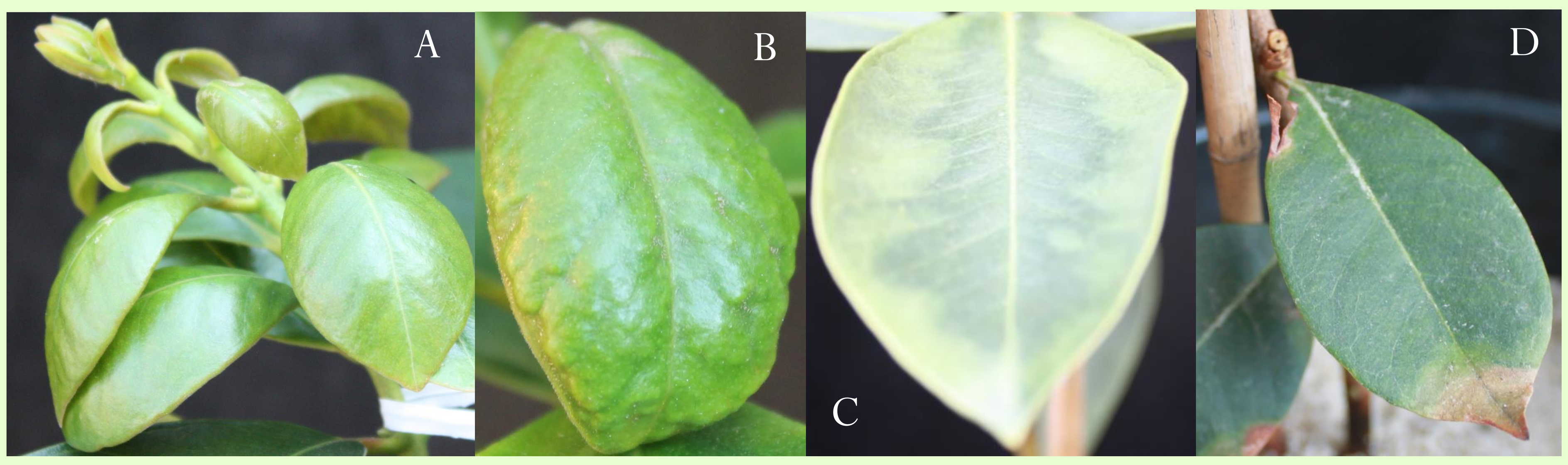

Fig. 5: Salinity symptoms in the sixth week of salt application (A)+(B) cupping of the leaf, and formation of protuberances on the leaf surface (C) chlorosis at the leaf margins (D) necrosis at the tip of the leaf.

3) Results and Discussion

- **Leaf dry biomass decreased with increasing salinity (Fig. 1)**
  - → constant in stems and roots
  - → shoot/root ratio decreased; root less sensitive (Tab. 1)
- **Proline increased with higher salinity (Fig. 2)**
  - → proline accumulation indicates an adaptation strategy to maintain osmotic regulation in the organism
- **Sugar content of the leaves increased with increasing salinity (Fig. 3)**
  - → accumulation of glucose and fructose another adaption strategy to salt stress
- **Net photosynthesis rate (Assimilation) decreased with increasing salinity (Tab. 2)**
  - → reduction of the water potential[1]
  - → high concentrations of the Na^{+} and Cl^{-} ions which accumulated in the chloroplasts and inhibited the synthesis of chlorophyll[2,3]
- **Guava was not efficient at excluding Na from the transpiration stream (Fig. 4)**
  - → Na accumulated in the leaves with increasing salinity
  - → typical symptoms in form of chlorosis and necrosis (Fig. 5) were identified at the leaves

4) Conclusion

- **Na intrusion and accumulation inhibits plant physiological processes in guavas → guava is not able to prevent Na uptake under salinity**
- **Guavas under salt-stress reduce their transpiration and therefore their Water Consumption**
- **Guava plants tolerate salt-stress up to 40 mM NaCl (EC=6.77 mS/cm)**

Literature:

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[3]MITEVA, T. S., ZHELEV, N. Z. H. and POPOVA, L. P. (1992): Effect of salinity on the synthesis of ribulose-1,5-bisphosphate carboxylase/ oxygenase in barley leaves. J. Plant Physiol. 140. S. 46–51.