Alfalfa to get back into planetary boundaries

2025 world alfalfa congress
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Sequence 2: Physiology and Genetics

Dejan Soković

Young researcher session

FROM 03 › TO 06 nov. 2025

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Biochemical and genetic response of alfalfa genotypes to aluminum toxicity under acid soil conditions

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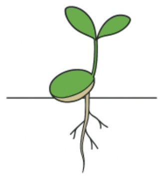

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Background and problem

Soil acidity is a major limiting factor worldwide, as well as in Serbia;

Understanding alfalfa Al-tolerance mechanisms is essential for developing more tolerant genotypes.

Research aim

Main objectives:

- To analyze both biochemical and genetic responses of different alfalfa genotypes under aluminum toxicity;
- To identify tolerant and sensitive genotypes based on those responses;
- To understand the mechanisms behind this tolerance.

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Material and Methodology

- **30 genotypes** (varieties, local populations, and breeding lines)

1. Hydroponic system

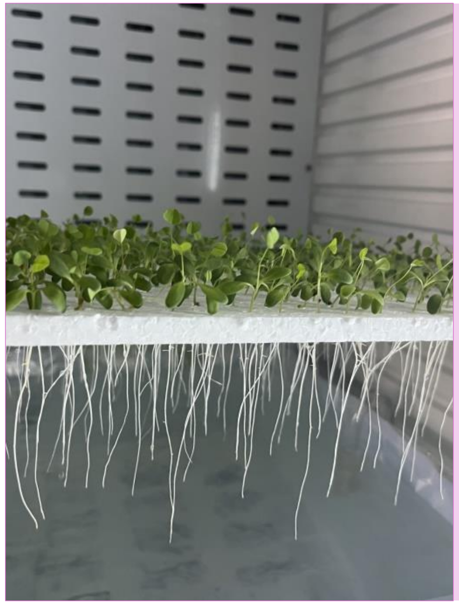
Used Hoagland nutrient solution ½ strenght in controlled conditions in three treatments:

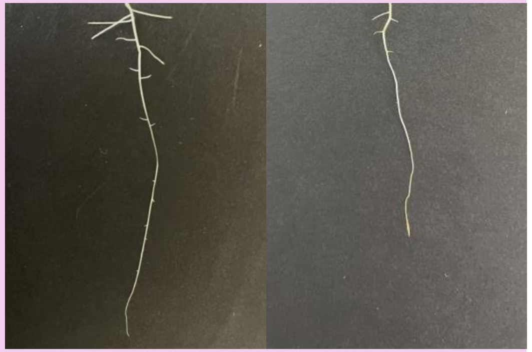
I. pH 6; without $AlCl_3$
II. pH 4.5; without $AlCl_3$
III. pH 4.5; 100 µM $AlCl_3$

2. Pot experiment

Used neutral soil under greenhouse conditions in five treatments:

I. pH 6; without $AlCl_3$
II. pH 4.5; without $AlCl_3$
III. pH 4.5; 2 mM $AlCl_3$
IV. pH 4.5; 5 mM $AlCl_3$
V. pH 4.5; 10 mM $AlCl_3$





Control — 100 µM $AlCl_3$

In both types of experiments, it was evaluated:

- **Biochemical response** including:
  1) Antioxidant enzyme activity (SOD, CAT, GPX, APX)
  2) Enzyme activity involved in nitrogen fixation (NR)
  3) Lipid peroxidation (MDA)
  4) Prolin acumulation
  5) Photosyntetic pigments
  6) Sugars
  7) Phenols and flavonoids
  8) Al and nutrient content (Ca, K, Na, P, Fe, Cu, Mg, Mn, Zn)

- **Genetic response** based on selected **morphological traits** (root and shoot features). This phenotypic aproach was used to estimate the level of genetic variability and identify genotypes with potentially better adaptation to aluminum stress.

Conclusion and significance

- This study identified **morphological and biochemical markers** associated with aluminum tolerance in alfalfa;
- **Genetic variability** was detected within the material for these markers;
- These insights can support **alfalfa breeding programs** and **improve alfalfa performance** on acidic, aluminum-rich soils.

Practical significance:

Enhancing alfalfa Al-tolerance contributes to sustainable forage production and livestock farming on acid, aluminum-rich arable lands.

Thank you for your attention!

Questions?

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