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Screening new genetic resources of grain amaranth (*Amaranthus* spp.) for salinity tolerance

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Introduction

Salt-affected soils are found on all continents, and in Europe, several million hectares of agricultural land are considered to be affected by salinization due to human activities, pollution and climate change [1]. The global demand for crops with minimal yield loss on such land is currently being in consideration. Amaranth, as a naturally gluten-free and protein-rich grain pseudocereal, is known for its high nutritional value and ability to adapt to challenging environments. The aim of our work is to screen a collection of promising new genetic resources of grain amaranth (Fig. 1), previously generated by radiation mutagenesis at our institute [2], for salinity tolerance and to explore their response to salinity stress at morphological, physiological, molecular and biochemical levels.

Figure 1: *Amaranthus* spp.

Methodology

Seeds of five selected grain amaranth varieties, namely *Amaranthus cruentus* L. (Ficha and Slovak cultivated variety 'Pribina') and *Amaranthus hypochondriacus* x *Amaranthus hybridus* (K-433, commercial variety Plainsman and Slovak cultivated variety 'Zobor'), were germinated on petri dishes in the presence of water or 100, 150 and 200 mM NaCl for 5 days. The percentage of germination was evaluated (Tab. 1). Simultaneously, 4-weeks old amaranth plants growing in a soil were irrigated with saline water (200 mM NaCl) or tap water (control) and assessed after 5 days of treatment. Selected morphological parameters of plants (Fig. 2 and Fig. 3) and the salt tolerance indexes (Tab. 2 and Tab. 3) were calculated for three biological replicates per treatment.

Results and Discussion

Our results indicate different tolerance capability of the selected amaranth varieties to salinity stress.

Table 1: Germination (%) of seeds of selected amaranth varieties after 5-days under control (water) and 200 mM NaCl treatment.

	Germination (%)			
Amaranths	Control	100 mM NaCl	150 mM NaCl	200 mM NaCl
'Pribina'	82	74	39	4
Plainsman	100	84	30	4
'Zobor'	94	86	71	36
Ficha	86	32	0	2
K-433	98	66	38	28

In general, it can be assumed that hybrid grain amaranth cv. 'Zobor' had the highest percentage of germination under salt conditions, followed by the varieties K-433, cv. 'Pribina' and Plainsman. Ficha was the most sensitive variety.

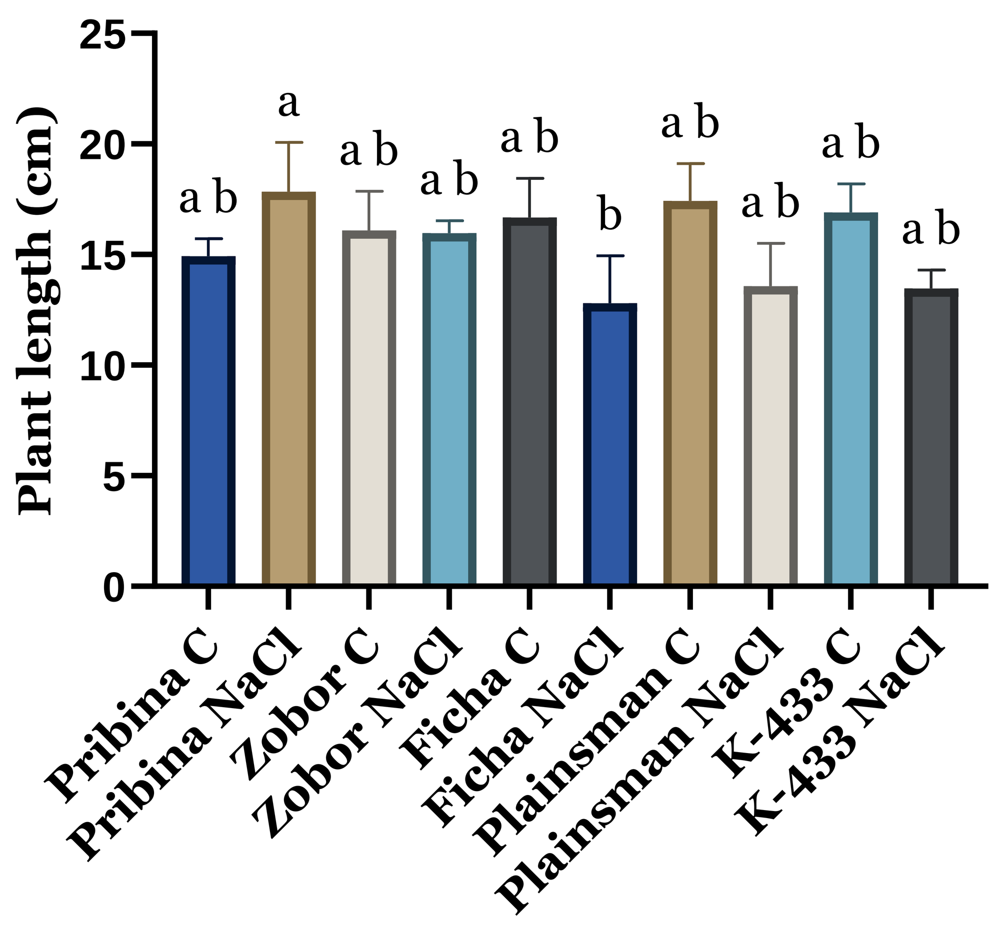

Figure 2: Total plant length (in cm) of control (C) and salt (200 mM NaCl) treated plants. Different letters indicate significant differences between treatments at p-value ≤ 0.05 according to Tukey´s HSD test.

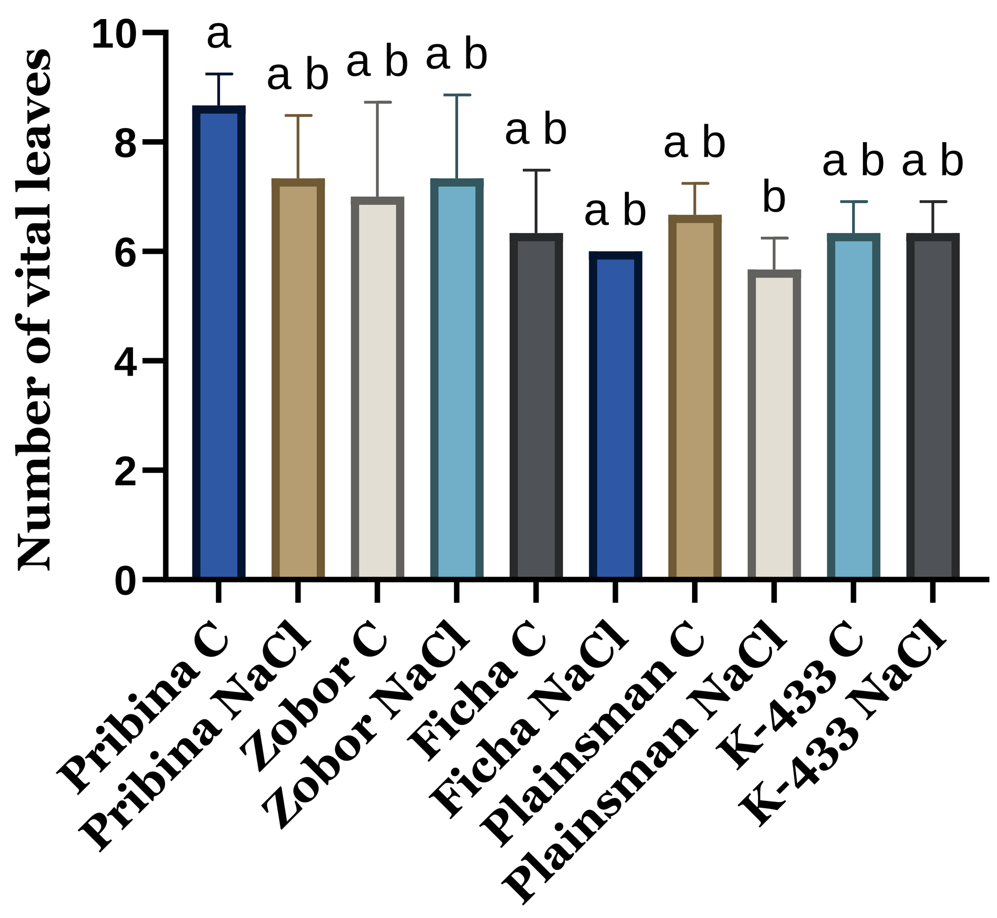

Figure 3: Number of vital leaves of control (C) and salt (200 mM NaCl) treated plants. Different letters indicate significant differences between treatments at p-value ≤ 0.05 according to Tukey´s HSD test.

Table 2: Salt tolerance index (STI) of selected amaranth varieties based on total plant, root and shoot length (in cm).

STI	Plant length	Root length	Shoot length
'Pribina'	1.2 ± 0.2 a	1.1 ± 0.2	1.2 ± 0.2 a
Plainsman	0.8 ± 0.1 b	0.9 ± 0.1	0.7 ± 0.1 b
'Zobor'	1.0 ± 0.1 ab	1.1 ± 0.3	1.0 ± 0.1 ab
Ficha	0.8 ± 0.1 b	0.9 ± 0.3	0.7 ± 0.2 b
K-433	0.8 ± 0.1 b	1.0 ± 0.0	0.8 ± 0.1 b

Table 3: Salt tolerance index (STI) of selected amaranth varieties based on some leaves parameters.

STI	Number of leaves per plant	Number of vital leaves	5th leaf area (cm^2)	5th leaf perimeter (cm)
'Pribina'	1.0 ± 0.1	0.8 ± 0.1	1.0 ± 0.2	1.0 ± 0.1
Plainsman	0.9 ± 0.1	0.9 ± 0.0	0.9 ± 0.3	1.0 ± 0.1
'Zobor'	1.0 ± 0.3	1.1 ± 0.6	0.9 ± 0.1	1.0 ± 0.4
Ficha	0.8 ± 0.1	1.0 ± 0.2	1.2 ± 1.0	1.1 ± 0.4
K-433	1.1 ± 0.1	1.0 ± 0.0	0.8 ± 0.4	0.9 ± 0.5

Most crop plants fail to tolerate high levels of salt in a soil. Salt stress leads to a disruption of plant cellular functions, ionic imbalance and consequently a reduction in plant growth, development and biomass production. There is great variability in the response of different amaranth lines to salt stress [3], as also shown in this work. The acquisition and utilization of adapted plants is therefore one of our goals for the sustainable use of salt-affected soils.

Conclusions

Our preliminary results suggest that cultivated Slovak grain amaranth varieties could possess enhanced parameters for salinity tolerance. Further investigations are necessary for completing this task.

References

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Salt-affected soils: threats and potentials