Improved drought and salinity tolerance in barley by root application of potassium nitrate

This study was conducted to evaluate if KNO_3 or salicylic acid (SA) can alleviate the negative effects of stress caused by salinity or water deficit in barley (Hordeum vulgare L. cv. Gustoe). Grains were sown in plastic pots containing 2 kg of soil. Substrate was composed of soil, sand and potmos at 2:1:1 v/v ratio. The soil mixture had a pH of 7,2, an EC of 1,65 ds/m and available K^+ of 55 ppm. Three week old plants were subjected to various treatments for two weeks. Different levels of NaCl (50, 100 and 150 mM), or drought stress (80%, 70% and 50% of soil water content (SWC)) were applied. Only at the highest salinity and drought stress levels the effect of treatment with SA or KNO_3 was investigated. SA (50 µM) was spray-applied or KNO_3 (10 mM) was added to the nutrient solution.

Increasing the salt or water deficit stress reduced shoot fresh weight, shoot height, leaf photosynthetic pigments (Chl A, Chl B and carotenoids), K^+ content, and provoked oxidative stress in leaves. This was confirmed by measurement of considerable changes in soluble carbohydrate, proline, malondialdehyde (MDA), total phenolic compounds, antioxidant activity and Na^+ contents. The Na^+/K^+ ratio increased with increasing salt and water deficit treated plants. Addition of KNO_3 showed significant alleviation of both salinity and drought stress, in the same order of magnitude compared to the SA spray treatments. The addition of KNO_3 prevented leaf chlorosis, increased the shoot growth and leaf photosynthetic capacity measured by content of chlorophyll and carotenoid pigments (Table 1).

The level of oxidative damage of lipids was measured as increase in MDA content. In

plants grown under the highest salinity (150 mM NaCl) and water deficit (50% SWC) stress, without the addition of KNO_3 to the nutrient solution, MDA content increased to 140% and 158% of the control. However, addition of KNO_3 to medium of plants under these highest stress conditions, resulted in similar MDA levels as found in plants under the lowest salt-stress (50 mM) or lowest water deficit stress (80% SWC).

Moreover, addition of KNO_3 in the nutrient solution has proven to be effective in decreasing the Na^+/K^+ ratio in leaves of plants under salinity and drought stress. It is suggested that this is due to prevention of osmotic stress related leakage of K^+ from the cell through the plasma membrane. It can be concluded that the addition of KNO_3 alleviated the oxidative stress in barley plants caused by either salinity or drought.

Table 1. Effect of salt stress, water deficit stress and 10 mM KNO_3 treatments on shoot height, pigment content (Chl A, Chl B and carotenoids), Na^+ and K^+ content of barley plants.

Treatments	Shoot height (cm)	Pigment content (mg/g DW)	Na^+ content (mg/g DW)	K^+ content (mg/g DW)	Na^+/K^+ ratio
Control	23,9	2,6 (100%)	11,1	35,8	0,3
150 mM NaCl	15,2	1,1 (43%)	19,8	19,8	1,0
150 mM NaCl + 10 mM KNO_3	17,9	1,9 (73%)	15,8	37,3	0,4
50% SWC	17,8	1,3 (49%)	13,7	28,2	0,5
50% SWC + 10 mM KNO_3	21,5	2,0 (78%)	12,5	40,2	0,3