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STUDY OF SOME CROPS TOLERANCE AND PHYTODESALINATION POTENTIAL FOR SUSTAINABLE SALINE AGRICULTURE

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Introduction

Large areas of arable land are withdrawn every year due to salinization, which is the result of a combination of natural and anthropogenic factors [3]. This process especially develops in arid and semi-arid climatic regions with high groundwater table, poor quality of irrigation water, traditional irrigation methods implemented with improper drainage systems. Soil high salinity reduces agricultural productivity, affecting crop yields. Cultivation of salt-tolerant plants is regarded as an innovative approach for desalination and remediation of salt-impacted agricultural soils. From this point of view, the effects of irrigation water with different concentrations of NaCl on some growth traits and development of wheat, oat, emmer, and barley under hydroponic conditions were studied and compared. Basing on the studies on accumulation of ions in plants and their resistance to salt stress, the phytodesalination potential of crops at increasing NaCl concentrations in root medium was assessed.

Methodology

Wheat, oat, emmer and barley were grown at six different degrees of salinity (0, 100, 200, 300, 400, 500 mM NaCl) in a hydroponic system that was set up under greenhouse with strictly maintained experimental conditions: natural daylight, 25-35 °C and 60-70% relative humidity. Thirty days after completion of salt treatment all plants were collected and some morphological and physiological parameters of plants were investigated [1,2].

Table 2. The mass of Na^+ and Cl^- (mg) accumulated in the above-ground mass of the studied crops (per plant)

Crops	Salinity degree (NaCl, mM)	Na^+	Cl^-	Crops	Salinity degree (NaCl, mM)	Na^+	Cl^-
Wheat	100	19.95	1.11	Emmer	100	37.05	1.59
	200	19.36	6.69		200	47.44	15.28
	300	21.87	12.89		300	59.65	35.52
	400	19.94	13.08		400	57.42	38.97
	500	28.22	26.49		500	51.13	40.82
Oat	100	65.31	3.91	Barley	100	54.12	2.41
	200	66.65	11.36		200	54.48	20.36
	300	57.95	22.23		300	53.86	30.41
	400	68.80	43.96		400	55.89	50.35
	500	72.05	68.07		500	51.68	47.66

Results and Discussion

Study results demonstrate different tolerance capability of wheat, oat, emmer and barley to increasing concentrations of NaCl in the root medium. There was significantly more adverse effect of rising level of root medium salinity on main growth attributes, relative electrolytic leakage, leaf succulence, chlorophyll content index, photosynthetic rate, and transpiration rate of emmer compared with barley, oat and wheat. The results of the present study prove that the ability to tolerate salt stress is a function of ion accumulation and the capacity to uptake K^+ by roots and transfer it to the leaves. Significant increase in Na^+ noted in the leaves of wheat, oat and barley under salinity stress was concomitant with the increase in K^+ concentrations, which indicated the activation of some physiological adaptation mechanisms. However, in the leaves of emmer, along with the increase in Na^+ content, a decrease in K^+ concentration was observed.

Thus, emmer was impacted the most followed by wheat, oat and barley at the highest level of root medium salinity. And since emmer is the most sensitive to salinity stress it will be impractical to grow it on salinized soils. Growing of comparatively tolerant species like oat and barley may be more appropriate and realistic; accordingly they could be the better choice for saline agriculture. It should be mentioned that oat, in addition to salt stress tolerance developed larger biomass and accumulated more Na^+ and Cl^- in shoots comparing with the rest of studied crops, therefore it had the strongest phytodesalination capacity.

Table 1. Effect of NaCl stress on ionic content of crops root, stem and leaf (mg/g, n = 3, P < 0.05)

Crops	Salinity degree (NaCl, mM)	K^+			Na^+			Cl^-		
		root	stem	leaf	root	stem	leaf	root	stem	leaf
Wheat	0	3.41	14.80	9.36	7.67	0.81	1.48	0.02	0.02	0.02
	100	4.01	19.80	9.80	12.33	8.47	9.89	1.11	0.50	0.47
	200	3.99	20.00	9.89	18.04	10.80	12.92	3.63	3.95	3.75
	300	3.25	16.10	10.07	18.94	20.10	17.33	6.04	10.85	13.40
	400	2.77	14.60	11.45	18.70	23.20	19.05	10.15	14.50	14.60
	500	2.74	11.97	10.96	19.30	33.62	23.86	11.01	32.00	21.10
Oat	0	2.64	12.07	6.32	5.23	4.54	5.58	0.04	0.04	0.03
	100	5.45	13.50	6.34	15.50	20.95	23.00	0.45	0.84	3.12
	200	4.88	12.37	6.62	19.01	30.30	26.76	2.21	5.22	4.35
	300	3.49	11.60	8.77	19.92	38.10	28.66	7.15	13.50	15.30
	400	1.71	11.45	10.72	18.78	45.45	35.42	7.55	28.30	25.50
	500	1.41	11.05	11.32	18.35	46.78	39.85	7.52	44.60	36.10
Emmer	0	5.49	12.45	9.68	5.63	3.32	3.36	0.09	0.03	0.13
	100	4.97	14.63	5.61	16.98	19.72	8.48	1.20	0.56	1.46
	200	3.76	13.95	5.75	19.25	33.28	15.65	6.07	10.88	4.43
	300	2.85	9.76	4.55	21.64	62.28	27.14	9.55	36.00	20.10
	400	2.73	7.24	3.21	19.78	64.03	26.75	12.60	43.50	18.00
	500	2.31	7.26	3.31	18.58	65.20	27.32	10.54	53.30	17.40
Barley	0	3.72	12.23	11.45	7.50	4.08	4.08	0.05	0.04	0.03
	100	3.48	17.10	18.96	19.86	22.30	13.35	0.53	1.05	0.38
	200	2.04	14.70	19.22	24.00	34.13	18.85	6.25	13.50	4.16
	300	0.84	12.50	14.35	24.40	48.64	27.20	5.12	25.70	22.20
	400	0.65	10.15	14.85	23.80	61.51	32.90	5.34	56.00	27.40
	500	0.64	10.05	14.75	20.50	60.43	37.28	4.97	56.40	32.00

Conclusions

Considering the fact that barley and oat accumulate large amounts of ions in their above-ground parts and that they are survivable and productive, these plants could be assumed as promising tolerant and salt accumulating crops for further research in the field of sustainable crop production and concurrent phytodesalination.

References

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