J. Appl. Genet. 42(3), 2001, pp. 289-292

Short communication

Salt tolerance of *Triticum monococcum* L., *T. dicoccum* (Schrank) Schubl., *T. durum* Desf. and *T. aestivum* L. seedlings

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Abstract. Responses to salt stress of diploid wheat *Triticum monococcum* L., tetraploid wheats *T. dicoccum* (Schrank) Schubl. and *T. durum* Desf. cv. Grandur, and hexaploid wheats *T. aestivum* L. cvs. Begra and Gama were studied. Seeds were germinated on filter paper in Petri dishes, moistened in Hoagland medium containing 0 (control), 10, 20, 50, 100 and 200 mM NaCl. Index of tolerance to salt treatments was calculated on the basis of shoot length. Increase in salt concentration led to decrease in seed germination and inhibition of shoot and root elongation. Hexaploid and diploid wheats were more tolerant to salt stress than tetraploid wheats.

Key words: germination, salt tolerance, seedling growth, *Triticum aestivum*, *Triticum dicoccum*, *Triticum durum*.

Salinity is one of the most important abiotic stresses limiting agricultural production (TIMM et al. 1991). A chance to reduce crop-yield losses caused by salinity is a development of cultivars of higher tolerance to this stress.

In the present study five wheat accessions: *Triticum monococcum* L. (genome AA), *T. dicoccum* (Schrank) Schubl. (AABB), *T. durum* Desf. cv. Grandur (AABB) and *T. aestivum* L. cvs. Begra and Gama (AABBDD) were investigated. The effect of NaCl on seed germination and seedling growth was analysed.

The seed samples (10 seeds per sample) were placed on Petri dishes with filter paper moistened in Hoagland medium with 0 (control), 10, 20, 50, 100 and 200 mM NaCl. In each combination of NaCl concentration, 150 seeds of every

Received: November 15, 2000. Accepted: January 3, 2001.
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wheat were germinated. The Petri dishes with seeds were incubated in a thermostat at 20°C. After 2 days the energy of seed germination and after 5 days the capacity of seed germination, number of seedling roots and maximal length of roots and shoots were assessed. On the basis of shoot length, the tolerance index (TI) to salt treatment was calculated by the formula:

$$TI = (\text{mean shoot length of treated seedlings} / \text{mean shoot length of control}) \times 100\%$$

Mean values of the measurements were compared using the Tukey test.

Analysis of seed germination revealed a strong influence of NaCl on the germination of *T. dicoccum*. The influence on the germination of the remaining wheats was lower (Table 1). The shoot length of 5-day seedlings declined with the increase in NaCl concentration (Table 2). NaCl inhibited shoot elongation in *T. dicoccum* and *T. durum* cv. Grandur seedlings most strongly.

Table1. The effect of different concentrations of NaCl on seed germination in wheats

Species	Germination energy (%)						Germination capacity (%)					
	NaCl (mM)											
	0	10	20	50	100	200	0	10	20	50	100	200
T. monococcum	96.0	98.3	85.6	86.1	85.8	78.1	97.4	98.3	94.2	91.5	86.6	81.2
T. dicoccum	84.0	76.6	65.8	59.7	47.4*	40.3*	90.3	86.6	73.3	65.4	50.9*	40.3*
T. durum cv. Grandur	94.3	98.4	96.5	91.7	82.6	65.2	95.6	98.4	96.5	92.9	85.6	69.5
T. aestivum cv. Begra	93.4	88.5	82.8	77.5	73.3	71.6	94.6	89.6	88.2	80.1	78.3	75.2
T. aestivum cv. Gama	98.5	96.6	94.1	88.3	86.0	79.5	98.5	97.8	95.4	92.3	88.9	85.5

*result significantly different from the control (0 mM NaCl) at $P = 0.05$

NaCl had a weaker influence on seedling root length (Table 2). The number of wheat roots decreased with increase in salt concentration, but not significantly. The most negative salt effects were observed at 200 mM NaCl in roots of *T. dicoccum*. These roots were shortened and deformed. Near their meristem zone lateral roots were formed. The elongation of these lateral roots was probably inhibited in the area of primary cortex. A morphological symptom of this phenomenon was an irregular thickness observed along root axis. Similar changes in cucumber roots treated with aluminium ions have been observed by SZYMAŃSKA and MOLAS (1995). KUIPER et al. (1990) found that root growth in saline environments is generally less inhibited than leaf growth. They concluded that the root is an organ which can reduce the negative results of ion accumulation in the environment.

Table 2. The effect of different concentrations of NaCl on the root and shoot length of 5-day wheat seedlings

Species	Root length (mm)						Shoot length (mm)					
	NaCl (mM)											
	0	10	20	50	100	200	0	10	20	50	100	200
T. monococcum	66.15	62.34	57.02	51.17	45.40	34.50*	80.31	79.32	77.93	70.27	49.43	39.46*
T. dicoccum	62.72	54.05	53.31	50.21	36.92	28.20*	68.28	52.46	51.27	47.83	19.32*	5.81*
T. durum cv. Grandur	82.30	71.75	68.87	62.42	60.83	54.92	62.45	60.48	52.88	50.12	29.89*	14.96*
T. aestivum cv. Begra	93.48	84.90	85.30	82.81	61.05	53.29*	68.38	61.65	60.19	57.95	44.25	36.57*
T. aestivum cv. Gama	81.83	80.17	76.36	76.81	62.58	48.15	58.93	54.84	53.82	53.74	43.75	34.18

* result significantly different from the control (0 mM NaCl)) at P = 0.05

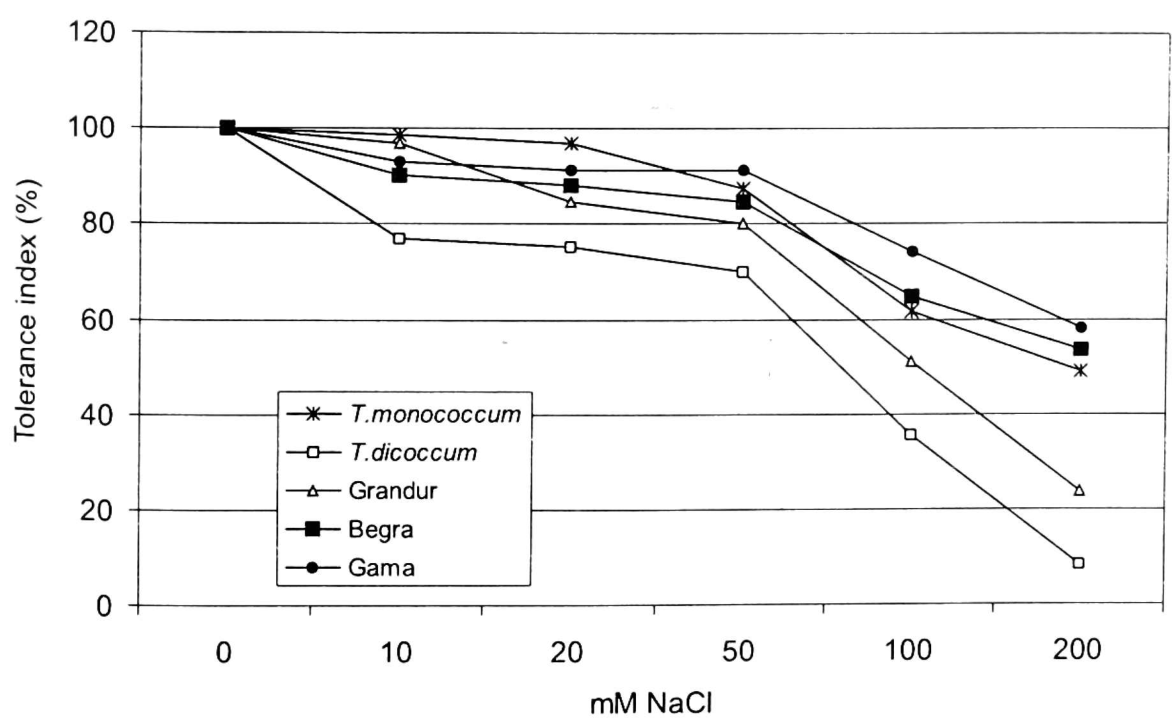

Figure 1. Tolerance index of *Triticum* genotypes in response to salt treatment

In concentrations of 100 and 200 mM NaCl, hexaploid cultivars Begra and Gama and diploid wheat *T. monococcum* were characterized by considerably higher salt tolerance than tetraploid wheats *T. dicoccum* and *T. durum* cv. Grandur (Figure 1). GORHAM (1990), on the basis of investigations on a synthetic hexaploid wheat, noticed that differences between di-, tetra- and hexaploid wheats in salt tolerance depend on a gene(s) which enhances the discrimination between Na and K in ion transport to shoots. The gene responsible for the enhanced K/Na discrimination is located on chromosome 4D in hexaploid wheat, and probably on chromosome 4A of diploid wheat. He suggested that the enhanced K/Na discrimination has been lost in the evolution of the tetraploid wheats. Differences in salt tolerance between diploid and tetraploid wheats probably result from modifications of the A genome, which originated during the evolution of tetraploid wheats (SHANG et al. 1989).

The obtained results seem to confirm the hypothesis about higher salt tolerance in di- and hexaploid wheats than in tetraploid ones.

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