BIOLOGIA PLANTARUM 34 (5-6): 439-443, 1992

Effect of salinity and tryptophan on growth and some metabolic changes in wheat and sorghum plants

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Abstract

During the germination, wheat and sorghum plants tolerated salinity up to 10 mM NaCl. Seedling growth and dry matter production remained more or less unchanged up to 10 mM NaCl in case of wheat and up to 5 mM NaCl in case of sorghum. The water content of test plant species exhibited nearly constant values irrespective of the salinity level applied. The proline and carbohydrate content increased with elevating NaCl, while free amino acids content decreased. Irrigating of seedlings with tryptophan had non significant effect at all salinity levels used.

Introduction

It has been generally recorded that salinity adversely affects seed germination and seedling growth of glycophytic plants. Many workers have used phytohormones and/or proline to ameliorate the unfavourable influence of salinity on seedling growth (*e.g.* Singh and Darra 1971, Boucaud and Ungar 1976, Heikal *et al.* 1982). However, the interactive effects of salt stress and tryptophan (as a precursor of IAA) on crop plants have scarcely been studied, therefore the present work is an attempt to throw light on these effects during germination and seedling growth of wheat and sorghum plants.

Material and methods

Grains of wheat (*Triticum vulgare* L. cv. Sakha "69") and sorghum (*Sorghum bicolor* L. cv. Dorado "9") were supplied by Agricultural Research Center in Giza, Egypt. Twenty grains of the experimental plants were pretreated with 10 % Clorox for 4 min, and then allowed to germinate in Petri dishes at about 25 ^{o}C under the following salinities: 0.0 (control), 5, 10, 15, 20 and 25 mM NaCl. Three replicate petri dishes were prepared for every treatment. Grains were considered to be germinated after the radicle emerged.

Received 14 May1991, *accepted* 19 October 1991.
Abbreviations: IAA - indolyl acetic acid; TCA - trichlorcacetic acid.

Another experiment was conducted simultaneously to test the interaction effect between tryptophan and salinity by adding tryptophan to each salinity level at the concentration of 1 mM. After 10 d of germination, the seedling length was measured. The fresh seedlings were then dried in an aerated oven at 80 °C until constant dry mass was achieved. Soluble carbohydrates were extracted with 5 % TCA and determined according to the method of Naguib (1964). Free proline was determined as recommended by Bates *et al.* (1973). Total free amino acids other than proline were estimated in accordance to the method of Moore and Stein (1948). Data of all experiments were subjected to analysis by the least significant difference test (L.S.D.).

Results and discussion

The germination percentage of wheat remained more or less unchanged up to the level of 10 mM NaCl, thereafter the values tended to decrease with the increase of NaCl level (Table 1).

Table 1. Effect of various salinity (0 to 25 mM NaCl) and tryptophan (1 mM) on percentage of germination of wheat and sorghum grains after 24, 48 and 72 h.

Treatment		Wheat			Sorghum		
NaCl	tryptophan	24 h	48 h	72 h	24 h	48 h	72 h
0	0	88	95	100	84	93	100
5	0	85	92	100	79	88	100
10	0	78	82	100	73	85	98
15	0	70	78	96	62	76	94
20	0	61	71	90	55	66	87
25	0	56	68	85	51	70	84
5	1	89	96	100	84	97	100
10	1	83	92	100	80	92	100
15	1	79	88	100	73	83	99
20	1	70	83	98	68	77	92
25	1	65	77	93	60	78	89

With sorghum grains (Table 1), there was no effect of salinity up to the level of 5 mM NaCl, above which, the germination was reduced. This reduction accords with the data obtained by Khan and Naqvi (1984). The grains supplied with tryptophan solution exhibited an increase in their germination up to the level of 10 mM NaCl in sorghum and up to the level of 15 mM NaCl in wheat (Table 1). The seedling length as well as dry matter production of sorghum remained nearly unaffected up to the level of 5 mM NaCl, these values decreased with increasing NaCl concentrations (Table 2). The length of wheat seedlings was nearly unaffected to the level of 5 and 10 mM NaCl, thereafter the length decreased. The dry matter yield of wheat seedlings exhibited an increase up to the level of 10 mM NaCl, and decreased at higher levels of NaCl used (Table 2).

Table 2. Effect of various salinity and tryptophan on seedling length [cm], dry matter [mg] and water content [g(H_2O) (100 g)$^{-1}$ (f.m.)] of wheat and sorghum plants.

Treatment NaCl	tryptophan	Wheat length	dry matter	water content	Sorghum length	dry matter	water content
0	0	23.9	36.6	84.78	22.0	15.3	88.70
5	0	16.2	31.0	86.61	23.4	19.6	89.79
10	0	17.2	40.1	85.03	16.6	13.0	89.23
15	0	14.5	26.3	83.86	12.0	12.1	88.40
20	0	11.8	20.0	83.50	9.2	10.7	86.80
25	0	6.6	17.0	83.48	5.9	9.8	82.60
L.S.D. 1 %		2.4	5.3	6.1	1.5	2.3	2.6
5 %		1.6	3.5	4.0	1.0	1.5	1.7
5	1	18.2	36.8	85.26	24.4	23.5	88.62
10	1	19.6	50.1	81.57	17.5	15.3	88.43
15	1	15.8	30.6	82.29	13.4	13.3	88.75
20	1	12.9	28.5	78.03	10.6	11.9	88.10
25	1	9.1	19.8	83.48	7.0	10.2	85.49
L.S.D. 1 %		2.2	5.8	6.0	1.8	1.8	2.9
5 %		1.4	3.8	4.0	1.2	1.2	1.9

Table 3. Effect of various salinity and tryptophan on carbohydrates [mg g^{-1}(d.m.)], total free amino acids and proline [µmol g^{-1}(d.m.)] content of wheat and sorghum plants.

Treatment NaCl	tryptophan	Wheat carbo-hydrates	amino acids	proline	Sorghum carbo-hydrates	amino acids	proline
0	0	210.9	70.0	22.8	173.4	50.9	15.8
5	0	233.6	62.9	25.7	188.7	50.0	17.0
10	0	261.4	55.6	29.3	212.6	46.2	19.6
15	0	283.2	48.8	35.8	238.3	41.8	23.2
20	0	329.8	36.3	38.2	225.0	48.4	29.8
25	0	298.9	29.7	44.1	233.2	37.3	27.5
L.S.D. 1 %		11.8	4.3	3.9	9.2	0.2	3.0
5 %		7.8	2.9	2.6	6.1	0.1	2.0
5	1	176.3	76.2	16.8	150.8	57.7	13.0
10	1	182.6	71.6	18.7	169.2	48.9	15.0
15	1	193.7	67.4	21.4	188.1	46.8	19.2
20	1	218.5	58.0	26.6	177.6	54.6	23.6
25	1	204.8	46.9	33.8	180.7	42.7	21.0
L.S.D. 1 %		13.3	3.8	2.9	8.8	1.5	0.7
5 %		8.8	2.5	1.9	5.8	1.0	0.4

The water content of both plants remained unchanged irrespective of the salinity level tested (Table 2). The results of seedling length, dry matter and water content of the test plants were approximately the same in the corresponding treatments with salinity-tryptophan combination (Table 2). Soluble carbohydrates content of both plants was significantly increased with increasing NaCl rate (Table 3). Similarly an increase in soluble sugar concentration was observed in various organs of water stressed wheat plants by Townley-Smith and Hurd (1979). Osmotic adjustment of plants growing in saline conditions may be achieved by the mobilization and utilization of newly carbohydrates (Munns and Termaat 1986, Turner *et al.* 1978). In this connection nearly the same trend but with less values was achieved under the effect of salinity-tryptophan interaction for both plants (Table 3). The pattern of changes in amino acids was opposite that of proline (Table 3) indicating that the increase in proline is at the expense of other amino acids (Boggess *et al.* 1976, Morris *et al.* 1969). In case of tryptophan application with salinity, the same results but of lower amounts of proline as well as the opposite pattern of amino acids was reached when compared with the respective NaCl levels used (Table 3).

The present findings showed also that tryptophan failed to counteract the unfavourable effects of salinity on germination, seedling growth and dry matter production in the two plant species used.

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