BRIEF COMMUNICATION

Soil salinity effect on soluble saccharides, phenol, fatty acid and mineral contents, and respiration rate of garlic cultivars

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Abstract

The effect of salinity on contents of water, soluble saccharides, phenols, minerals and on respiration rate in bulbs of five garlic (*Allium sativum* L.) cultivars differing in salinity tolerance was determined. Cultivar HG-6 was found to be the most tolerant followed by cvs. G-1 and G-42, and cv. Aru the least tolerant to salinity. The cultivars which were tolerant showed lesser reduction in water content of the bulbs by salinity. Initial contents of phenolic compounds and sulphur were comparatively low in salinity tolerant cultivars but they increased under high salinity levels whereas reverse was found in salt sensitive cultivars. The fatty acids profile did not show significant changes under saline conditions. Contents of K and Ca were reduced, content of Na was increased and there were no changes in the contents of N, Mn, Cu, Zn and Fe. The changes in soluble saccharides content and respiration rate were not found to be associated with the salinity tolerance.

Additional key words: *Allium sativum* L., salt tolerance.

Garlic (*Allium sativum* L.) is the second most widely cultivated *Allium* after onion because of its flavoring, medicinal, insecticidal, fungicidal and bactericidal properties. Silenzi *et al.* (1985) and Mangal *et al.* (1990) found that salinity reduced the garlic sprouting. In the present communication, the salinity effects on different quality parameters like mineral composition, saccharides, phenols, fatty acids, and rate of respiration have been reported.

The experiments were conducted at the Vegetable Research Farm of Haryana Agricultural University during the years 1991-92 and 1992-93. Five levels of soil salinity (ECe) 0.85 (control), 4, 6, 8, and 10 dS m^{-1} were developed by using

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Abbreviation: ECe - electrical conductivity of saturated extract.
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a mixture of salts NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ in the ratio of 1:1:1:1. Ten garlic cloves of uniform size of each cultivar (Aru, G-1, G-41, HG-1 and HG-6) were planted per treatment. For details see Mangal *et al.* (1990).

On maturity, the cloves were harvested and analysed. Moisture content was determined on dry mass basis. The dried and well grounded cloves were extracted in aqueous ethanol (80 %). The total soluble saccharides were estimated in this extract according to Yemm and Willis (1954) and total phenols by the method of Amorium *et al.* (1977). Oil was extracted from the cloves with chloroform and methanol mixture 2:1. Methyl esters of fatty acids were prepared from the oil by the method of Luddy *et al.* (1968), separated by *Hewlett-Packard* gas liquid chromatograph by using 20 % *DEGS* columns (for details see Sangwan *et al.* 1986). For mineral analysis, the dried and well ground cloves were digested in mixture of H_2SO_4 and $HClO_4$. From the digest, nitrogen was estimated by micro-Kjeldahl method, calcium by EDTA-versenate method, sulphur by turbidimetric method of Chesnin and Yien (1951), potassium and sodium by flame photometric method, and copper, iron, zinc and manganese by atomic absorption spectro-photometric method. Respiration rate of garlic cloves were determined with infra red gas analyzer (*ADC-223, MK3* model, London, U.K.). The experimental data were statistically analyzed using two factorial completely randomized design and critical differences (C.D.) at 5 % level of significance were determined. There were no significant differences between the results of 1991-92 and 1992-93, therefore both year data were pooled and averaged.

In all the cultivars, there was significant reduction in water content with increasing salinity (Table 1). Interestingly, the water content of cv. HG-6 which previously showed maximum salt tolerance (Mangal *et al.* 1990) did not decrease upto salinity level of 8.0 dS m^{-1}.

All the cultivars showed a decreasing trend in soluble saccharides content with increasing salinity levels (Table 1). Significant reduction in saccharides content was noticed at salinity 6.0 dS m^{-1} in cvs. Aru, G-1 and G-41, but in cvs. HG-1 and HG-6 such reduction was noticed only at 8.0 dS m^{-1}.

Cv. HG-6 had minimum whereas cvs. G-1 and HG-1 had maximum phenols in garlic bulbs under control condition. At salinity 4.0 dS m^{-1}, cvs. HG-1 and HG-6 showed increase whereas cv. Aru showed a decline and cvs. G-1 and G-41 no change in phenol content. At salinity 10 dS m^{-1}, the phenol content was higher in cv. HG-6, not significantly affected in cvs. HG-1 and G-1 and significantly reduced in cvs. Aru and G-41.

In the cloves of garlic cv. HG-6, the profile of saturated fatty acids revealed that palmitic acid (C 16:0) was ranging from 18.6 - 20.9 %, palmitoleic acid (C 16:1) was in traces and stearic acid (C 18:0) was very low and not consistent. The unsaturated fatty acids oleic (C 18: 1), linoleic (C 18:2) and linolenic (C 18:3) were ranging from 18.8 - 20.2, 56.7 - 60.1 and 1.6 - 2.3 %, respectively. The concentrations of both saturated and unsaturated fatty acids did change significantly under saline conditions (data not presented). Similarly, Gupta *et al.* (1995) observed unaffected fatty acid profile and their concentrations in coriander under saline conditions.

The content of sulphur which is mainly responsible for pungency in garlic was maximum in cv. G-1, followed by cvs. HG-1, Aru, G-41 and HG-6 (Table 1). The sulphur content at 4.0 dS m^{-1} was significantly increased in cvs. HG-6 and HG-1 whereas in other cultivars, it was significantly reduced. At higher salinity levels, no consistent trend was observed.

Table 1. Effect of salinity on contents of water, soluble saccharides, phenols and sulphur in the bulbs of five garlic cultivars (data are averages of two years).

	Salinity [dS m^{-1}]	cv. Aru	cv. G-1	cv. G-41	cv. HG-1	cv. HG-6
Moisture content [%]	0.85 (control)	43.6	54.6	45.2	45.7	43.7
	4.0	43.8	51.2	36.8	46.5	45.7
	6.0	41.8	51.1	36.1	46.7	43.7
	8.0	40.3	50.5	39.5	49.4	43.0
	10.0	38.2	50.0	34.1	46.5	38.9
	C.D. at 5 %	S = 1.50	V = 2.40	S × V = 2.43		
Soluble saccharides [mg g^{-1}(d.m.)]	0.85 (control)	296	291	391	193	375
	4.0	289	296	396	283	291
	6.0	250	261	365	291	285
	8.0	250	247	360	231	236
	10.0	220	236	301	227	222
	C.D. at 5 %	S = 8.8	V = 12.3	S × V = 19.8		
Phenols [mg g^{-1}(d.m.)]	0.85 (control)	12.3	19.0	11.9	14.4	7.6
	4.0	9.8	19.0	11.9	16.2	12.8
	6.0	10.9	15.3	9.2	15.6	8.4
	8.0	9.8	19.5	12.5	13.6	13.8
	10.0	8.0	18.1	9.7	14.4	12.0
	C.D. at 5 %	S = 0.48	V = 0.61	S × V = 1.08		
Sulphur [mg g^{-1}(d.m.)]	0.85 (control)	0.53	1.20	0.49	0.57	0.38
	4.0	0.35	0.90	0.41	0.88	0.50
	6.0	0.54	0.49	0.32	0.64	0.35
	8.0	0.65	0.93	0.32	0.52	0.40
	10.0	0.68	0.76	0.60	0.53	0.40
	C.D. at 5 %	S = 0.02	V = 0.02	S × V = 0.63		

S - salinity; V - cultivar; S × V - interaction

The minerals N, Na, K, Ca, Mn, Cu, Zn and Fe in garlic cloves were analysed only in case of salt tolerant cv. HG-6. Na content increased significantly only when soil salinity value exceeded 8.0 dS m^{-1}. Potassium and calcium contents were reduced when salinity exceeded 6.0 dS m^{-1} and were minimum at 10.0 dS m^{-1}. Reduced accumulation of K and Ca in garlic bulbs under saline conditions may probably be because of interference caused by excess of Na ions in the media, as suggested by Singh *et al.* (1976). Increased concentration of Na in onion bulbs under saline conditions has been reported by Malik (1973). There was no significant change in the levels of N, Mn, Cu, Zn and Fe (Table 2).

The respiration rate progressively increased with increasing salinity levels in cvs. Aru and G-1 (Table 3). However, in cvs. HG-1 and G-41, the respiration rate decreased under saline conditions, but there was no significant difference amongst the various levels of salinity. In cv. HG-6, there was no significant effect at 4.0 dS m^{-1}, but at higher salinity levels the respiration rate decreased.

Table 2. Effect of salinity [dS m^{-1}] on mineral composition [mg g^{-1}(d.m.)] of garlic bulbs of cv. HG-6 (data are averages of two years).

Salinity	N	Ca	Na	K	Mn	Cu	Zn	Fe
0.85	33.8	8.2	12.6	623	8.33	12.5	113.2	126.6
4.0	31.0	9.0	12.6	592	9.02	11.6	138.6	140.0
6.0	34.0	9.8	13.0	614	9.02	11.6	105.3	160.0
8.0	33.1	5.3	14.5	507	9.71	13.5	134.3	166.6
10.0	30.9	4.0	18.8	496	9.02	17.7	118.6	166.6
C.D. at 5 %	NS	1.2	2.2	31.5	NS	NS	NS	NS

NS indicates non significant differences.

Table 3. Effect of salinity [dS m^{-1}] on respiration rate [$\mu g(CO_2)$ g^{-1}(d.m.) s^{-1}] of five garlic cultivars (data are averages of two years).

Salinity	cv. Aru	cv. G-1	cv. G-41	cv. HG-1	cv. HG-6
0.85	0.025	0.032	0.037	0.018	0.016
4.0	0.039	0.033	0.021	0.012	0.016
6.0	0.128	0.045	0.019	0.012	0.011
8.0	0.132	0.049	0.021	0.012	0.011
10.0	0.139	0.089	0.020	0.012	0.010
C.D. at 5 %	S = 0.003	V = 0.003	S × V = 0.007		

S - salinity; V - cultivar; S × V - interaction.

Thus, it appears that the tendency of the tolerant cultivars to resist the change in moisture content of the bulbs, and to increase the phenols under saline conditions may be responsible for their observed tolerance. The respiration rate and total saccharide content were not found to be associated with salinity tolerance.

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