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RESPONSE OF PEACH AND APRICOT SEEDLINGS TO HUMIC ACID TREATMENTS UNDER SALINITY CONDITION

Eissa, Fawzia M.; M.A. Fathi and S.A. El-Shall
Hort. Res. Inst., Agric. Res. Center, Giza, Egypt

ABSTRACT

Peach (*Prunus persica*, Batsch) and apricot (*P. armeniaca* L.) seedlings were observed under 0, 1000 and 2000 ppm saline irrigation water containing mixed salts of: NaCl, $CaCl_2$, $MgSO_4$ and $NaHCO_3$. Also, the effect of humic acid treatments as soil, foliar and soil + foliar applications on the growth parameters (shoot length, number of leaves, leaf area and leaf chlorophyll content), nutritional status (percentage of leaf dry matter and NPK content), root system growth (root length, number of roots, dry matter of main and secondary roots), toxic ions (chloride and sodium leaf content), and amino acid proline were also studied. Salinity treatments directly decreased growth parameters, nutritional status and root system growth, while it increased toxic ions and proline amino acid content. Florda Prince peach budded on 'Nemaguard' peach rootstock was markedly more salt tolerant than 'Canino' apricot budded on Balady apricot rootstock. Moreover, humic acid application especially as soil treatment with 20 ml Actosol (2.9 % humic acid) in l L of water every other week from late June till Oct.15th minimized the harmful effect of salinity and enhanced salt tolerance.

INTRODUCTION

Faust (1989) and Grattan & Grieve (1998) indicated that salinity may affect plant growth in three ways: 1) The osmotic pressure of the soil solution may becomes high enough to limit the availability of water to plant; 2) The high concentration of salts may also facilitate the uptake of one or more ions and their accumulation to the derangement of the normal metabolism; and 3) Occurrence of complex interactions that affect plant metabolism, susceptibility to injury, or internal nutrient requirement. Moreover, Hoffman *et al.* (1989) suggested that chloride was the dominant ion causing plum foliar damage. Accordingly, leaf chloride content of apricot, nectarine and peach was reported as a good indicator of salinity level (Boland *et al.*, 1993, and 1997 and Volsckenk & Villiers, 2000). Also, 'Nemagaurd' and 'Lovell' peach rootstocks minimized Na^+ release to the vegetative parts but failed to control Cl^- mobility (Fathi & Catlin, 1994). Humic acid (polymeric polyhydroxy acid) is the most significant component of organic substances in aquatic system (Mecan & Petrovic, 1995). It has a branched open network in fresh water, but it forms a compact and close network with increasing salinity (Baalousha *et al.*, 2006).Moreover, It has been demonstrated to have a good influence on plant growth and development (Bohme & Lua, 1997; Hartwigsen & Evans, 2000 and Liu & Cooper, 2002).

Therefore, this study was conducted to investigate the response of apricot and peach seedlings to irrigation with saline water. The possibility of using humic acid as a soil conditioner to reduce the harmful effects of salinity was also included.

MATERIALS AND METHODS

One-year-old seedlings of 'Canino' apricot/'Balady' and 'Florda prince' peach/'Nemaguard' were used in this study during 2004 and 2005 seasons in the orchard of the Horticulture Research Institute, Agricultural Research Center, Giza.

A split-split plot system in a randomized complete block design was used with three replicates. Each replicate consisted of 3 pots, each containing one seedling. Pots were 35 x 50 cm and were filled with a mixture of 15 kg sand + 100 g peatmoss. The pots were planted during January in the two seasons. The two crops were allocated to the main plots. Watering was done using tap water until the end of June in each season. Thereafter, salinity treatments were applied until Oct 15th. Three salinity treatments were applied twice a week as sub-plots, viz., 0, 1000, and 2000 ppm of a mixture of equal parts by weight of sodium chloride, calcium chloride, magnesium sulfate and sodium bicarbonate salts. Sub-sub treatments were applied every other week during the same period, i.e., from July 1st to Oct. 15th using humic acid (in the form of Actosol) as follows: (a) soil application at the rate of 20 ml Actosol in 1 L water, (b) foliar application with 0.5 % Actosol solution + soil application as above, (c) foliar application as above and (d) control (only water application). Actosol is a commercial product that contains 2.9 % humic acid and 10-10-10 NPK. It is manufactured by Arctick Inc., Chentilly, VA, USA.

Foliage measurements included the following characters: (a) relative shoot length expressed as percentage of shoot length and relative number of leaves as percentage of number of leaves compared to control which were recorded in August, September and October of both tested seasons and (b) leaf area and leaf chlorophyll content as measured on Aug. 20th in 20 fully-expanded leaves per seedling. These leaves were sampled from the middle of shoots. Leaf area was recorded using a CI203Area Meter (CID, Inc., USA), while a SPAD 502 chlorophyll meter (Minolta Corporation, Ramsey, N.J., USA) was used in recording chlorophyll readings.

Subsequently, in December of both seasons, measurements were made on the percentage of dry matter in vegetative growth, i.e., remaining leaves and stems alongwith main and secondary roots.

Chemical analysis was made on leaf samples to determine mineral elements content. Samples were taken from an intermediate position on scion shoots in August. Leaves were first washed several times with tap water; followed by distilled water and 0.1 N HCl, dried at 70 ^{o}C, to a constant weight and finely ground. Samples, 0.5 g each, were digested using H_2SO_4-H_2O_2 as described by Cottenie (1980). Then, extracts were prepared for chemical analysis as described by Jackson (1973). Nitrogen was determined according to the modified Kjeldahl method as described by A.O.A.C. (1975). Phosphorus content was clorimetrically estimated according to Troug and Meyer (1939). Wet digestion was used for the determination of potassium as described by Piper (1950) using a flame photometer according to Brown and Lilleland (1946). Sodium was determined by using flame photometer (Brown and Lilleland, 1946). Chloride content was assessed according to the methods of Higinbothan *et al.* (1967). Proline content was then colorimetrically estimated at 520 nm according to Bates *et al.* (1973).

The obtained data were statistically analysed according to Snedecor and Cochran (1990). Mean separation was calculated using L.S.D values at the 5 % level.

RESULTS

Growth parameters

Growth parameters of peach and apricot seedlings included shoot length (Fig.1), number of leaves (Fig.2), leaf area, and leaf chlorophyll content (Table 1). Humic acid treatment (especially soil application) effectively decreased the deleterious effect due to salt accumulation in plant tissues, as it supported peach and apricot plants to produce longer shoots, maintain higher number of functioning leaves, with better expansion and higher chlorophyll content.

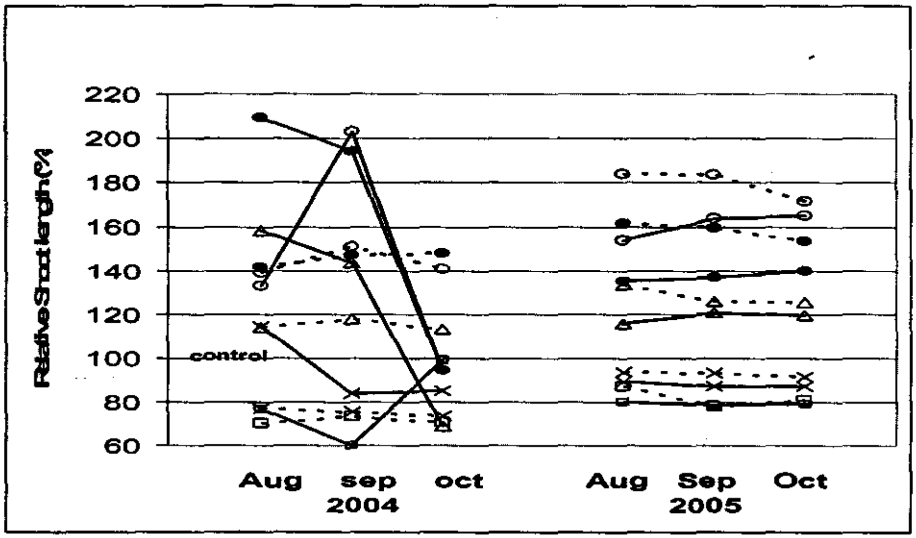

Fig. (1): Relative shoot length (expressed as percentage of length in the control), as affected by humic acid treatments (O soil, Δ foliar and • foil + foliar) and salinity treatments (× 1000 and □ 2000 ppm) for peach (–) and apricot (--------) .

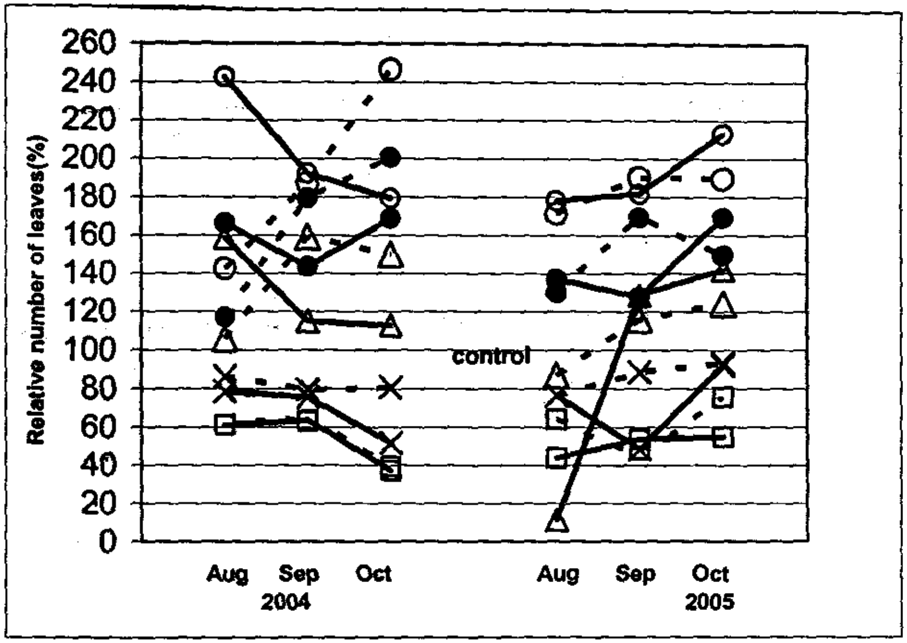

Fig. (2): Relative number of leaves (expressed as percentage of number in the control), as affected by humic acid treatments (O soil, Δ foliar and • soil + foliar) and salinity treatments (× 1000 and □ 2000 ppm) for peach and (____) apricot (--------).

Meanwhile, apricot plants were more sensitive to salinity treatments as they recorded shorter shoots (70.4 %), fewer number of leaves/seedlings (53.5 %), lower leaf area (22.3 cm^2) and lower leaf chlorophyll content (34.5 SPAD reading). On the contrary, peach seedling showed higher degree of salt tolerance since they exhibited better growth parameters (80.7 % shoot length, 75.7 % number of leaves relative to the control, 38.3 cm^2 leaf area and 37.7 SPAD reading).

Generally, salinity treatments significantly decreased the growth rate (as shoot length) of peach to 59.9 % in 2004 and to 78.6 % in 2005 season, as well as of apricot to 70.4 % in 2004 and to 77.9 % in 2005 season, respectively, comparing to control (100.0 %). The number of leaves, also decreased as salinity dose increased from 0 to 1000 and then to 2000 ppm. Leaf area significantly decreased from 25.2 to 24.4 and then to 22.3 cm^2 in 2004 and from 38.6 to 34.4 and then to 30.7 cm^2 in 2005 season. Leaf chlorophyll content (SPAD reading) decreased from 39.5 to 36.5 and then to 32.4 in 2004 season, as well as from 39.6 to 34.7 and then to 33.5 in 2005 season, as salinity of irrigation water increased.

2. Nutritional status:

We assessed the percentage of leaf content of dry matter (Table 1) and NPK elements (Table 2) as indicators of nutritional status.

J. Agric. Sci. Mansoura Univ., 32 (5), May, 2007

Table (1): Effect of humic acid (A) and salinity of irrigation water (C) on leaf area, percentage of dry matter and leaf chlorophyll content of peach and apricot seedlings (B).

(A)	(C)	Leaf area (cm^2)						% Dry matter						Chlorophyll (SPAD reading)					
		2004 season			2005 season			2004 season			2005 season			2004 season			2005 season		
		Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)
Control	0	23.2	19.1	21.2	24.5	20.3	22.4	55.3	43.9	49.6	44.3	49.4	46.9	40.3	35.5	37.9	34.6	35.3	35.0
	1000	20.6	17.4	19.0	21.0	20.8	20.9	43.2	37.0	40.1	41.5	47.8	44.7	42.2	34.2	38.2	29.7	27.0	28.4
	2000	18.3	15.6	17.0	22.1	17.9	20.0	40.6	38.6	39.6	31.8	30.1	31.0	30.4	28.7	29.6	29.3	26.1	27.7
Ave. (A x B)		20.7	17.4	Ave (A) 19.0	22.5	19.7	Ave (A) 21.1	46.4	39.8	Ave (A) 43.1	39.2	42.4	Ave (A) 40.8	37.6	32.8	Ave (A) 35.2	31.2	29.5	Ave (A) 30.3
Soil	0	33.2	21.2	27.2	50.0	45.3	47.7	61.1	57.3	59.2	56.1	50.3	53.2	47.5	42.3	44.9	46.4	39.5	43.0
	1000	31.7	15.3	23.5	50.6	41.2	45.9	60.7	52.8	56.8	55.6	49.1	52.4	42.1	37.1	39.6	39.4	36.1	37.8
	2000	25.9	18.8	22.4	47.5	37.5	42.5	55.6	52.9	54.3	43.0	42.5	42.8	36.9	33.5	35.2	37.6	34.9	36.3
Ave. (A x B)		30.3	18.4	Ave (A) 24.4	49.4	41.3	Ave (A) 45.3	59.1	54.3	Ave (A) 56.7	51.6	47.3	Ave (A) 49.4	42.2	37.6	Ave (A) 39.9	41.1	36.8	Ave (A) 39.0
Foliar	0	25.5	25.6	25.6	41.7	32.6	37.2	45.5	49.8	47.7	40.0	44.0	42.0	39.3	37.6	38.5	40.7	36.3	38.5
	1000	24.5	38.2	31.4	39.6	26.4	33.0	41.1	47.6	44.4	39.8	42.1	41.0	34.6	35.4	35.0	36.6	34.9	35.8
	2000	23.6	28.8	26.2	20.3	27.2	23.8	40.2	48.6	44.4	38.8	38.9	38.9	31.9	32.2	32.1	33.3	31.3	32.3
Ave. (A x B)		24.5	30.9	Ave (A) 27.7	33.9	28.7	Ave (A) 31.3	42.3	48.7	Ave (A) 45.5	39.5	41.7	Ave (A) 40.6	35.3	35.1	Ave (A) 35.2	36.9	34.2	Ave (A) 35.5
Soil + foliar	0	27.8	25.6	26.7	50.6	43.6	47.1	45.4	48.0	46.7	46.5	49.7	48.1	37.8	35.6	36.7	44.7	39.3	42.0
	1000	26.1	21.3	23.7	44.0	31.2	37.6	48.2	45.5	46.9	46.4	44.5	45.5	35.2	30.8	33.0	36.3	37.6	37.0
	2000	26.3	21.2	23.8	47.7	25.3	36.5	47.9	43.9	45.9	43.1	41.3	42.2	34.2	31.2	32.7	36.4	38.8	37.6
Ave. (A x B)		26.7	22.7	Ave (A) 24.7	47.4	33.4	Ave (A) 40.4	47.2	45.8	Ave (A) 46.5	45.3	45.2	Ave (A) 45.3	35.7	32.5	Ave (A) 34.1	39.1	38.6	Ave (A) 38.9
Ave. (B x C)	0	27.4	22.9	Ave (C) 25.2	41.7	35.5	Ave (C) 38.6	51.8	49.8	Ave (C) 50.8	46.7	48.4	Ave (C) 47.6	41.2	37.8	Ave (C) 39.5	41.6	37.6	Ave (C) 39.6
	1000	25.7	23.1	24.4	38.8	29.9	34.4	48.3	45.7	47.0	45.8	45.9	45.9	38.5	34.4	36.5	35.5	33.9	34.7
	2000	23.5	21.1	22.3	34.4	26.9	30.7	46.1	46.0	46.1	39.2	38.2	38.7	33.4	31.4	32.4	34.2	32.8	33.5
Ave. (B)		25.5	22.4		38.3	30.8		48.7	47.2		43.9	44.2		37.7	34.5		37.1	34.8	
LSD at 5% for:																			
Humic acid (A)				2.31			3.19			3.149			4.493			3.37			2.96
Peach and apricot (B)				2.00			2.77			2.728			3.891			2.92			2.56
Salinity (C)				2.00			2.77			2.728			3.891			2.92			2.56
A x B				3.27			4.52			4.454			6.354			4.77			4.19
A x C				4.00			5.53			5.455			7.782			5.84			5.13
B x C				2.83			3.91			3.857			5.503			4.13			3.63
A x B x C				5.66			7.82			7.715			11.010			8.26			7.25

Table (2): Effect of humic acid (A) and salinity of irrigation water (C) on percentage of leaf content of nitrogen (N), phosphorus (P) and potassium (K) of peach and apricot seedlings (B).

(A)	(C)	N (%)						P (%)						K (%)					
		2004 season			2005 season			2004 season			2005 season			2004 season			2005 season		
		Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)
Control	0	1.37	1.40	1.39	1.67	1.49	1.58	0.18	0.21	0.20	0.19	0.23	0.21	0.69	1.11	0.90	1.66	1.11	1.39
	1000	1.03	0.98	1.01	1.12	1.09	1.11	0.17	0.15	0.16	0.18	0.19	0.19	0.67	0.32	0.50	0.67	0.26	0.47
	2000	0.82	0.69	0.76	0.80	0.79	0.80	0.00	0.17	0.09	0.00	0.18	0.09	0.54	0.54	0.54	0.56	0.24	0.40
Ave. (A x B)		1.07	1.02	Ave (A) 1.05	1.20	1.12	Ave (A) 1.16	0.12	0.18	Ave (A) 0.15	0.12	0.20	Ave (A) 0.16	0.63	0.66	Ave (A) 0.65	0.99	0.54	Ave (A) 0.77
Soil	0	2.84	2.69	2.77	2.34	2.09	2.22	0.39	0.16	0.28	0.40	0.16	0.28	1.51	0.99	1.25	1.48	0.99	1.24
	1000	2.22	1.97	2.10	1.92	1.88	1.90	0.22	0.21	0.22	0.22	0.22	0.22	0.54	1.03	0.79	1.57	0.83	1.20
	2000	2.00	1.85	1.93	1.98	1.66	1.82	0.18	0.21	0.20	0.17	0.22	0.20	0.08	0.59	0.34	1.08	0.62	0.85
Ave. (A x B)		2.35	2.17	Ave (A) 2.26	2.08	1.88	Ave (A) 1.98	0.26	0.19	Ave (A) 0.23	0.26	0.20	Ave (A) 0.23	0.71	0.87	Ave (A) 0.79	1.38	0.81	Ave (A) 1.10
Foliar	0	1.10	1.75	1.43	1.92	1.66	1.79	0.00	0.17	0.09	0.00	0.18	0.09	0.70	0.93	0.82	1.12	0.93	1.03
	1000	1.31	1.40	1.36	1.22	1.49	1.36	0.14	0.19	0.17	0.15	0.18	0.17	0.77	0.52	0.65	0.71	0.44	0.58
	2000	0.63	1.05	0.84	1.13	1.15	1.14	0.18	0.22	0.20	0.19	0.22	0.21	0.49	0.11	0.30	0.55	0.14	0.35
Ave. (A x B)		1.01	1.40	Ave (A) 1.21	1.42	1.43	Ave (A) 1.43	0.11	0.19	Ave (A) 0.15	0.11	0.19	Ave (A) 0.15	0.65	0.52	Ave (A) 0.59	0.79	0.50	Ave (A) 0.65
Soil + foliar	0	2.50	2.36	2.43	2.31	2.45	2.38	0.24	0.16	0.20	0.23	0.17	0.20	1.10	1.26	1.18	1.33	1.26	1.30
	1000	1.68	1.25	1.47	1.86	1.39	1.63	0.14	0.00	0.07	0.14	0.00	0.07	1.33	1.05	1.19	1.06	0.96	1.01
	2000	1.23	1.30	1.27	1.14	1.10	1.12	0.27	0.00	0.14	0.26	0.00	0.13	0.68	0.21	0.45	0.70	0.21	0.46
Ave. (A x B)		1.80	1.64	Ave (A) 1.72	1.77	1.65	Ave (A) 1.71	0.22	0.05	Ave (A) 0.14	0.21	0.06	Ave (A) 0.13	1.04	0.84	Ave (A) 0.94	1.03	0.81	Ave (A) 0.92
Ave. (B x C)	0	1.95	2.05	Ave (C) 2.00	2.06	1.92	Ave (C) 1.99	0.20	0.18	Ave (C) 0.19	0.21	0.19	Ave (C) 0.20	1.00	1.07	Ave (C) 1.04	1.40	1.07	Ave (C) 1.24
	1000	1.56	1.40	1.48	1.53	1.46	1.50	0.17	0.14	0.16	0.17	0.15	0.16	0.83	0.73	0.78	1.00	0.62	0.81
	2000	1.17	1.22	1.20	1.26	1.18	1.22	0.16	0.15	0.16	0.16	0.16	0.16	0.45	0.36	0.41	0.75	0.30	0.53
Ave. (B)		1.56	1.56		1.62	1.52		0.18	0.16		0.18	0.17		0.76	0.72		1.05	0.66	
LSD at 5% for:																			
Humic acid (A)				0.271			0.257			0.007			0.007			0.107			0.109
Peach and apricot (B)				0.233			0.223			0.006			0.006			0.092			0.094
Salinity (C)				0.233			0.223			0.006			0.006			0.092			0.094
A x B				0.384			0.364			0.010			0.010			0.151			0.154
A x C				0.470			0.446			0.012			0.012			0.185			0.188
B x C				0.332			0.315			0.008			0.008			0.131			0.133
A x B x C				0.664			0.631			0.017			0.017			0.261			0.266

Humic acid treatments (especially soil application) exhibited a remarkable increment in the percentage of leaf content of dry matter (56.7 %), nitrogen (2.26 %), phosphorus (0.23 %), and potassium (0.79 %) than the control (43.1 %, 1.05 %, 0.15 % and 0.65 %, respectively Tables 1 and 2). Meanwhile, under salinity condition, peach leaves accumulated in the 1st season higher levels of N (1.56 %), P (0.18 %) and K (0.76 %) than apricot leaves (1.56 %, 0.16% and 0.72 %, respectively).

In the second season salinity treatments reduced leaf dry weight of peach from 46.7 % to 45.8 % and then to 39.2 % and of apricot from 48.4 % to 45.9 % and then to 38.2 % as salinity dose increased from 0 to 1000 and then to 2000 ppm, respectively. The reduction in the leaf content of N (from 1.99 % to 1.50 % and then to 1.22 %), P (from 0.20 % to 0.16 % and then to 0.16%), and K (from 1.24 % to 0.81 % and then to 0.53 %) due to salinity treatments in 2005 was parallel to the increase in salt level. It was also noticeable that under normal conditions peach and apricot leaves contained higher nitrogen levels (2.00 %-1.99 %) than potassium (1.04 %-1.24 %) which was inturn, higher than phosphorus (0.19 % -0.20 %) in 2004 and 2005, respectively.

Concerning the interaction effect, peach seedling were less responsive to the deleterious salinity effect, while they responded better than apricot seedlings to humic acid treatments, specially in soil application.

3- Root system growth

The root system growth (Fig. 3 and 4) included measurements on root length (Table 3) and number of roots (Table 4) separated according to diameter to < 0.5, 0.5-1.5 and > 1.5 cm. We also calculated the percentage of dry matter of main and secondary roots (Table 5). The present data showed that, it is valuable to treat peach and apricot seedling with humic acid (especially soil application) to eliminate the unfavorable effect of salinity where it effectively increased root length to 9.57, 38.0 and 16.6 cm and increased number of roots to 0.50, 7.72 and 11.1 comparing to control (7.10, 11.8 and 7.2 cm as well as 0.40, 2.52 and 4.50). It also enhanced main roots (39.2 %) and secondary roots (38.7 %) to accumulate more percentage of dry matter if compared with control (24.4 and 26.0 %, respectively).

Table (3): Effect of humic acid (A) and salinity of irrigation water (C) on root length (>1.5, 1.5-0.5 and < 0.5 cm) of peach and apricot seedlings (B).

(A)	(C)	> 1.5 cm						1.5-0.5 cm						<0.5 cm					
		2004 season			2005 season			2004 season			2005 season			2004 season			2005 season		
		Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)
Control	0	8.70	18.30	13.50	8.00	0.00	4.00	16.9	10.6	13.8	10.7	13.3	12.0	13.9	37.6	25.8	9.8	6.9	8.4
	1000	0.00	9.30	4.65	0.00	9.30	4.65	13.0	9.1	11.1	12.3	9.6	11.0	8.2	7.8	8.0	8.6	7.3	8.0
	2000	3.30	3.30	3.30	3.30	3.50	3.40	12.8	8.6	10.7	12.6	7.2	9.9	6.9	32.4	19.7	6.7	4.0	5.4
Ave. (A x B)		4.00	10.30	Ave (A) 7.15	3.77	4.27	Ave (A) 4.02	14.2	9.4	Ave (A) 11.8	11.9	10.0	Ave (A) 11.0	9.7	25.9	Ave (A) 17.8	8.4	6.1	Ave (A) 7.2
Soil	0	0.00	23.80	11.90	9.90	6.00	7.95	33.6	118.4	76.0	29.2	25.6	27.4	16.5	13.8	15.2	20.2	18.8	19.5
	1000	0.00	15.80	7.90	0.00	2.50	1.25	23.3	29.9	26.6	26.0	26.3	26.2	13.3	37.7	25.5	14.9	15.2	15.1
	2000	0.00	17.80	8.90	13.30	0.00	6.65	13.3	9.5	11.4	21.0	23.4	22.2	33.8	34.6	34.2	13.4	17.0	15.2
Ave. (A x B)		0.00	19.13	Ave (A) 9.57	7.73	2.83	Ave (A) 5.28	23.4	52.6	Ave (A) 38.0	25.4	25.1	Ave (A) 25.3	21.2	28.7	Ave (A) 25.0	16.2	17.0	Ave (A) 16.6
Foliar	0	0.00	15.10	7.55	4.60	6.70	5.65	17.5	19.2	18.4	13.9	17.0	15.5	36.6	10.0	23.3	12.9	37.4	25.2
	1000	0.00	9.50	4.75	4.50	0.00	2.25	15.0	17.5	16.3	10.7	14.7	12.7	8.5	6.1	7.3	11.0	8.0	9.5
	2000	0.00	5.50	2.75	0.00	0.00	0.00	11.0	9.6	10.3	73.3	10.0	41.7	7.0	32.3	19.7	7.8	32.4	20.1
Ave. (A x B)		0.00	10.03	Ave (A) 5.02	3.03	2.23	Ave (A) 2.63	14.5	15.4	Ave (A) 15.0	32.6	13.9	Ave (A) 23.3	17.4	16.1	Ave (A) 16.8	10.6	25.9	Ave (A) 18.3
Soil + foliar	0	11.70	9.40	10.55	11.30	0.00	5.65	25.3	11.0	18.2	34.8	26.3	30.6	15.0	13.4	14.2	111.0	19.6	65.3
	1000	5.70	12.00	8.85	5.50	0.00	2.75	20.1	14.4	17.3	26.1	23.5	24.8	63.0	12.5	37.8	22.8	10.0	16.4
	2000	0.00	15.10	7.55	14.30	0.00	7.15	14.5	9.2	11.9	22.6	19.5	21.1	6.4	9.8	8.1	8.5	4.6	6.6
Ave. (A x B)		5.80	12.17	Ave (A) 8.98	10.37	0.00	Ave (A) 5.18	20.0	11.5	Ave (A) 15.8	27.8	23.1	Ave (A) 25.5	28.1	11.9	Ave (A) 20.0	47.4	11.4	Ave (A) 29.4
Ave. (B x C)	0	5.10	16.65	Ave (C) 10.88	8.45	3.18	Ave (C) 5.82	23.3	39.8	Ave (C) 31.6	22.2	20.6	Ave (C) 21.4	20.5	18.7	Ave (C) 19.6	38.5	20.7	Ave (C) 29.6
	1000	1.43	11.65	6.54	2.50	2.95	2.73	17.9	17.7	17.8	18.8	18.5	18.7	23.3	16.0	19.7	14.3	10.1	12.2
	2000	0.83	10.43	5.63	7.73	0.88	4.31	12.9	9.2	11.1	32.4	15.0	23.7	13.5	27.3	20.4	9.1	14.5	11.8
Ave. (B)		2.45	12.91		6.23	2.34		18.0	22.2		24.5	18.0		19.1	20.7		20.6	15.1	
LSD at 5% for:																			
Humic acid (A)				0.325			0.358			6.52			4.33			5.37			7.82
Peach and apricot (B)				0.282			0.310			5.64			3.75			4.65			6.77
Salinity (C)				0.282			0.310			5.64			3.75			4.65			6.77
A x B				0.460			0.507			9.22			6.12			7.60			11.06
A x C				0.563			0.621			11.29			7.50			9.31			13.55
B x C				0.389			0.439			7.98			5.30			6.58			9.58
A x B x C				0.797			0.878			15.96			10.60			13.16			19.16

Table (4): Effect of humic acid (A) and salinity of irrigation water (C) on number of root (>1.5, 1.5-0.5 and < 0.5 cm) of peach and apricot seedlings (B).

(A)	(C)	> 1.5 cm						1.5-0.5 cm						<0.5 cm					
		2004 season			2005 season			2004 season			2005 season			2004 season			2005 season		
		Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)
Control	0	0.70	1.00	0.85	0.70	0.00	0.35	3.50	2.17	2.84	3.80	3.20	3.50	8.5	9.0	8.8	5.5	6.8	6.2
	1000	0.00	0.31	0.16	0.00	0.70	0.35	3.00	2.00	2.50	2.70	2.20	2.45	4.3	8.7	6.5	4.2	4.3	4.3
	2000	0.30	0.07	0.19	0.30	0.70	0.50	2.00	1.00	1.50	2.00	1.20	1.60	3.8	2.3	3.1	3.8	2.5	3.2
Ave. (A x B)		0.33	0.46	Ave (A) 0.40	0.33	0.47	Ave (A) 0.40	2.83	1.72	Ave (A) 2.28	2.83	2.20	Ave (A) 2.52	5.5	6.7	Ave (A) 6.1	4.5	4.5	Ave (A) 4.5
Soil	0	0.00	1.00	0.50	0.70	0.70	0.70	5.00	5.50	5.25	8.20	8.20	8.20	12.2	10.3	11.3	14.5	11.3	12.9
	1000	0.00	1.00	0.50	0.00	0.30	0.15	3.00	4.70	3.85	8.20	7.00	7.60	11.8	9.0	10.4	11.7	9.2	10.5
	2000	0.00	1.00	0.50	1.30	0.00	0.65	2.00	4.70	3.35	7.20	7.50	7.35	11.5	5.6	8.6	10.8	8.8	9.8
Ave. (A x B)		0.00	1.00	Ave (A) 0.50	0.67	0.33	Ave (A) 0.50	3.33	4.97	Ave (A) 4.15	7.87	7.57	Ave (A) 7.72	11.8	8.3	Ave (A) 10.1	12.3	9.8	Ave (A) 11.1
Foliar	0	0.00	1.30	0.65	0.70	0.30	0.50	5.30	3.80	4.55	5.00	4.00	4.50	11.5	8.2	9.9	13.9	13.8	13.9
	1000	5.30	1.00	3.15	0.70	0.00	0.35	2.90	3.20	3.05	2.30	1.70	2.00	9.2	7.7	8.5	10.7	8.0	9.4
	2000	0.00	0.70	0.35	0.00	0.00	0.00	2.30	2.00	2.15	2.50	1.00	1.75	8.3	6.3	7.3	7.3	5.0	6.2
Ave. (A x B)		1.77	1.00	Ave (A) 1.38	0.47	0.10	Ave (A) 0.28	3.50	3.00	Ave (A) 3.25	3.27	2.23	Ave (A) 2.75	9.7	7.4	Ave (A) 8.5	10.6	8.9	Ave (A) 9.8
Soil + foliar	0	0.52	1.00	0.76	0.70	0.00	0.35	4.00	3.80	3.90	7.00	6.70	6.85	12.0	9.0	10.5	19.0	18.5	18.8
	1000	0.23	0.70	0.47	0.30	0.00	0.15	3.50	3.20	3.35	6.30	6.30	6.30	12.3	8.7	10.5	17.3	17.0	17.2
	2000	0.00	1.30	0.65	0.70	0.00	0.35	1.00	3.00	2.00	6.70	6.00	6.35	9.5	7.2	8.4	15.8	12.0	13.9
Ave. (A x B)		0.25	1.00	Ave (A) 0.63	0.57	0.00	Ave (A) 0.28	2.83	3.33	Ave (A) 3.08	6.67	6.33	Ave (A) 6.50	11.3	8.3	Ave (A) 9.8	17.4	15.8	Ave (A) 16.6
Ave. (B x C)	0	0.31	1.08	Ave (C) 0.70	0.70	0.25	Ave (C) 0.48	4.45	3.82	Ave (C) 4.14	6.00	5.53	Ave (C) 5.77	11.1	9.1	Ave (C) 10.1	13.2	12.6	Ave (C) 12.9
	1000	1.38	0.75	1.07	0.25	0.25	0.25	3.10	3.28	3.19	4.88	4.30	4.59	9.4	8.5	9.0	11.0	9.6	10.3
	2000	0.08	0.77	0.43	0.58	0.18	0.38	1.83	2.68	2.26	4.60	3.93	4.27	8.3	5.4	6.9	9.4	7.1	8.3
Ave. (B)		0.59	0.87		0.51	0.23		3.13	3.26		5.16	4.59		9.6	7.7		11.2	9.8	
LSD at 5% for:																			
Humic acid (A)				0.327			0.135			0.795			0.868			1.82			1.77
Peach and apricot (B)				0.283			0.117			0.689			0.752			1.58			1.54
Salinity (C)				0.283			0.117			0.689			0.752			1.58			1.54
A x B				0.462			0.191			1.124			1.228			2.57			2.51
A x C				0.566			0.233			1.377			1.503			3.15			3.07
B x C				0.400			0.165			0.974			1.063			2.23			1.88
A x B x C				0.800			0.330			1.948			2.126			4.45			4.35

Table (5): Effect of humic acid (A) and salinity of irrigation water (C) on percentage of dry matter in main and secondary roots of peach and apricot seedlings (B).

(A)	(C)	Main roots (%)						Secondary roots (%)					
		2004 season			2005 season			2004 season			2005 season		
		Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)
Control	0	50.0	53.6	51.8	30.4	25.8	28.1	42.7	49.6	46.2	31.6	27.5	29.6
	1000	50.1	44.2	47.2	27.8	24.5	26.2	45.7	43.6	44.7	29.4	22.5	26.0
	2000	40.4	33.5	37.0	22.7	15.2	19.0	37.8	36.2	37.0	22.1	23.1	22.6
Ave. (A x B)		46.8	43.8	Ave (A) 45.3	27.0	21.8	Ave (A) 24.4	42.1	43.1	Ave (A) 42.6	27.7	24.4	Ave (A) 26.0
Soil	0	59.5	52.9	56.2	43.2	44.0	43.6	49.5	43.0	46.3	39.2	46.1	42.7
	1000	58.2	49.4	53.8	40.9	36.7	38.8	47.9	42.9	45.4	34.2	33.1	33.7
	2000	53.5	46.1	49.8	38.8	31.4	35.1	49.5	41.1	45.3	39.2	40.4	39.8
Ave. (A x B)		57.1	49.5	Ave (A) 53.3	41.0	37.4	Ave (A) 39.2	49.0	42.3	Ave (A) 45.7	37.5	39.9	Ave (A) 38.7
Foliar	0	48.1	49.5	48.8	29.8	31.0	30.4	46.8	40.2	43.5	33.8	30.6	32.2
	1000	43.5	43.1	43.3	31.3	29.5	30.4	44.2	39.7	42.0	32.6	27.3	30.0
	2000	41.9	40.4	41.2	22.5	28.6	25.6	41.0	37.9	39.5	23.6	22.6	23.1
Ave. (A x B)		44.5	44.3	Ave (A) 44.4	27.9	29.7	Ave (A) 28.8	44.0	39.3	Ave (A) 41.6	30.0	26.8	Ave (A) 28.4
Soil + foliar	0	57.6	52.2	54.9	35.1	31.8	33.5	53.6	44.4	49.0	35.8	40.0	37.9
	1000	54.0	46.1	50.1	32.9	26.4	29.7	45.3	45.1	45.2	33.7	34.1	33.9
	2000	49.7	44.9	47.3	25.2	26.2	25.7	41.0	41.2	41.1	25.6	16.5	21.1
Ave. (A x B)		53.8	47.7	Ave (A) 50.8	31.1	28.1	Ave (A) 29.6	46.6	43.6	Ave (A) 45.1	31.7	30.2	Ave (A) 31.0
Ave. (B x C)	0	53.8	52.1	Ave (C) 53.0	34.6	33.2	Ave (C) 33.9	48.2	44.3	Ave (C) 46.3	35.1	36.0	Ave (C) 35.6
	1000	51.5	45.7	48.6	33.2	29.3	31.3	45.8	42.8	44.3	32.5	29.3	30.9
	2000	46.4	41.2	43.8	27.3	25.4	26.4	42.3	39.1	40.7	27.6	25.7	26.7
Ave. (B)		50.6	46.3		31.7	29.3		45.4	42.1		31.7	30.3	
LSD at 5 % for:													
Humic acid (A)				4.972			2.695			3.699			3.486
Peach and apricot (B)				4.306			2.334			3.203			3.019
Salinity (C)				4.306			2.334			3.203			3.019
A x B				7.032			3.811			5.231			4.930
A x C				8.612			4.668			6.407			6.039
B x C				6.090			3.301			4.530			4.270
A x B x C				12.180			6.601			9.060			

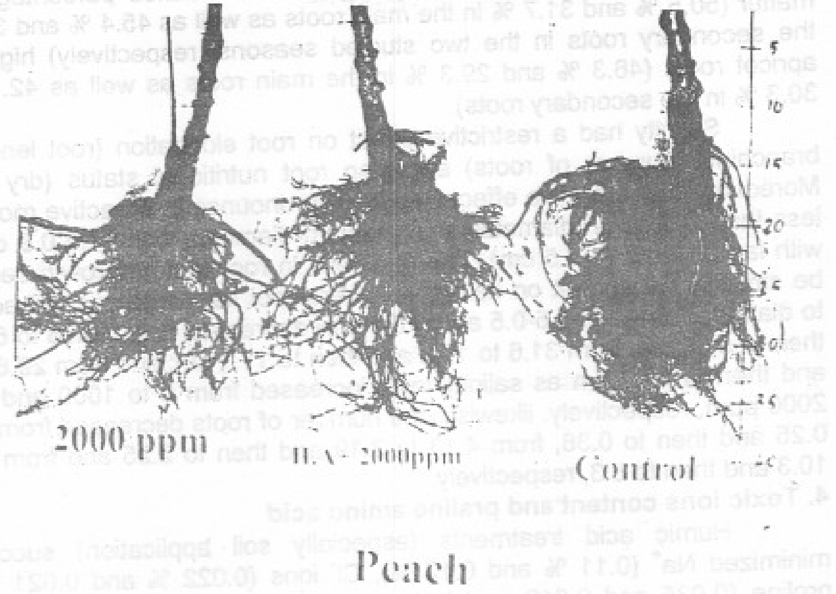

Fig. (3): Effect of humic acid treatment soil application on root growth of 'Florda Prince' peach on 'Nemaguard' rootstock at 2000 ppm salinity.

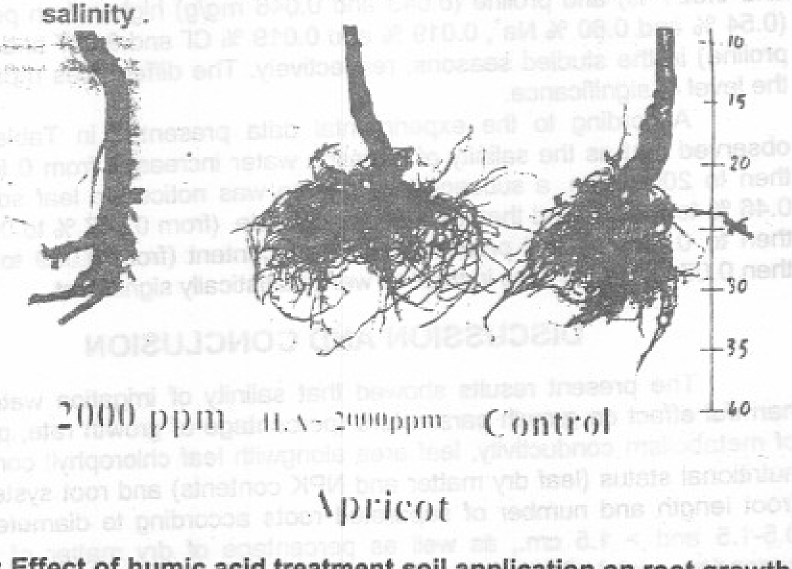

Fig. (4): Effect of humic acid treatment soil application on root growth of 'Canino' apricot on 'Balady' rootstock at 2000 ppm salinity.

It was noticed that root was elongation and branching was mostly higher with apricot in the 1st season (2004), while it was higher with peach in the 2nd season (2005). Also, peach roots accumulated percentage of dry matter (50.5 % and 31.7 % in the main roots as well as 45.4 % and 31.7 % in the secondary roots in the two studied seasons, respectively) higher than apricot roots (46.3 % and 29.3 % in the main roots as well as 42.1 % and 30.3 % in the secondary roots).

Salinity had a restrictive effect on root elongation (root length) and branching (number of roots) and also root nutritional status (dry matter). Moreover, this restrictive effect was more pronounced with active roots (roots less than 0.5 cm in diameter) and medium diameter roots (1.5-0.5 cm) than with larger roots (> 1.5 cm). The reduction in root system growth seemed to be strongly dependent on salt level, where root length (separated according to diameter to > 1.5, 1.5-0.5 and < 0.5 cm) decreased from 10.88 to 6.54 and then to 5.63 cm; from 31.6 to 17.8 and then to 11.1 cm; and from 29.6 to 12.2 and then to 11.8 cm as salinity level increased from 0 to 1000 and then to 2000 ppm, respectively. likewise, the number of roots decreased from 0.48 to 0.25 and then to 0.38, from 4.13 to 3.19 and then to 2.25 and from 12.9 to 10.3 and then to 8.3, respectively.

4. Toxic ions content and praline amino acid

Humic acid treatments (especially soil application) successfully minimized Na^+ (0.11 % and 0.12 %), Cl^- ions (0.022 % and 0.021 %) and proline (0.035 and 0.018 mg/g) content comparing to control (1.36 % and 1.44 % Na^+, 0.028 % and 0.021 % Cl^-, as well as 0.058 and 0.057 mg/g proline). Therefore, salinized peach and apricot seedlings with humic acid as soil application could be grown as near normal as under non-saline condition.

Comparing peach and apricot response to salinity, apricot leaves tended to accumulate levels of Na^+ (0.57 % and 0.70 %), Cl^- (0.030 % and 0.021 %) and proline (0.043 and 0.046 mg/g) higher than peach leaves (0.54 % and 0.60 % Na^+, 0.019 % and 0.019 % Cl^- and 0.037 and 0.036 mg/g proline) in the studied seasons, respectively. The differences mostly attained the level of significance.

According to the experimental data presented in Table 6, it was observed that as the salinity of irrigation water increased from 0 to 1000 and then to 2000 ppm, a subsequent increase was noticed in leaf sodium (from 0.46 % to 0.65 % and then to 0.84 %), chloride (from 0.017 % to 0.025 % and then to 0.031 %) and proline amino acid content (from 0.009 to 0.037 and then 0.074 mg/g). These increases were statistically significant.

DISCUSSION AND CONCLUSION

The present results showed that salinity of irrigation water exerted harmful effect on growth parameters (percentage of growth rate, percentage of metabolism conductivity, leaf area alongwith leaf chlorophyll content), leaf nutritional status (leaf dry matter and NPK contents) and root system growth (root length and number of separated roots according to diameter to <0.5, 0.5-1.5 and > 1.5 cm., as well as percentage of dry matter of main and secondary roots). On the other hand, peach and apricot leaves accumulated increasingly toxic ions (Na^+ and Cl^-) and proline amino acid by increasing salinity level.

Similar results were also achieved by Swiedan *et al.* (1992) who reported that salinity tended to restrict apple growth and plant elongation. Also, Hoffman *et al.* (1989) suggested that chloride was the dominant ion causing plum foliage damage which led others (Shahin, 1989; Boland *et al.*, 1993 and 1997; and Volschenk; & Villiers, 2000) to consider leaf chloride content in apricot, plum, nectarine and peach as a good indicator of salinity level.

Meanwhile, apricot seedlings were more sensitive to salinity treatment as they recorded less growth parameters, nutritional status and root system growth, while they accumulated higher amounts of sodium, chloride and proline amino acid comparing with peach seedlings. This finding is in line with, Shahin (1989) who disclosed that 'Marianna' plum rootstock was more sensitive to salinity than 'Marianna 2624' or 'Myrobalan 29C'. Also, 'Nemaguard' and 'Lovell' peach rootstocks minimized Na^+ release to the vegetative parts but failed to control Cl^- mobility (Fathi & Catline, 1994).

However, humic acid treatment (especially soil application) effectively decreased the deleterious effect due to salt accumulation in both plant tissues and in the soil. Consequently, it enhanced peach and apricot plants to grow better (with vegetative and root system) and to accumulate higher amounts of NPK elements and dry matter), while it reduced leaf content of toxic ions (Na^+ and Cl^-) and proline towards the normal level. Generally, Macan & Peterovic (1995) stated that humic acid was the most significant component of organic substances in aquatic systems. According to Baalousha *et al.* (2006), it was exhibitsed a more compacted and close network with increasing salinity. It has a positive influence on plant growth and development (Bohme & Lua, 1997; Hartwingsen & Evans, 2000; and Liu & Cooper, 2002).

Table (6): Effect of humic acid (A) and salinity of irrigation water (C) on proline amino acid, percentage of sodium (Na) and chloride (Cl) of peach and apricot seedlings (B).

(A)	(C)	Proline (mg/g)						Na (%)						Cl (%)					
		2004 season			2005 season			2004 season			2005 season			2004 season			2005 season		
		Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)	Peach	Apricot	Ave (AxC)
Control	0	0.024	0.009	0.017	0.005	0.009	0.007	0.81	0.89	0.85	0.85	0.96	0.91	0.010	0.020	0.015	0.010	0.007	0.009
	1000	0.072	0.059	0.066	0.072	0.056	0.064	1.60	1.62	1.61	1.71	1.49	1.60	0.018	0.043	0.031	0.018	0.033	0.026
	2000	0.086	0.098	0.092	0.085	0.113	0.099	1.62	1.63	1.63	1.76	1.85	1.81	0.030	0.045	0.038	0.030	0.026	0.028
Ave. (A x B)		0.061	0.055	Ave (A) 0.058	0.054	0.059	Ave (A) 0.057	1.35	1.38	Ave (A) 1.36	1.44	1.43	Ave (A) 1.44	0.019	0.036	Ave (A) 0.028	0.019	0.022	Ave (A) 0.021
Soil	0	0.010	0.007	0.009	0.010	0.017	0.014	0.09	0.11	0.10	0.10	0.12	0.11	0.031	0.017	0.024	0.015	0.017	0.016
	1000	0.011	0.021	0.016	0.012	0.021	0.017	0.11	0.12	0.12	0.12	0.13	0.13	0.016	0.024	0.020	0.022	0.025	0.024
	2000	0.021	0.140	0.081	0.021	0.025	0.023	0.12	0.13	0.12	0.13	0.13	0.13	0.015	0.030	0.023	0.015	0.032	0.024
Ave. (A x B)		0.014	0.056	Ave (A) 0.035	0.014	0.021	Ave (A) 0.018	0.11	0.12	Ave (A) 0.12	0.12	0.13	Ave (A) 0.12	0.021	0.024	Ave (A) 0.022	0.017	0.025	Ave (A) 0.021
Foliar	0	0.003	0.001	0.002	0.005	0.001	0.003	0.58	0.61	0.60	0.71	0.70	0.71	0.009	0.022	0.016	0.018	0.016	0.017
	1000	0.043	0.052	0.048	0.045	0.053	0.049	0.55	0.63	0.59	0.72	0.75	0.74	0.018	0.045	0.032	0.010	0.017	0.014
	2000	0.081	0.093	0.087	0.083	0.091	0.087	0.60	0.68	0.64	0.72	0.79	0.76	0.024	0.042	0.033	0.024	0.022	0.023
Ave. (A x B)		0.042	0.049	Ave (A) 0.046	0.044	0.048	Ave (A) 0.046	0.58	0.64	Ave (A) 0.61	0.72	0.75	Ave (A) 0.73	0.017	0.036	Ave (A) 0.027	0.017	0.018	Ave (A) 0.018
Soil + foliar	0	0.010	0.004	0.007	0.018	0.003	0.011	0.10	0.12	0.11	0.13	0.13	0.13	0.009	0.020	0.015	0.018	0.020	0.019
	1000	0.033	0.008	0.021	0.028	0.067	0.048	0.11	0.12	0.12	0.14	0.15	0.15	0.019	0.020	0.020	0.019	0.023	0.021
	2000	0.049	0.027	0.038	0.050	0.092	0.071	0.13	0.13	0.13	0.14	1.16	0.65	0.030	0.030	0.030	0.030	0.018	0.024
Ave. (A x B)		0.031	0.013	Ave (A) 0.022	0.032	0.054	Ave (A) 0.043	0.11	0.12	Ave (A) 0.12	0.14	0.48	Ave (A) 0.31	0.019	0.023	Ave (A) 0.021	0.022	0.020	Ave (A) 0.021
Ave. (B x C)	0	0.012	0.005	Ave (C) 0.009	0.010	0.008	Ave (C) 0.009	0.40	0.43	Ave (C) 0.42	0.45	0.48	Ave (C) 0.47	0.015	0.020	Ave (C) 0.018	0.010	0.007	Ave (C) 0.009
	1000	0.040	0.035	0.038	0.039	0.049	0.044	0.59	0.62	0.61	0.67	0.63	0.65	0.018	0.033	0.026	0.018	0.033	0.026
	2000	0.059	0.090	0.075	0.060	0.080	0.070	0.62	0.64	0.63	0.69	0.98	0.84	0.025	0.037	0.031	0.030	0.026	0.028
Ave. (B)		0.037	0.043		0.036	0.046		0.54	0.56		0.60	0.70		0.019	0.030		0.019	0.022	
LSD at 5% for:																			
Humic acid (A)				0.021			0.002			0.007			0.080			0.0074			0.0030
Peach and apricot (B)				0.018			0.002			0.006			0.069			0.0064			0.0026
Salinity (C)				0.018			0.002			0.006			0.069			0.0064			0.0026
A x B				0.030			0.003			0.010			0.113			0.0104			0.0043
A x C				0.037			0.004			0.012			0.138			0.0128			0.0052
B x C				0.026			0.003			0.009			0.098			0.0090			0.0074
A x B x C				0.052			0.005			0.017			0.195			0.0181			0.0074

Therefore, it is recommended to peach and apricot nursery growers under saline condition to use soil application of humic acid at the rate of 20 ml of Actosol in 1 L water every other week during the period from end of June till Oct.15th to minimize the harmful effect of salinity

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استجابة شتلات الخوخ والمشمش للمعاملة بحامض الهيوميك تحت ظروف الملوحة

فوزية محمد عيسى، مصطفى أحمد فتحي وسعد عبد الواحد الشال
معهد بحوث البساتين-مركز البحوث الزراعية

شملت الدراسة صنف الخوخ فلوردا برنس المطعوم على أصل الخوخ نيماجارد وكذلك صنف المشمش كانينو المطعوم على اصل مشمش بذرى. كانت النباتات بعمر سنة ومزروعة فى أكياس وتروى بماء مالح يحتوى على مخلوط بنسب متساوية من كلوريد الصوديوم، وكلوريد الكالسيوم، وسلفات الماغنسيوم ، وبيكربونات الصوديوم بتركيز صفر أو ١٠٠٠ أو ٢٠٠٠ جزء فى المليون.

أيضا تمت دراسة تأثير المعاملة بحامض الهيوميك (معاملة التربة أو الرش على المجموع الخضرى أو هما معا) على صفات النمو الخضرى (طول الفرع، وعدد الأوراق، ومساحة الورقة، ومحتوى الأوراق من الكلوروفيل) والحالة الغذائية للنبات (% للمادة الجافة فى الأوراق، ومحتوى الأوراق من عناصر النيتروجين والفوسفور والبوتاسيوم) وكذلك نمو المجموع الجذرى للنبات (طول وعدد الجذور، والنسبة المئوية للمادة الجافة فى الجذور الرئيسية والفرعية) وأيضا محتوى الأوراق من عنصرى الصوديوم والكلور والحامض الأمينى برولين.

أظهرت النتائج أن الخوخ كان أكثر تحملا لملوحة ماء الرى عن المشمش وعموما أحدثت الملوحة نقصا واضحا فى كل مظاهر النمو الخضرى والحالة الغذائية للنباتات ونمو المجموع الجذرى، بينما أحدثت زيادة معنوية فى محتوى الأوراق من عنصرى الصوديوم والكلور والحامض الامينى برولين. لكن معاملة النباتات بحامض الهيوميك (خصوصا معاملة التربة بـ٢٠ مل أكتوسول (٢,٩ % هيوميك أسيد، و ١٠-١٠-١٠ N P K) لكل لتر ماء مرة كل أسبوعين من أواخر يونيو حتى منتصف أكتوبر) قللت بوضوح التأثيرات الضارة للملوحة على نباتات الخوخ والمشمش.