J. Japan. Soc. Hort. Sci. 52(4) : 420—428. 1984.

Salt Tolerance of Muskmelons as Affected by Various Salinities in Soil Culture[1]

Akira NUKAYA, Masao MASUI and Akira ISHIDA
College of Agriculture, Shizuoka University, Ohya, Shizuoka 422

Summary

Muskmelons (*Cucumis melo* L.) were grown in soil to determine the salt tolerance as affected by salinization of sea water, NaCl, Na_2SO_4 and $MgCl_2$ in Experiment I, and $MgSO_4$ in Experiment II, at osmotic potentials of −0.95 (only $MgSO_4$), −1.20, −1.70 and −2.70 bars compared with a control of −0.70 bars of base nutrient solution. Fruit fresh weight and whole plant dry weight were greatest in the control and tended to decrease in each salinity with decreasing osmotic potentials of treatment solutions. At −2.70 bars fruit fresh weight was 61.3, 55.7, 63.2, 54.0 and 35.9% compared with the control in the sea water, NaCl, Na_2SO_4, $MgCl_2$ and $MgSO_4$ series, respectively. Most of the plants at −2.70 bars died within 60 days after transplanting in the $MgSO_4$ series. No plants died in the other series. Growth in decreasing order was control>sea water≒NaCl≒Na_2SO_4≒$MgCl_2$>$MgSO_4$. Na, Mg, Cl and SO_4 content in leaves and soil solution (SSo) tended to increase with decreasing osmotic potentials of treatment solutions in sodium-, magnesium-, chloride- and sulfate-salinities, respectively. EC values of SSo increased and osmotic potentials of SSo decreased as osmotic potentials of treatment solutions decreased.

Introduction

Salt tolerance of muskmelons as affected by various salinities in sand culture has been reported(14). That experiment was undertaken to explain the effect of salt source and concentration on the growth and development, using single salts added to a base nutrient solution. It was concluded that the growth in decreasing order was control>sea water≒NaCl>$MgCl_2$>Na_2SO_4≒$MgSO_4$ series. Also, the salt tolerance of muskmelons grown in different media (sand, soil and nutrient solution) has been studied using diluted sea water(11). It was shown that growth was more suppressed in sand than in soil culture. Thus, it is inferred that different salinities may affect plant growth suppression variously and alter the chemical properties of soil solutions in sand and soil cultures. Therefore, the present experiment was conducted to compare the effect of various salinities on salt tolerance of muskmelons in sand and soil cultures.

Received for publication May 12, 1983.
This work was partly supported by Grants-in-Aid for young scientist from the Ministry of Education.

Materials and Methods

This study consisted of 2 experiments. Sea water and single salts, such as NaCl, Na_2SO_4 and $MgCl_2$, were added to a base nutrient solution in Experiment I and $MgSO_4$ was added in Experiment II.

Experiment I Uniform muskmelon seedlings, cv. Fall No. 1 of Earl's Favourite in the 4 leaf stage were transplanted in wooden containers (40×40×20 cm) filled with 16 liters of paddy soil and placed in a greenhouse on Sept. 7, 1977. Temperature inside the greenhouse was above 18°C. Plants were topped at the 20th node and allowed to bear only one fruit per plant around the 10th node. Lateral shoots and other flower buds were removed. The paddy soil used was a mixture of light clay paddy soil taken at Shizuoka and sandy clay paddy soil taken at Iwata in the ratio of 1 : 1 by volume. There were 13 treatments, as shown in Table

Table 1. Composition of treatment solutions and base nutrient solution.

No.	Treatments: Salinities	π (bars)[z]	Added salt concentrations	EC (mS/cm)
1	Base nutr. soln.	−0.70	None	2.43
2	Sea water[y]	−1.21	1.9%	3.45
3		−1.70	3.8%	4.50
4		−2.70	7.6%	6.60
5	NaCl	−1.20	687 mgNaCl/liter	3.38
6		−1.70	1,374	4.65
7		−2.70	2,748	7.05
8	Na_2SO_4	−1.20	1,261 mgNa_2SO_4/liter	3.66
9		−1.70	2,521	5.18
10		−2.70	5,042	8.08
11	$MgCl_2$	−1.20	1,728 mg$MgCl_26H_2O$/liter	3.67
12		−1.70	3,456	5.24
13		−2.70	6,912	8.21

Composition of base nutrient solution		
1. $Na_2HPO_4 \cdot 12\,H_2O$		1 mM
2. K_2SO_4		3 mM
3. $MgSO_4 \cdot 7\,H_2O$		2 mM
4. $Ca(NO_3)_2 \cdot 4\,H_2O$		4 mM
5. Fe	1 ppm	(Fe-EDTA)
6. Zn	0.05 ppm	($ZnSO_4 \cdot 7\,H_2O$)
7. Cu	0.02 ppm	($CuSO_4 \cdot 5\,H_2O$)
8. B	0.5 ppm	(H_3BO_3)
9. Mo	0.05 ppm	($Na_2MoO_4 \cdot 2\,H_2O$)
10. Mn	0.5 ppm	($MnSO_4$)
pH≒6.0		

[z] Osmotic potential. The π of treament solutions includes −0.70 bars of base nutrient solution.

[y] Sea water contains 20,500 ppm Cl, 10,082 ppm Na, 2,632 ppm SO_4, 1,262 ppm Mg, 445 ppm K and 393 ppm Ca.

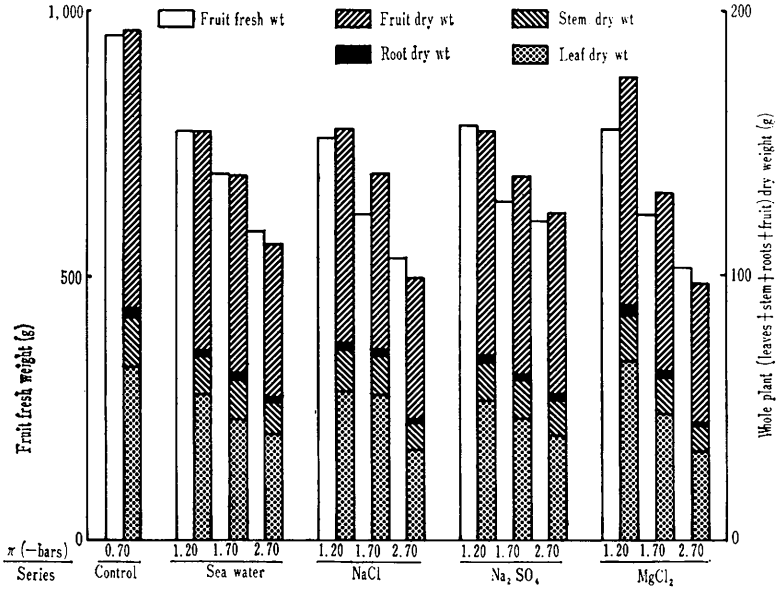

Fig. 1. Effect of various salinities on fruit fresh weight and whole plant (leaves+stem+roots+fruit) dry weight. Figures below columns indicate osmotic potential (-bars) of treatment solutions.

1, consisting of control (base nutrient solution), and sea water, NaCl, Na_2SO_4 and $MgCl_2$ dissolved in the base nutrient solution at osmotic potentials of −0.50, −1.00 and −2.00 bars. The osmotic potential of the base nutrient solution was −0.70 bars. The sea water was taken from Shimizu (Miho). Each treatment had 5 replications. Thus, there were 65 containers. Treatment solutions were applied to the soil medium from Sept. 11 to harvest (late Nov.). Applications (0.5 to 1 liter/container/time) were made twice on sunny days, once on cloudy days and none on rainy days. At the end of the

experiment, leaf, stem, root and fruit fresh and dry weights were measured. Extraction of soil solutions (SSo) at pF 0 to 3.8 and the other analytical methods on leaves, fruit and SSo were the same as described in earlier papers(10, 14).

Experiment II Uniform muskmelon seedlings, cv. Fall No. 1 of Earl's Favourite in the 2.5 leaf stage were transplanted in wooden containers filled with 16 liters of the light clay paddy soil and placed in the greenhouse on Sept. 14, 1979. $MgSO_4$ was dissolved in the base nutrient solution at osmotic potentials of 0 (control), −0.25, −0.50, −1.00 and −2.00 bars. Treatment solutions, as shown in Table 6, were applied to the soil medium from Sept. 17 to harvest (early Dec.). The other experimental procedures and methods of analyses were the same as in Experiment I.

Results

Experiment I

Growth and fruit quality (Table 2, Fig. 1) Fruit fresh weight and whole plant, leaf, stem and root dry weight tended to be greatest in the control and decreased in each salinity as osmotic potentials of treatment solutions decreased. At isosmotic concentrations similar suppression of growth was observed in all series. At −1.20 bars in the $MgCl_2$ series, leaf, stem and root dry weights were especially not significantly different from the control and whole plant dry weight was greater than in the other series. Fruit fresh weight decreased to the same extent at isosmotic potentials. At −2.70 bars fruit fresh weight was 61.3, 55.7, 63.2 and 54.0% compared with the control in the sea water, NaCl, Na_2SO_4 and $MgCl_2$ series, respectively. These values were not significantly different. Fruit soluble solids seemed to be less affected by treatments, but were relatively low in the control. Fruit taste varied with the salts added to the base nutrient solution: salty in the sea water and NaCl series; salty, bitter and astringent in the Na_2SO_4 series; and bitter in the $MgCl_2$ series. The intensity of taste increased with decreasing osmotic potentials

Table 2. Effect of various salinities on fruit quality of muskmelons in soil culture.

Osmotic potential (bars)	Salinities: Sea water	NaCl	Na_2SO_4	$MgCl_2$
	Soluble solids (%)			
Control[z]	14.1e[y]			
−1.20	15.0cd	15.0cd	15.2bcd	14.7de
−1.70	15.3bcd	15.3bcd	15.4bcd	15.6bc
−2.70	15.3bcd	16.0b	16.9a	15.4bcd
	Taste (degree[x])			
Control	0			
−1.20	0∼0.5	0.5	0.5	0.5
−1.70	0.5	1	1	1
−2.70	0	1∼1.5	2	1∼2

[z] Control does not contain any additional salts and is maintained at −0.70 bars of osmotic potential.

[y] Mean separation in each item by Duncan's multiple range test, 5% level.

[x] Tastes were evaluated from 0 (none) to 5 : salty in sea water and NaCl ; salty, bitter and astringent in Na_2SO_4 ; and bitter in $MgCl_2$.

Table 3-1. Effect of various salinities on Na, Mg, Cl and SO_4 content in leaves in soil culture (% of dry matter).

Osmotic potential (bars)	Salinities: Sea water	NaCl	Na_2SO_4	$MgCl_2$
	Na			
Control[z]	0.16ef[y]			
−1.20	0.18ef	0.22ef	0.36de	0.14ef
−1.70	0.35de	0.48cd	0.58c	0.10f
−2.70	0.87a	0.65bc	0.83ab	0.08f
	Mg			
Control	1.20ef			
−1.20	1.23ef	1.09fg	1.18fg	2.19c
−1.70	1.34de	1.04g	1.15fg	2.77b
−2.70	1.40d	0.80h	0.88h	3.94a
	Cl			
Control	0.68e			
−1.20	1.80d	2.45d	0.64e	2.63d
−1.70	3.90c	3.95c	0.63e	4.31c
−2.70	6.85a	6.20ab	0.66e	5.75b
	SO_4			
Control	0.86e			
−1.20	0.95e	1.87d	5.52c	0.78e
−1.70	0.50e	0.66e	7.66b	0.53e
−2.70	0.55e	0.40e	9.50a	0.35e

[z],[y] Same as Table 2.

Table 3-2. Effect of various salinities on total-N, P, Ca and K content in leaves in soil culture (% of dry matter).

Osmotic potential (bars)	Salinities			
	Sea water	NaCl	Na_2SO_4	$MgCl_2$
Total-N				
Control[z]	2.51ef[y]			
−1.20	2.71bcde	2.63de	3.10a	2.70bcde
−1.70	2.89b	2.81bcd	2.61de	2.69bcde
−2.70	2.52ef	2.86bc	2.65cde	2.33f
P				
Control	0.57c			
−1.20	0.74a	0.73ab	0.71ab	0.76a
−1.70	0.71ab	0.81a	0.73ab	0.76a
−2.70	0.68abc	0.69abc	0.75a	0.60bc
Ca				
Control	6.92bc			
−1.20	7.27ab	7.46a	7.05abc	6.78bc
−1.70	7.27ab	7.54a	6.92bc	6.66c
−2.70	7.23ab	7.47a	5.94d	5.77d
K				
Control	1.75c			
−1.20	0.74e	1.81bc	1.98abc	1.17d
−1.70	1.35d	2.23ab	2.00abc	1.20d
−2.70	2.03abc	2.30a	2.33a	1.05de

[z],[y] Same as Table 2.

Table 4. Effect of various salinities on Na, Mg, Cl and Ca content in fruit in soil culture (% of dry matter).

Osmotic potential (bars)	Salinities			
	Sea water	NaCl	Na_2SO_4	$MgCl_2$
Na				
Control[z]	0.26f[y]			
−1.20	0.54e	0.62de	0.73cd	0.26f
−1.70	0.89bc	0.77cd	0.88bc	0.21f
−2.70	1.02b	1.18a	1.19a	0.23f
Mg				
Control	0.24d			
−1.20	0.23de	0.21efg	0.21efg	0.29c
−1.70	0.22ef	0.22ef	0.21efg	0.34b
−2.70	0.21efg	0.18h	0.19gh	0.40a
Cl				
Control	0.57e			
−1.20	1.46d	1.50d	0.63e	1.54d
−1.70	2.09c	1.99c	0.52e	2.12c
−2.70	3.05b	3.23a	0.52e	3.41a
Ca				
Control	0.17cd			
−1.20	0.19bcd	0.22ab	0.16d	0.19bcd
−1.70	0.22ab	0.25a	0.21abc	0.20cd
−2.70	0.22ab	0.23ab	0.16d	0.19bcd

[z],[y] Same as Table 2.

of treatment solutions.

Chlorosis and cupping were observed on lower leaves of the plant at −1.70 and −2.70 bars in the sea water and NaCl series. Only chlorosis appeared on lower leaves in the $MgCl_2$ series at −1.70 and −2.70 bars. Plants did not wither in all series. Yellowish white spots on leaves in the $MgCl_2$ series and interveinal chlorosis in the Na_2SO_4 series reported in the previous sand culture experiment, were not observed in the present soil culture experiment.

Major mineral elements in leaves (*Table 3*) Na, Mg, Cl and SO_4 content increased with decreasing osmotic potentials of treatment solutions in sodium-, magnesium-, chloride- and sulfate-salinities, respectively. Here, sea water was classified as sodium- and chloride-salinities because Na and Cl are dominant ions. Na was relatively higher in the Na_2SO_4 series than in the other sodium-salinities. Mg was much higher in the $MgCl_2$ series than in the other series. Cl was almost similar at isosmotic potentials in the chloride-salinity. SO_4 was much higher in the Na_2SO_4 series (5.52 to 9.50%) and somewhat higher at −1.20 bars in the NaCl series (1.87%) than in the control (0.86%). P tended to be higher in all series (0.60 to 0.81%) than in the control (0.57%). Ca was lower at −2.70 bars in the Na_2SO_4 (5.94%) and $MgCl_2$ (5.77%) series than in the control (6.92%). Total-N and K were not affected.

Major mineral elements in fruit (*Table 4*) Na, Mg and Cl content increased with decreasing osmotic potentials of treatment solutions in sodium-, magnesium- and chloride-salinities, respectively. SO_4 was present only in traces compared with other ions (data not shown). Ca was less affected by the treatments. Na and Mg, and Cl tended to

Table 5-1. Chemical properties of soil solution (pF= 0 to 3.8) at the end of the experiment.

Osmotic potential (bars)	Salinities			
	Sea water	NaCl	Na_2SO_4	$MgCl_2$
	Na (me/*l*)			
Control[z]	24.1h[y]			
−1.20	69.0g	93.3fg	108.4ef	34.4h
−1.70	131.2e	159.0d	181.5cd	23.5h
−2.70	186.5c	218.0b	239.4a	29.4h
	Mg (me/*l*)			
Control	17.2h			
−1.20	27.6fg	25.7fgh	15.6h	73.7c
−1.70	42.8e	33.5efg	17.8h	143.8b
−2.70	56.7d	32.1efg	19.4gh	274.7a
	Cl (%)			
Control	0.064f			
−1.20	0.325e	0.430de	0.102f	0.475d
−1.70	0.665c	0.775c	0.081f	0.744c
−2.70	1.055b	1.060b	0.073f	1.453a
	SO_4 (%)			
Control	0.24g			
−1.20	0.25fg	0.31defg	0.59c	0.26fg
−1.70	0.29defg	0.34def	1.06b	0.35de
−2.70	0.32defg	0.27ef	1.71a	0.37d

[z,y] Same as Table 2.

Table 5-2. Chemical properties of soil solution (pF= to 3.8) at the end of the experiment.

Osmotic potential (bars)	Salinities			
	Sea water	NaCl	Na_2SO_4	$MgCl_2$
	NO_3-N (ppm)			
Control[z]	181bcde[y]			
−1.20	190bcd	160cdef	136def	136def
−1.70	220abc	180bcde	201abc	129ef
−2.70	221ab	185bcde	245a	116f
	P (ppm)			
Control	6.5c			
−1.20	5.7cde	6.0cd	8.1b	4.8ef
−1.70	5.4def	6.2cd	9.0b	4.4f
−2.70	5.6cde	5.5cde	11.0a	5.3def
	Ca (me/*l*)			
Control	26.1e			
−1.20	34.4d	36.3d	16.5f	48.6c
−1.70	49.5c	48.3c	15.0f	70.1b
−2.70	55.1c	50.5c	14.2f	98.0a
	K (me/*l*)			
Control	5.4f			
−1.20	6.8ef	7.6cdef	7.4def	8.2cde
−1.70	11.4ab	10.0bcd	8.2cde	9.7bcd
−2.70	13.0a	11.3ab	10.2bc	12.1ab

[z,y] Same as Table 2.

accumulate more in the outer flesh (outer mesocarp) and rind (epicarp), respectively.

Chemical properties of SSo at the end of the experiment (*Table 5*) As osmotic potentials of treatment solutions decreased, Na, Mg, Cl and SO_4 concentrations increased in sodium-, magnesium-, chloride- and sulfate-salinities, respectively. Na was lower in the sea water series, higher in the NaCl series and highest in the Na_2SO_4 series in the sodium-salinity. Cl was relatively high in the $MgCl_2$ series compared with the sea water and NaCl series. P was higher in the Na_2SO_4 series and lower in the $MgCl_2$ series than in the control. Ca in the $MgCl_2$ series increased with decreasing osmotic potentials of treatment solutions and was higher than that in the control. K and EC values tended to increase and osmotic potentials tended to decrease as osmotic potentials of treatment solutions decreased. NO_3-N and pH were less affected by treatments.

Table 5-3. Chemical properties of soil solution (pF= to 3.8) at the end of the experiment.

Osmotic potential (bars)	Salinities			
	Sea water	NaCl	Na_2SO_4	$MgCl_2$
	EC (mS/cm)			
Control[z]	5.94d[y]			
−1.20	11.58cd	11.90bcd	9.42cd	13.03bcd
−1.70	17.91abcd	16.51abcd	15.86abcd	18.55abc
−2.70	19.77abc	24.04ab	20.05abc	27.51a
	Osmotic potential (bars)			
Control	− 2.73a			
−1.20	− 5.23b	− 7.20c	− 5.34b	− 6.25bc
−1.70	−10.25ef	−11.39f	− 7.47cd	− 9.15de
−2.70	−14.28g	−11.74f	−10.71ef	−15.19g
	pH			
Control	6.69de			
−1.20	6.65def	6.90cd	7.28ab	6.72de
−1.70	6.52ef	6.85d	7.39a	6.53ef
−2.70	6.79d	6.70de	7.09bc	6.42f

[z,y] Same as Table 2.

Table 6. Effect of $MgSO_4$ salinity on growth of muskmelons in soil culture.

Osmotic potential (bars)	Amount of added $MgSO_4 \cdot 7H_2O$ (mg/l)	EC (mS/cm)	Dry weight (g)			Fruit	
			Leaves	Stem	Plant top	Fresh weight (g)	Soluble[x] solids (%)
Control[z]	0	2.43	68.5a[y]	15.9a	185.2a	1,137a	14.8
−0.95	1,922	3.20	68.1a	16.1a	179.5a	1,076a	14.7
−1.20	3,875	3.94	61.8a	14.6a	174.4a	887b	14.6
−1.70	7,750	5.52	53.1a	11.6b	142.2b	777b	15.4
−2.70	15,500	8.28	33.4b	8.1c	64.8c	408c	w

[z,y] Same as Table 2.

[x] Not subjected to statistical analysis.

[w] Plants died before harvest.

Table 7. Effect of $MgSO_4$ salinity on major elements in muskmelon leaves (% of dry matter).

Osmotic potential (bars)	Total-N	P	K	Ca	Mg	Na	SO_4	Cl
Control[z]	2.87b[y]	0.42b	1.68a	4.40a	1.85e	0.16a	3.10b	0.79a
−0.95	2.86b	0.46b	1.64a	3.47b	3.46d	0.08b	2.92b	0.74a
−1.20	2.76b	0.49b	1.35ab	2.80c	4.70c	0.07b	3.67b	0.64a
−1.70	3.05b	0.59a	0.87b	2.10d	5.47a	0.06b	4.11b	0.81a
−2.70	3.98a	0.64a	1.00b	1.20e	5.22b	0.08b	7.86a	0.78a

[z,y] Same as Table 2.

Experiment II

Growth (Table 6) Leaf dry weights at −0.95 to −1.70 bars were not significantly different from the control, but at −2.70 bars was much less. Stem and plant top dry weights were significantly reduced at −1.70 bars compared with the control. Fruit fresh weight decreased from −1.20 to −2.70 bars with decreasing osmotic potentials of treatment solutions. Visible symptoms of excess $MgSO_4$, such as interveinal necrosis and necrotic spots on leaves, were very slight at −1.20 bars, moderate at −1,70 bars and very severe at −2.70 bars. Most of the plants at −2.70 bars died by Nov. 12, about 60 days after transplanting.

Major mineral elements in leaves (Table 7) Mg increased, and Ca and K decreased as osmotic potentials of treatment solutions decreased. SO_4, total-N and P were high at lower (−1.70 and −2.70 bars) osmotic potentials of treatment solutions.

Chemical properties of SSo at the end of the experiment (Table 8) Mg and SO_4 concentrations and EC values increased and Na tended to decrease with decreasing osmotic potentials of treatment solutions. Ca and pH values were not affected by treatments.

Discussion

Fruit fresh weights at −2.70 bars were 61.3, 55.7, 63.2, 54.0 and 35.9% compared with the control in the sea water, NaCl, Na_2SO_4, $MgCl_2$ and $MgSO_4$ series, respectively. Whole plant and leaf dry weights showed similar tendencies. The estimated osmotic potential of treatment solutions which caused a 50% loss in fruit fresh weight was −3.5 to −4.0 bars in the sea water, NaCl, Na_2SO_4 and $MgCl_2$ series, but it was −1.56 bars in the $MgSO_4$ series. The degree of tolerrance to salinity in sand culture was, on an average, almost half as compared with that in soil culture. Similar results were reported in green soybeans(12, 13). Hayward and Bernstein(5) pointed out that, in general, sand culture was effective in specification and other physiological studies, while soil culture was widely used for salt tolerance studies. In the previous sand(14) and present soil culture experiments, SSa (solution of sand medium) and SSo (solution of soil

Table 8. Chemical properties of soil solution (pF=0 to 3.8) at the end of the experiment.

Osmotic potential (bars)	K (me/l)	Ca (me/l)	Mg (me/l)	Na (me/l)	SO_4 (%)	EC (mS/cm)	pH
Control[z]	9.2b[y]	20.7a	22.4e	20.0b	0.26c	6.70d	5.80a
−0.95	11.8a	21.0a	90.2d	25.3a	0.64bc	10.38c	5.51a
−1.20	12.5a	20.9a	174.3c	23.4ab	0.91b	14.26b	5.51a
−1.70	12.6a	20.7a	262.0b	19.9b	1.97a	17.96a	5.52a
−2.70	9.8b	19.8a	322.0a	13.8c	2.01a	19.52a	5.75a

[z,y] Same as Table 2.

medium) were centrifugally extracted at pF 0 to 3.8 to explain the difference in growth suppression between the two cultures. Cations, anions and EC were lower in SSa, although growth suppression was more severe in sand culture. Therefore, as a preliminary experiment, SSa and SSo at various pF values were extracted from sand and soil used in the $MgSO_4$ experiment in the previous sand and present soil cultures. Water content was 21.9, 7.1 and 1.1% in sand and 8.4, 11.7 and 23.3% in soil at pF 0 to 1.8, 1.8 to 3.8 and more than 3.8, respectively. EC values at pF 1.8 to 3.8 were 8.1, 10.8 and 13.8 mS/cm in sand culture and 8.9, 16.6 and 25.7 mS/cm in soil culture at −0.70 (control), −1.20 and −2.70 bars, respectively, in the $MgSO_4$ series. Though these values were much higher in soil than in sand culture, practically EC, cations and anions must be higher in sand than in soil culture. This is supported by the fact that Na, Mg and SO_4 content in leaves was higher in sand than in soil culture.

Another pronounced difference between sand and soil cultures was in the Na_2SO_4 series where the growth in sand culture was suppressed to the same extent as in the $MgSO_4$ series. In soil culture the growth suppression in the Na_2SO_4 series was not so severe as in the $MgSO_4$ series and was the same as in the sea water, NaCl and $MgCl_2$ series. Fruit fresh weights at −1.20, −1.70 and −2.70 bars in the Na_2SO_4 series were 66.4, 44.8 and 11.8%, and 82.3, 69.7 and 63.2% in sand and soil cultures, respectively, compared with the control. Na and SO_4 in leaves were markedly higher in the Na_2SO_4 series than in the sea water and NaCl series. Also, Na in leaves was markedly higher in sand than in soil culture. Therefore, accumulated Na and SO_4 could be one of the causes for reduced growth in the Na_2SO_4 series in sand culture. In the nutrient solution culture experiment(15), the growth was suppressed in the Na_2SO_4 series to a lesser extent than in the $MgCl_2$ and $MgSO_4$ series.

According to some reports(9, 17, 18) the mechanism of salinity damage is different in chloride and sulfate types of salinity. The percentage of the pentose-phosphate pathway increased with increasing NaCl salinity while Na_2SO_4 salinity did not affect it(18). Higher concentrations of NaCl inhibited respiration in pea root tips(17) compared with Na_2SO_4. Therefore, in muskmelons, physiological responses may vary with salinities in spite of similar plant growth.

It has been observed by many investigators (1, 2, 3, 4, 6, 7, 8, 16) that different plant species exhibit different responses to isosmotic potentials of Cl and SO_4, or Na and Mg. Some of them reported that sulfate-salinity was more toxic in sugarcane(7) and corn seedlings(8) than chloride-salinity, and that sulfate-salinity depressed growth in tomatoes more than chloride-salinity(12). The specific ion effect of Cl has been observed in green soybeans(12, 13) and honeylocust (1). Joolka *et al.*(6) found that grape cultivars differed in their responses to Cl and SO_4 salts. The specific toxicity of Mg was stressed in red kidney beans(3), spinach, turnip, celery, Welsh onion, kidney beans and chard(16). Joshi and Naik(7) reported toxicity of Na to be greater than that of Mg. The result of this experiment revealed $MgSO_4$ salinity to be more toxic

to muskmelons than the other salinities. This confirms the specific ion effect of Mg and SO_4 in muskmelons. Reduced growth in the $MgSO_4$ series compared with the Na_2SO_4 and $MgCl_2$ series seems to be due to synergistic effect of Mg and SO_4 ions, higher ion concentration in the medium and higher ion uptake by plants.

Acknowledgement

Recognition is given Dr. T. Asahira, Professor at Kyoto Univ., Dr. W. J. Clore, Horticulturist Emeritus and Dr. E. L. Proebsting, Horticulturist at IAREC, WSU, U. S. A. and Dr. M. F. R. Mallick, post-doctral fellow (research student of Monbusho) at Shizuoka Univ. for the critical review of this manuscript.

Literature Cited

1. Dirr, M. A. 1974. Tolerance of honeylocust seedlings to soil-applied salts. HortScience 9 : 53—54.
2. Fisher, K. J. 1967. Specific ion effects of certain excess soluble salts on the growth and development of glasshouse tomatoes grown in nutrient culture. J. Hort. Sci. 42 : 243—252.
3. Gauch, H. G., and C. H. Wadleigh. 1944. Effects of high salt concentrations on growth of bean plants. Bot. Gaz. 105 : 379—387.
4. Hason-Porath, E., and A. Poljakoff-Mayber. 1970. Effect of chloride and sulphate types of salinity on the nicotinamide-adenine-dinucleotides in pea root tips. J. Exp. Bot. 21 : 300—303.
5. Hayward, H. E., and L. Bernstein. 1958. Plant-growth relationships on salt-affected soils. Bot. Rev. 24 : 584—635.
6. Joolka, N. K., J. P. Singh, and A. P. Khera. 1977. Mineral composition of grape as affected by chloride and sulphate salts of sodium in soils. Indian. J. Agric. Sci. 47 : 201—203.
7. Joshi, G. V., and G. R. Naik. 1980. Response of sugarcane to different types of salt stress. Plant and Soil 56 : 255—263.
8. Kaddah, M. T., and S. I. Ghowail. 1964. Salinity effects on the growth of corn at different stages of development. Agron. J. 56 : 214—217.
9. Lapina, L. P., S. A. Bikmukhametova, and I. N. Murashov. 1976. Effects of Na_2SO_4 and NaCl on activity of photosynthetic phosphorylation in plants with different salt resistance. Soviet Plant Physiol. (Translated from Fiziologiya Rastenii) 23 : 279—285.
10. Nukaya, A., M. Masui, A. Ishida, and T. Ogura. 1977. Salt tolerance of green soybeans. J. Japan. Soc. Hort. Sci. 46 : 18-25.
11. Nukaya, A., M. Masui, and A. Ishida. 1980. Salt tolerance of muskmelons grown in different media. J. Japan. Soc. Hort. Sci. 49 : 354—360.
12. Nukaya, A., M. Masui, and A. Ishida. 1982. Salt tolerance of green soybeans as affected by various salinities in sand culture. J. Japan. Soc. Hort. Sci. 50 : 487—496.
13. Nukaya, A., M. masui, and A. Ishida. 1982. Salt tolerance of green soybeans as affected by various salinities in soil culture. J. Japan. Soc. Hort. Sci. 51 : 62—69.
14. Nukaya, A., M. Masui, and A. Ishida. 1983. Salt tolerance of mukmelons as affected by various salinities in sand culture. J. Japan. Soc. Hort. Sci. 51 : 427—434.
15. Nukaya, A., M. Masui, and A. Ishida. 1983. Salt tolerance of muskmelons as affected by various salinities in nutrient solution culture. J. Japan. Soc. Hort. Sci. 52 : 167—173.
16. Osawa, T. 1963. Studies on salt tolerance of vegetable crops with special reference to osmotic effects and specific ion effects. J. Japan. Soc. Hort. Sci. 32 : 211—223. (In Japanese with English summary)
17. Porath, E., and A. Poljakoff-Mayber. 1964. Effect of salinity on metabolic pathways in pea root tips. Israel J. Bot. 13 : 115—121.
18. Porath, E., and A. Poljakoff-Mayber. 1968. The effect of salinity in the growth medium on carbohydrate metabolism in pea root tips. Plant&Cell Physiol. 9 : 195—203.

各種塩類が土耕におけるメロンの耐塩性に及ぼす影響

糠谷　明・増井正夫・石田　明
静岡大学農学部　422 静岡市大谷

摘　要

メロンの耐塩性と塩の種類との関係を明らかにするため，土耕により本実験を行った．塩類源として実験Ⅰでは，海水，NaCl, Na_2SO_4, $MgCl_2$ を，実験Ⅱでは，$MgSO_4$ を用いて，浸透ポテンシャルをそれぞれ −0.95 ($MgSO_4$ のみ)，−1.20，−1.70，−2.70 bar とし，基本培養液で育てた対照区（−0.70 bar）と生育を比較した．果実新鮮重と全植物体乾物重は，対照区で最大となり，処理培養液の浸透ポテンシャルが低下するにつれて，それぞれの塩類源で減少した．対照区を100%とした場合，−2.70 bar 区の果実新鮮重は，海水で 61.3%，NaCl で 55.7%，Na_2SO_4 で 63.2%，$MgCl_2$ で 54.0%，$MgSO_4$ で 35.9% となった．$MgSO_4$ では，定植後 60 日までに大部分の株が枯死した．その他の塩類では枯死した株はなかった．本実験における生育は，対照区で最大となり，次に海水，NaCl, Na_2SO_4, $MgCl_2$ で同程度に抑制され，$MgSO_4$ で最も抑制された．葉及び土壌溶液中の Na, Mg, Cl, SO_4 含量は，それぞれの処理区で処理培養液の浸透ポテンシャルが低下するにつれて増加する傾向を示した．処理培養液の浸透ポテンシャルが低下すにつれ，土壌溶液の EC 値は増加し，浸透ポテンシャルは減少した．