Toxicity of kiwifruit plant (*Actinidia chinensis* PLANCH.) by chloride and/or sodium ions.

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TOXICITE DES IONS DE CHLORURE ET/OU DE SODIUM SUR LES PLANTS DE KIWI (*ACTINIDIA CHINENSIS* PLANCH.).

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Fruits, Apr. 1985, vol. 40, n° 4, p. 261-263.

RESUME - Le chlorure de sodium à la concentration de 274 ppm a provoqué des symptômes toxiques sévères (brûlure, enroulement et chute des feuilles) sur de jeunes plants de kiwi âgés d'un an, cultivés sur du sable pur. Des concentrations de chlorure de sodium plus élevées, 548 et 1370 ppm, ont provoqué la mort de respectivement 50 p. 100 et 66 p. 100 des plants traités. Dans la même expérience, une pression osmotique de 1.7 bars dans le milieu rhizosphérique n'a provoqué aucun effet négatif sur la croissance des jeunes plants.

INTRODUCTION

The kiwifruit plant is a relatively new commercial crop with increased economic importance. In view of the rapid extension of the kiwi cultivation in many countries, studies on the nutrition problems of the plant should be very desirable. LIONAKIS and SCHWABE (1985) studied the effects of N, P, K and Mg ions deficiency on the growth of kiwi. Although toxicity effects of chloride or sodium have been reported for many plants (c.f. CHAPMAN, 1966), not a single paper on the toxicity effects of these ions on kiwi growth was found in the literature. BEUTEL (1977), however, in his informative leaflet recommends that the water used to irrigate kiwi plants should be low in total salts, probably below 700 ppm where furrow irrigated and less than 300 ppm if irrigated by overhead sprinklers. The present study was undertaken to evaluate the effects of various concentrations of chloride and/or sodium ions on the growth of one year old kiwi plants.

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MATERIALS AND METHODS

The plant material consisted of one year old rooted kiwi plants of the female cultivar 'Bruno' planted in 5 litre pots containing washed river sand. Forty two uniform plants were selected in spring and allocated randomly to the seven treatments of the experiment, each treatment having six replicates. The sand, the pots and the saucers, which were placed under the pots to collect the excess nutrient solution, had been washed well with tap water before the beginning of the experiment. The plants were irrigated by distilled water ; the amount of water held by the sand of each pot was found to be about 1 litre. The osmotic pressure of the test solutions ie : nutrients and mannitol which were applied in each pot (Table 1) was calculated on the basis of this volume, using the equation of Vanthoff, $P = n.R.T/V$, where P = osmotic pressu-

TABLE 1 - Design of the toxicity experiment.

Treatments	Osmotic pressure (OP) of salts * per pot (Bars)	Applied NaCl per pot ppm NaCl	OP (Bars)	ppm Cl^-	Total Cl^- per pot (ppm)	Total Na^+ per pot (ppm)	Applied Mannitol per pot gr/lit.	OP (Bars)	Total OP in each pot (Bars)
I	0.7	274	0.2	167	180	107	-	-	0.9
II	0.7	548	0.4	333	346	215	-	-	1.1
III	0.7	1370	1.0	831	844	539	-	-	1.7
IV	0.7	-	-	-	13	-	1.54	0.2	0.9
V	0.7	-	-	-	13	-	3.08	0.4	1.1
VI	0.7	-	-	-	13	-	7.71	1.0	1.7
VII	0.7	-	-	-	13	-	-	-	0.7

* - The applied salts per pot are shown in Table 2.

re in bars ; n = number of moles ; T = absolute temperature ; V = volume of solution in the pot.

The rooted plants were removed from the compost in the beginning of April, their roots were washed with plenty of water and planted in the pots with sand ; at that time the single bud which was left on each plant had just burst. Immediately after transplanting, the amounts of salts shown in Table 2 were diluted in water and applied to each pot. The composition in salts of the applied nutrient solution has been found previously to be suitable for kiwi plant growth (LIONAKIS and SCHWABE, 1985). The nutrient solution which was applied to each pot contained 13 ppm chloride while it did not contain sodium.

Four days after the application of nutrients, sodium chloride (treatments I, II, III) and mannitol (treatments IV, V, VI), were applied in the amounts shown in the table 1. Four levels of osmotic pressure were tested in this experiment i.e. 0.7 bars (treatment VII), 0.9 bars (treatments I and IV), 1.1 bars (treatments II and V) and 1.7 bars (treatments III and VI) (see also Table 1). Mannitol treatments were used to monitor any adverse effects of the test solutions on the growth of the plants due to the osmotic pressure alone.

RESULTS AND DISCUSSION

In all sodium chloride treatments (I, II, III) toxicity symptoms appeared about two weeks after the application of sodium chloride. Initially a chlorosis developed beginning at the leaf margins and tips. This chlorosis soon gave way to a marginal necrotic scorch, as the leaves enlarged, followed by leaf roll upwards or downwards (Plate 1). Almost all the leaves in treatments I, II, III finally developed symptoms, but these were more severe in the plants of treatments II and III.

Within two weeks after the appearance of the first symptoms abscission of leaves occurred and two weeks later, three plants out of six in treatment II and four plants out of six in treatment III died. None of the six plants in treatment I died, but the leaves of these plants developed severe necrotic symptoms and one to two leaves out of eight in each plant were shed. The plants of the treatments IV, V and VI (mannitol treatments) were as healthy as the plants of the treatment VII (control).

Sodium chloride also reduced the shoot growth (i.e length of stem and number of leaves). Thus the plants of

TABLE 2 - Amount of salts applied to each pot.

Macronutrients (gr)		Micronutrients (mgr)	
$Ca(NO_3)_2\ 4\ H_2O$	1.405	$MnSO_4\ 4\ H_2O$	1.900
$CaH_4(PO_4)_2\ H_2O$	0.117	$ZnSO_4\ 7\ H_2O$	0.206
$CaCl_2\ 2\ H_2O$	0.027	$CuSO_4\ 5\ H_2O$	0.074
$MgSO_4\ 7\ H_2O$	0.139	H_3BO_3	2.682
K_2SO_4	0.205	$Na_2MoO_4\ 2\ H_2O$	0.118
		$CoSO_4\ 7\ H_2O$	0.044
		$C_6H_8O_4N_2FeNa$	3.765

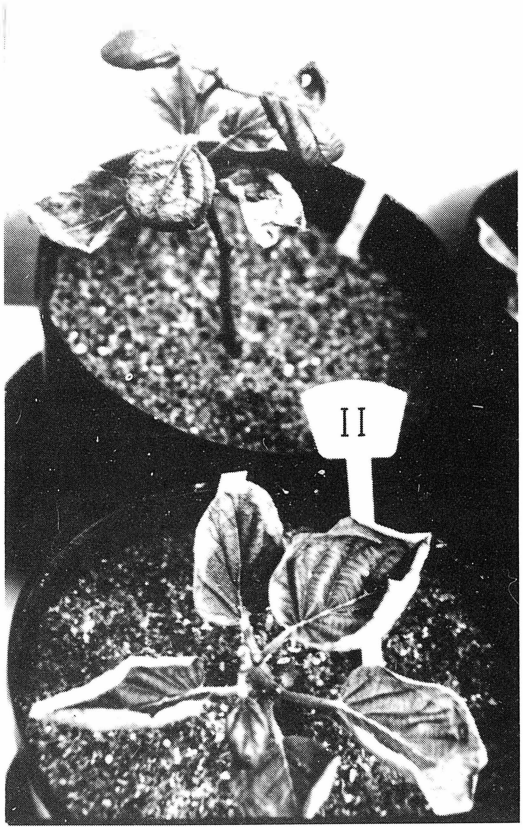

Plate 1. Kiwifruit plants, grown in sand showing toxicity symptoms due to chloride and/or sodium ions. Note the leaf burn and leaf roll. (Treatment II).

Plate 2. Kiwifruit plants without toxicity symptoms grown in sand in absence of sodium chloride. (Treatment VII).

treatment I had about 20 % smaller shoot growth than the plants of any one of the treatments IV, V, VI, VII. On the other hand no difference in shoot growth was observed between any one of the mannitol treatments (IV, V, VI) and the control treatment (VII).

Compared with other species the young kiwiplant seems to be very sensitive to chloride and/or sodium ions with 50 % and 66 % of plants being killed by concentrations of 346 ppm and 844 ppm sodium chloride respectively, even 180 ppm sodium chloride producing toxic leaf symptoms. By comparison, one year old peach plants grown in sand culture showed no damage at 355 ppm chloride ion and a concentration of 655 ppm produced only some leaf symptoms, while neither of these two concentrations produced any symptoms on one year old plants of apple, cherry or grape (DILLEY et al., 1958).

The above results also showed that the root system of one year old kiwiplants can safely withstand osmotic pressure up to 1.7 bars.

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