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Avocado sensitivity to salinity revisited – Akko Experiment 1984 – 1992

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Introduction

Avocado is one of the most salt sensitive tree crops. Because in past experiments a correlation was found between the level of salt in the root medium and chloride accumulation in the leaves and leaf burn, it was concluded that there is specific sensitivity of the crop to chloride. Mexican rootstocks are known to be more sensitive than West Indian rootstocks and they also accumulate more chloride in their leaves. Although it is widely accept that avocado is specifically sensitive to chloride ion toxicity, there is no clear cut evidence to support this conclusion with bearing trees.

The following are partial results of an experiment conducted over a period of nine years, 1984 – 1992, at the Akko experiment station by R. Steinhardt, D. Kalmar, E. Lahav and J. Shalhevet. The experiment was initiated as a result of the increase in chloride content in the irrigation water supplied to avocado growers in Israel and the increased use of effluent water with relatively high chloride content in orchard irrigation. Some results of this experiment were reported in the Proceedings of Avocado Brainstorming '99.

Methodology

Varieties and rootstocks:

'Hass', 'Ettinger', 'Fuerte' on Schmidt (Mexican), VC39 (West Indian) seedling rootstocks, 2 replicates.

Planting Density:

270 tree/ha.

Irrigation:

Microsprinklers: 1 per tree;
Irrigation Frequency: 10-day interval (~16 irrigations/season);
Irrigation Amount: 360 to 440 m^3/ha/irrigation (590 to 710 mm/season);
WA/Ep = 0.47 – 0.57;
Irrigation at 60% AWD in 0 – 40-cm depth layer (37% field capacity; 25% wilting point);
Water content measurement was taken 1 m away from the trees to 60-cm depth by a neutron probe.

Fertigation:

N – 30 mg/L, P – 10 mg/L, K – 20 mg/L, N+ 100 – 130 mg/L

Treatments:

NaCl added to treatment 2 and NaCl + $CaCl_2$ to treatment 4.

	Treatment			
	1	2	3	4
Cl_i (mg/l)	80	230	230/400	400
(mM/l)	2.3	6.4	8.8	11.2
EC_i (dS/m)	1.0	1.4	1.7	2.0
SAR	1.0	4.2		3.2
EC_e (dS/m)	0.9	1.4	1.5	1.7
Cl_e (mM/l)	3.3	7.7	8.8	11.7

The relation of saturation soil extract electrical conductivity, mean for the last two years of the experiment, to chloride content of the irrigation water was:

$Ec_e = 0.86 + 0.87\ Cl_i$ Cl_i in meq/l; Ec_e in dS/m.

The relationship between the electrical conductivity and the chloride content of the irrigation water was"

$EC_i = 0.74 + 0.111\ Cl_i$

One treatment at salinity level 2 was augmented with 70 to 100 mg/l N.

All salinity treatments were irrigated at two levels: 90 and 110% of estimated water requirements.

Treatment 3 was irrigated until the end of July with 240 mg/l Cl water and thereafter with 400 mg/l Cl water.

Summary of results

1. For 'Hass' on Mexican rootstock, chloride accumulation in the leaves and leaf burn in the fall correlated with leaf drop in the spring (mid-April) (Table 1). By mid-May there was heavy leaf drop (80%) for the high Cl treatment and only 35% for the low Cl treatment (Figure 1). Salinity may depress yield even when there is no leaf damage because of damage to the roots, which precedes damage to the leaves.

Table 1. Average chloride concentration in the leaves in the fall at age 2 – 7 years.

	Treatment (meq/l Cl)			
	2.2	6.2	6.2/12.0	12.0
'Hass'	0.41	0.90	0.93	1.12
'Ettinger'	0.32	0.58	0.67	0.80

2. Added N resulted in increased N in the soil but not in the leaves, and in decreased Cl in leaves. However, yields of 6-8 year old trees were depressed by added N (Table 2). Young trees showed some benefit from the added N.

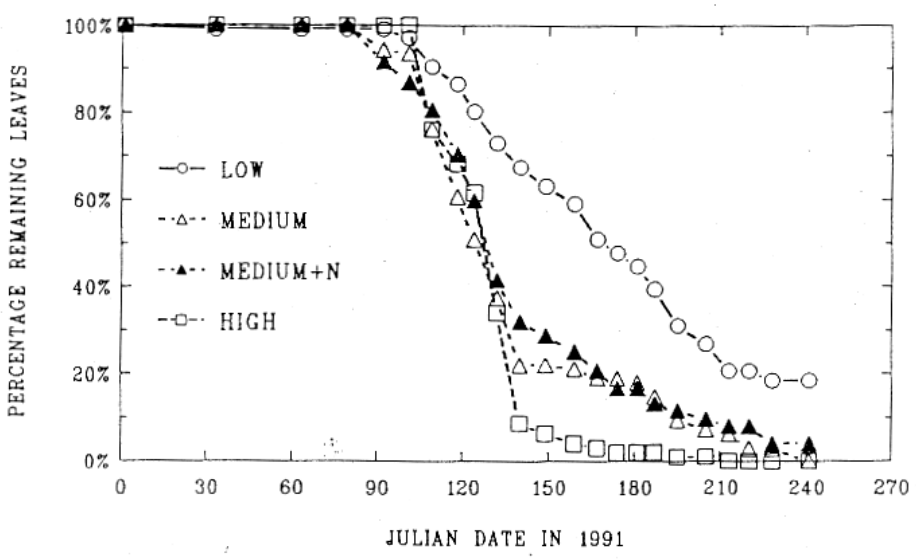

Figure 1. Leaf shedding as a function of time of 'Hass' on Mexican rootstock. Four salinity and nitrogen treatments are indicated.

Table 2. Yield decrease (%) due to addition of 80 – 90 g/m^3 nitrogen fertilizer to the basic level of 30 g/m^3 of irrigation water.

Variety/Rootstock	
'Hass'/VC28, VC66	21
'Ettinger'/VC28	41
'Ettinger'/VC51	8

3. Phosphorus and water uptake were reduce by increased salinity due to damage to the roots.
4. The depressive effect of salinity on yield is cumulative; it increases with time. 'Ettinger' on Mexican rootstock showed yield increase due to salinity up to age 4 and then yield was reduced (Figure 2). Only after 7 years did yield reduction with increased salinity stabilized. 'Hass' on Mexican rootstock showed a significant yield reduction commencing in the second year, which continued to increase with time (Figure 3).
5. Irrigating with 230 mg/l Cl until mid-July and then with 400 mg/l Cl did not mitigate yield reduction which depended on the weight mean seasonal salinity (see Figures 2 and 3). This is the case with many crops.

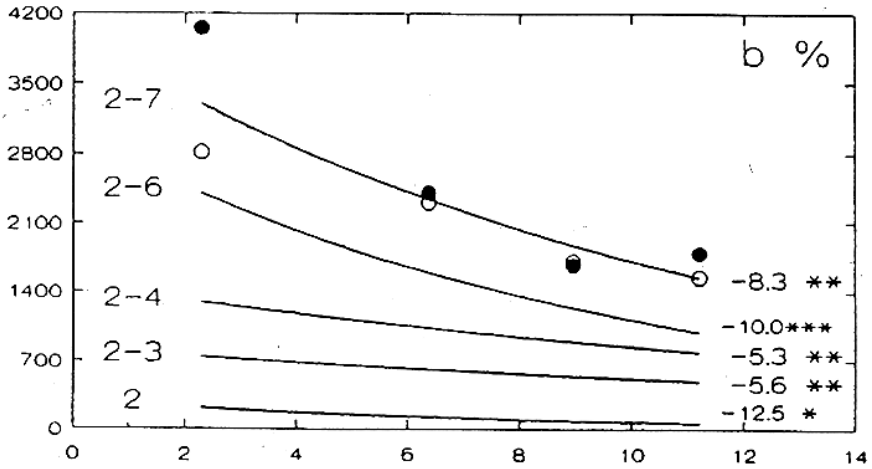

Figure 2. Cumulative yields in kg/0.1ha of 'Hass' on Mexican rootstock vs. chloride in the irrigation water in meq/l. Age group of trees is indicated on left, regression coefficient for exponential curve and significance level on the right.

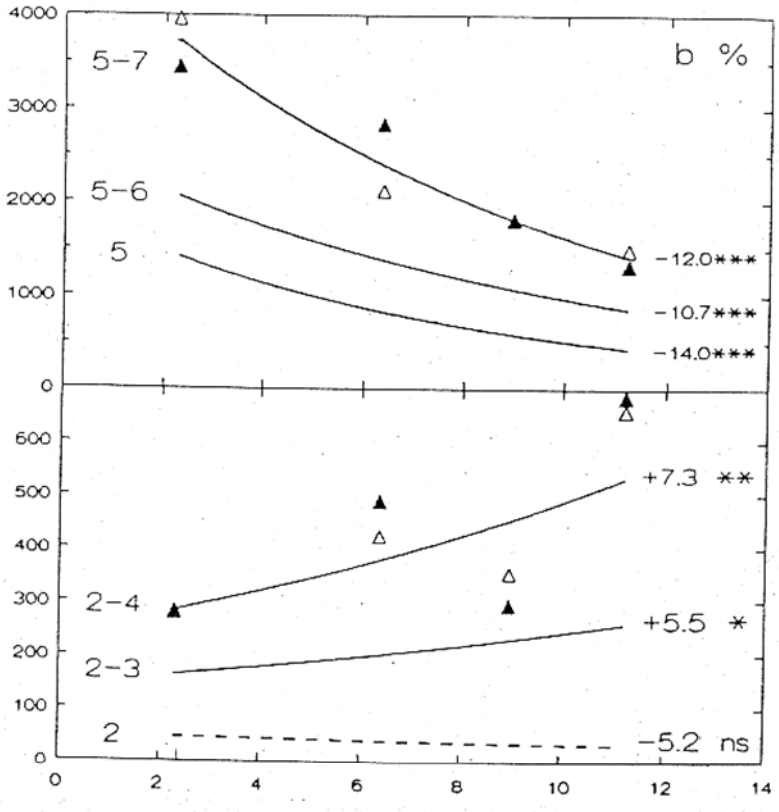

Figure 3. Cumulative yield in kg/0.1ha of 'Ettinger' on Mexican rootstock vs. chloride in the irrigation water in meq/l. Age group of trees is indicated on the left, regression coefficient for exponential curves and significance level on right.

Salinity response functions

6. ‘Hass’ + ‘Ettinger’ x Mexican: $Y_r = 100 – 56 (EC_e – 1)$ (age 5 – 8 years)
   $Y_r = 100 – 5.6 (Cl_i – 2.3)$
7. ‘Ettinger’ x Mexican: $Y_r = 100 – 44 (Ec_e – 1)$ (5 – 8 years)
   ‘Ettinger’ x West Indian: $Y_r = 100 – 39 (EC_e – 1)$ (5 - 8 years)
8. ‘Hass’ x Mexican $Y_r = 100 – 57 (EC_e – 1)$ (6 – 8 years)
   ‘Hass’ x West Indian $Y_r = 100 – 26 (EC_e – 1)$ (6 – 8 years)

   EC_e = electrical conductivity of the soil saturation extract in dS/m;

   Cl_i = chloride content of the irrigation water in meq/l; Y_r = relative yield in %.

Threshold salinity of 1.0 dS/m (2.3 meq/l Cl) was the lowest salinity used in the experiment. It is likely that at that salinity yield was already depressed to some extent and the actual threshold is even lower. The rate of yield reduction with increased salinity was greater on Mexican rootstocks (over 55% per dS/m or over 5.5% per meq/l) than on West Indian rootstocks. This was more apparent with ‘Hass’ than with the ‘Ettinger’ variety.