

SALT TOLERANCE OF HUNTALAS COMPARED WITH OTHER AVOCADO ROOTSTOCKS

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INTRODUCTION

The avocado root rot disease, *Phytophthora cinnamomi*, is a major problem to avocado growers. Considerable research has been done by plant pathologists to control the disease. Plant pathologists, plant breeders, and others have long been looking for new resistant avocado rootstocks. Recently Dr. G. A. Zentmyer mentioned in the California Avocado Yearbook that the Huntalas rootstocks (which is under test), a Mexican type obtained from Vista, California, might be resistant to root rot disease (11).

According to U.S. Salinity Laboratory reports (9) avocado is considered to be a salt-sensitive plant. Sodium and chloride accumulated in various plant parts of avocado—even in a growth medium containing low salt concentrations. The symptoms of Na and Cl toxicity in avocado leaves are always associated with high Na and Cl concentrations (1, 4, 7, 8). No information is available regarding salt tolerance of the Huntalas variety in comparison to other rootstocks. Therefore, the experiments were conducted to examine the salt tolerance and mineral uptake of the Huntalas rootstock with other commercially grown rootstocks (at various salt concentrations in the irrigation water).

MATERIALS AND METHODS

Experiment 1: Four different varieties of avocados (Fuchs 20, Huntalas, Lula 3, and Mexicola) were studied in a glasshouse at UCLA. The rooted cuttings obtained from E. F. Frolich were established in 6 cm peat pots before planting. The seedlings were then transplanted to metal containers 12.5 cm in diameter and 14 cm deep. The mixture of 1/3 kriliium treated Yolo clay loam and 2/3 redwood sawdust was used as the growing medium. The plants were irrigated twice a day with distilled-deionized water (dd), dd with medium-salt water (10 me NaCl/L), and dd with high-salt water (20 me NaCl/L), each with 15 ppm N in the form of NH_4NO_3 . Three plants were harvested at 7 weeks and three at 13 1/2 weeks after adding the treatments. The new leaves, old leaves, stem and root samples were taken, washed with 0.1 M HCl, then distilled deionized water, and dried in an oven. Dry weights were recorded and the samples prepared for analysis by emission spectroscopy (10).

Experiment 2: In this experiment Huntalas rooted cuttings (H) vs. Hass grafted on Huntalas rooted cuttings (HH) were used to study the effect of salinity on growth,

mineral content, and some physiological characters of avocado. The same salt concentrations (experiment 1) were used to irrigate the plants. Plants were under treatment for 13 1/2 weeks.

Photosynthesis and transpiration were measured by gas exchange equipment with a modified Siemens null-point chamber (2). These studies were made at 25°C chamber temperature, 310 ppm CO₂ concentration, and 33% relative humidity. The pressure bomb method was used for determining leaf water potential. Soil moisture was kept at field capacity. New and old leaves were harvested and prepared for analysis as in experiment 1. The CI was determined by potentiometric titrimetry.

RESULTS AND DISCUSSION

Growth decreased in all four varieties as the salt concentrations were increased in the irrigation water (Table 1). Huntalas variety appeared to be more salt-sensitive than the others. Relative tolerance of the different avocado varieties was in the following order: Lula 3

Fuchs 20 Mexicola Huntalas. Particularly in the root-rot resistant Huntalas variety, during the first four weeks, growth was normal and after that tip and slight marginal leaf burn were observed. Salt toxicity became worse after ten weeks of treatment. The symptoms were more pronounced on middle and old leaves of the plants. New growth was least affected by salts. In Mexicola, severe, in Fuchs 20 and Lula 3, slight toxicity was observed. The toxicity symptoms were similar to those described by Kadman (7, 8).

The experiment was harvested at two different stages and the results noted in Table 1. At first stage (7 weeks under treatment) the Na concentrations were found to be almost negligible in the new leaves and only slight in the old leaves. Mostly the Na was associated with the roots and some translocation was observed in the stems. In Lula 3 and Mexicola the Na concentration in the stems was higher than in Fuchs 20 and Huntalas. The Mn content in old leaves, stems, and roots increased as Na content increased in irrigation water.

Although Huntalas was sensitive to salts, very little Na was found in top leaves (Table 1). Salt injury then was not due to Na accumulation of either in roots. In the Huntalas and Fuchs 20 varieties, the Na was accumulated mostly in roots and stems. The Mexicola variety accumulated larger amounts of Na in new and old leaves than the other varieties. The Na concentration was 0.39% in new leaves and 0.58% in old leaves at the highest salt treatment. This may be the major cause for salt injury with this variety. In all avocado varieties, concentration of Na in new leaves was lower than in old leaves and roots. Considerable differences exist in Na accumulation and in their tolerance to NaCl in different avocado races. Lula 3 was more tolerant than the others which agrees with the results of Embleton et al. (6).

The Zn concentration of Fuchs 20 and Huntalas was decreased by salts in the top leaves. Generally the Fe and Mn concentrations in new and old leaves, stems and roots were increased by salts due to dilution. Interaction was observed between K and Na in roots in salt treatments.

In the second experiment Huntalas rooted cuttings and Hass grafted on Huntalas rooted

cuttings were grown under the same salt treatments. Similar to the first experiment, new and old leaves accumulated almost the same amount of Na, but the Cl concentration was much higher than the Na concentration (Table 2). The new leaves of Huntalas contained 50 $\mu\text{g/g}$ Na concentration at the highest salt treatment while Cl concentration was 25 times higher than Na at the same salt treatment. Similar results were obtained in the fruit experiment for Na accumulation. This indicates that the Huntalas variety is sensitive to Cl more than to Na because leaf burn was associated with Cl accumulation in leaves. Cooper (1951) concluded that the leaf burn on Fuerte avocado grown on Mexican rootstock was associated primarily with chloride accumulation in leaves. He observed very low Na concentration in leaves. The Hass scion on Huntalas rootstock accumulated more Cl than Huntalas alone. The P, K and Ca concentrations increased slightly in new and old leaves of the Huntalas variety by addition of salts. The old leaves of Hass grafted on Huntalas contained high Ca, Mg, Fe, and Mn levels in the high-salt treatments.

Gas exchange rates were determined for Huntalas and Hass on Huntalas rooted cuttings at a soil moisture of near field capacity. The data for leaf water potential, photosynthesis, and transpiration are shown in Table 3. In control and at medium-salt treatment very little difference was observed in leaf water potential and photosynthesis. High salt concentration tended to decrease leaf water potential and photosynthesis. Severe reduction in photosynthesis was observed in the Huntalas variety, more so than in Hass on Huntalas at the high-salt concentration. It was 0.90 mg CO₂, fixed/g dry wt-h while in Hass on Huntalas rootstock it was 3.84 mg CO₂ fixed/g dry wt-h. No differences in transpiration were observed under the various salt treatments in either case. Bernstein (1961) referred to unpublished data by W. L. Ehrler showing that transpiration per unit leaf area remained the same in control and in salt treatments. A slightly higher transpiration rate was observed in Hass on Huntalas rooted cuttings compared with other rooted cuttings.

SUMMARY

The Huntalas avocado rooted cuttings were grown in different salt concentrations in comparison with other rootstocks to determine the characteristics of the rootstocks for salt tolerance and mineral uptake. The Huntalas rooted cuttings appeared to be more salt-sensitive than Mexicola, Fuchs 20, and Lula 3 rootstocks. Particularly in Huntalas rooted cuttings Na was accumulated in roots and stems with very little translocated to leaves while Cl was translocated and accumulated in considerable amounts in leaves. The leaves of Huntalas accumulated 50 $\mu\text{g/g}$ Na and 0.12% of Cl at the highest salt treatment. Leaves of Hass scion grafted onto Huntalas rootstock contained more Cl than did Huntalas alone. The Zn concentrations of leaves were decreased by salts in Huntalas and Fuchs 20. Generally the salts increased Fe and Mn concentrations in plant parts of different avocados. The transpiration rate was not affected by salts while the leaf water-potential and photosynthesis decreased by salt application in Huntalas and Hass scion on Huntalas rooted cuttings.

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Table 1. Yields and Mineral Concentrations (on Dry Weight Basis) of Different Varieties of Avocado Irrigated with Differentially Saline Water

Varieties	Salt Conc. me/L	1st Sampling (7 Weeks under Treatment)						2nd Sampling (13½ Weeks under Treatment)					
		Total Yield g/Plant	Na µg/g	K %	Zn µg/g	Fe µg/g	Mn µg/g	Total Yield g/Plant	Na µg/g	K %	Zn µg/g	Fe µg/g	Mn µg/g
<u>New Leaves</u>													
Fuchs 20	0	26.0	<7	2.01	28	45	371	40.1	<7	2.72	31	58	952
	10	28.3	<7	1.79	20	52	1120	30.0	<7	2.16	<5	190	2775
	20	17.0	<7	2.09	19	93	1250	20.0	160	2.80	<5	169	3090
Huntalas	0	24.3	<7	1.64	32	55	185	30.1	<7	1.87	31	40	205
	10	17.3	<7	1.86	30	72	1040	19.7	<7	1.56	35	92	1320
	20	16.9	<7	1.43	17	82	1140	16.6	46	1.97	19	135	2080
Lula 3	0	24.1	<7	1.80	36	60	312	26.2	<7	1.80	35	43	305
	10	24.4	<7	1.92	22	58	1000	25.5	500	2.11	21	70	1180
	20	22.0	41	1.69	27	60	976	17.3	2600	2.38	38	151	1720
Mexicola	0	24.6	<7	1.53	32	54	70	21.0	<7	1.46	55	50	192
	10	22.6	83	1.33	36	43	375	16.4	434	1.87	34	74	608
	20	14.5	56	1.68	33	36	232	10.6	3920	1.72	32	92	469
<u>Old Leaves</u>													
Fuchs 20	0		91	1.98	17	46	341		77	1.92	25	51	755
	10		73	1.49	12	52	1080		104	1.84	14	91	1890
	20		90	2.40	22	104	1530		47	1.85	13	109	2285
Huntalas	0		83	1.26	29	52	276		85	1.35	32	38	375
	10		102	1.57	28	99	1480		75	1.61	20	110	1800
	20		66	1.33	10	108	1865		349	1.60	33	121	2135
<u>Stems</u>													
		1st Sampling (7 Weeks under Treatment)					2nd Sampling (13½ Weeks under Treatment)						
Varieties	Salt Conc. me/L	Na µg/g	K %	Zn µg/g	Fe µg/g	Mn µg/g	Na µg/g	K %	Zn µg/g	Fe µg/g	Mn µg/g		
<u>Old Leaves</u>													
Lula 3	0	<7	1.50	27	62	409	61	1.73	39	52	479		
	10	<7	1.48	20	57	815	450	1.73	61	106	1040		
	20	43	1.93	25	75	857	2093	1.68	28	90	1240		
Mexicola	0	82	1.21	29	52	181	92	1.36	46	57	233		
	10	71	0.93	27	55	380	524	1.47	27	60	485		
	20	63	1.50	33	53	368	5835	2.22	42	87	597		
<u>Stems</u>													
Fuchs 20	0	50	1.95	74	38	184	60	1.07	71	34	164		
	10	209	1.55	72	39	279	106	1.65	73	65	592		
	20	581	1.56	142	75	355	1240	1.45	93	109	670		
Huntalas	0	62	1.60	30	34	673	51	1.15	15	25	869		
	10	60	1.80	20	18	1200	1406	1.25	38	51	910		
	20	313	1.74	25	23	1340	2070	1.22	47	43	1550		
Lula 3	0	48	1.45	41	46	82	99	0.98	48	39	131		
	10	353	1.56	54	31	175	1148	1.15	45	41	715		
	20	2890	1.24	44	40	226	2770	0.74	71	54	766		
Mexicola	0	41	1.11	17	21	202	79	1.13	20	26	266		
	10	517	1.13	20	27	406	1615	0.96	16	32	586		
	20	1880	1.25	15	21	445	2190	0.50	24	37	471		

Continued

Table 3. Leaf Water Potential, Net Photosynthesis, and Transpiration of Huntalas (H) and Hass on Huntalas Rootstock (HH) of Avocado Irrigated with Saline Water.

Varieties	Salt Conc. me/L	Leaf ψ - bar	Photosynthesis mg/CO ₂ fixed/g dry wt. -h	Transpiration g water lost/g dry wt. -h
H	0	7.8	5.3	0.5
H	10	9.5	6.1	0.5
H	20	13.0	0.9	0.6
HH	0	7.6	5.3	0.6
HH	10	7.5	4.8	0.5
HH	20	16.1	3.8	0.7