California Avocado Society 1950 Yearbook 34: 153-160

EFFECT OF SODIUM CHLORIDE ON MEXICAN, GUATEMALAN, AND WEST INDIAN AVOCADO SEEDLINGS

A. R. C. HAAS
University of California, Riverside

Seedlings of the Mexican race of avocados are commonly used as rootstocks in California largely because of their cold hardiness (1) and other factors. Increasing use is being made of seedlings of the Guatemalan race, whereas few, if any, of the West Indian race are used.

Most avocado trees in Florida are grafted onto seedlings of the West Indian race, with seedlings of the Waldin variety being widely used (8).

In Texas the rootstocks of the West Indian race appear thus far to be the most adaptable to the Rio Grande Valley (7). The trees on West Indian root are said to have greater vigor than those on Mexican roots and the West Indian seedling trees are reported (5) as having greater vigor and less tipburn than the Mexican seedling trees. In Palestine the view is expressed (6) that avocado seedlings of the West Indian race are superior to those of the Mexican race for saline conditions.

It seemed desirable firstly to obtain some idea of the strengths of chloride that avocado seedlings will withstand and secondly to grow seedlings representative of the three races of avocados in order to learn their response to the same concentrations of sodium chloride added to soil cultures.

SAND CULTURES

Seed of the Topa Topa (Mexican) variety were germinated in the uncovered propagation frames within the glasshouse. Bottom heat was used to keep the temperature of the plaster sand at about 75° F. The seeds were first soaked in water for a short period and the seed coats removed. Thin slices were then cut away at the top and base of the seed. Germination was thereby made rapid and uniform (4).

When the tops of the seedlings were 2 to 3 inches in length, the seedlings were transferred to 3-gallon capacity silica sand cultures that were provided with suitable drainage. One seedling was used in each culture and the cultures were grown from January 4, 1950 to September 26, 1950 in the glasshouse.

The culture solution consisted of distilled water containing the following concentrations of nutrient elements (p.p.m.) ; Ca 318, Mg 54, K 185, SO_4 216, NO_3 1211, PO_4 105, plus .1 p.p.m. of boron, manganese, zinc, and iron respectively and 3 p.p.m. of aluminum as the citrate. To this culture solution was added the concentrations of chlorine in the form of calcium chloride as shown in column 2 of Table I. In the various cultures the height of

the tops were: 37, 36, 29, 29, 34, 31, 36, 39, and 21 inches respectively while the dry weight of the roots were: 19, 19, 14, 10, 17, 15, 12, 11, and 8 grams respectively. Only at the highest chlorine concentration was the top growth greatly retarded whereas the dry weight of the roots showed a decrease beginning with the second strength of chlorine. Much of the injury from excessive chlorine may occur in the root system which is quick to respond with new growth once the concentration of chlorine is greatly lowered. It should be noted here that the chlorine was added in the form of calcium chloride—calcium being a very beneficial element in the growth of avocado trees provided that potassium and magnesium are adequate.

TABLE I

Chlorine Content in Leaves, Trunk, and Roots of Avocado Seedlings of the Topa Topa (Mexican) Variety Grown in Three-Gallon Capacity Sand Cultures with a Nutrient Solution to Which Was Added Various Concentrations of Chlorine as Calcium Chloride

Culture number	Chlorine in culture solution (p.p.m.)	Chlorine in mature leaves (Percent in dry matter)		Chlorine in trunk (Percent in dry matter)	Chlorine in roots (Percent in dry matter)
		Upper leaves	Lower leaves		
1	0	0.010	0.065	0.006	0.056
2	35.2	0.018	0.052	0.019	0.090
3	70.4	0.078	0.210	0.031	0.160
4	140.8	0.332	0.641	0.055	0.130
5	211.2	0.671	0.856	0.056	0.095
6	281.5	0.396	0.439	0.076	0.119
7	422.3	0.958	1.612	0.160	0.232
8	563.0	0.894	1.659	0.098	0.259
9	703.8	0.931	1.875	0.148	0.323

The mature leaves of cultures 1-6 inclusive showed relatively little, if any, tipburn during the period of growth. As the leaves increase in age (columns 3 and 4 in table I) the chlorine content increases rapidly, so that the older the leaves become, the greater is the danger of injury from chlorine accumulation. In cultures No. 7, 8, and 9 the tipburn was very severe, the burn extending for about two inches from the tip. Figure 1, to the left, shows the tipburn of the lower leaves resulting from the excessive chlorine accumulation; whereas to the right is shown the type of leaf burn that results when the soil solution becomes too concentrated even with an otherwise favorable compound such as calcium nitrate. Table I shows the marked increase in the chlorine content of the leaves of cultures No. 7, 8, and 9. Even the upper mature leaves of these three cultures showed considerable tipburn.

The chlorine content was determined in the entire trunk of each culture and was found to be relatively very low even in the cultures in which the leaves were severely injured by the chlorine. These low percentages in the trunk are of interest when compared with the high percentages of chlorine reported (3) in fruit pedicels affected with ringneck in which the chlorine content ranged as high as 1.42 percent in the dry matter. The roots,

as seen in connect with each other. The water can be transpired from the leaf, but the unused portion of the chlorine moves toward the tip of the leaf. The accumulation of chlorine in plants has been found (2) to increase the acidity of the plant sap.

Table I, contained relatively low percentages of chlorine, the chlorine moving rapidly upward within the tree and accumulating in the leaf tip toward which the principal leaf veins converge. Figure 1, left, shows how the lateral veins

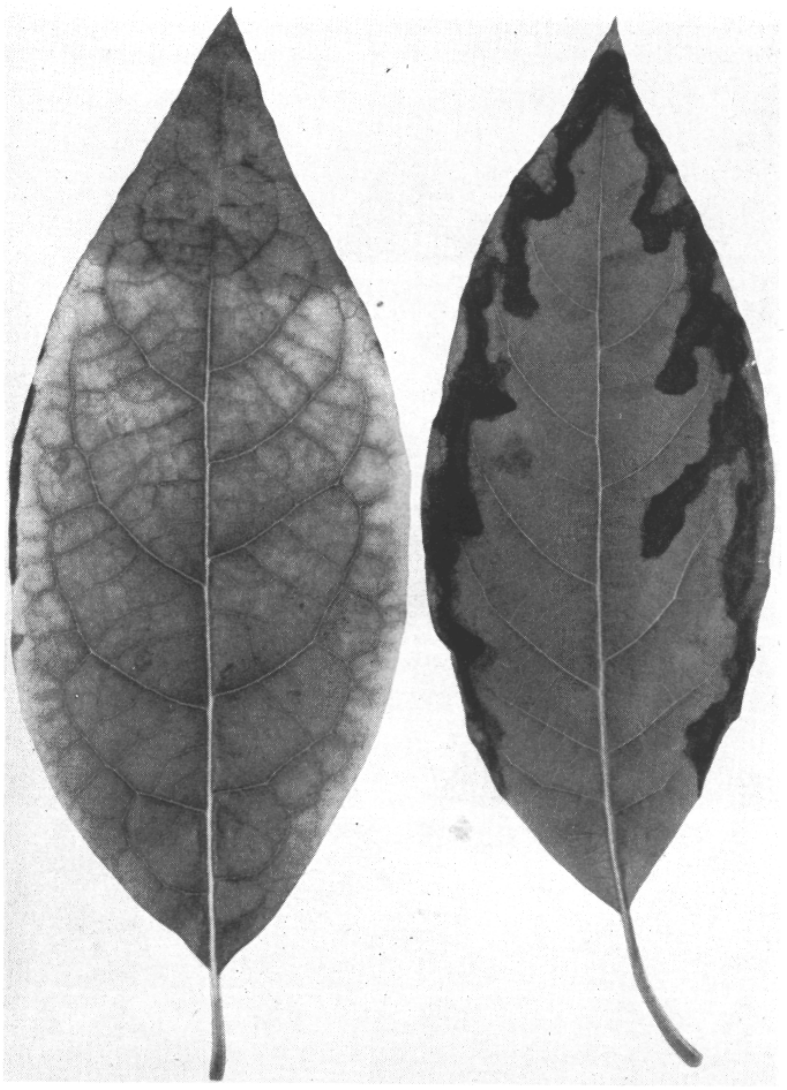

Fig. 1. *Avocado leaf burn: left, tipburn that resulted from excessive chlorine accumulation; right, marginal and interveinal burn that followed the excessive use (increased osmotic strength) of an otherwise favorable compound (calcium nitrate). In the leaf on the left can be seen how the lateral veins connect and converge the deposition into the leaf tip.*

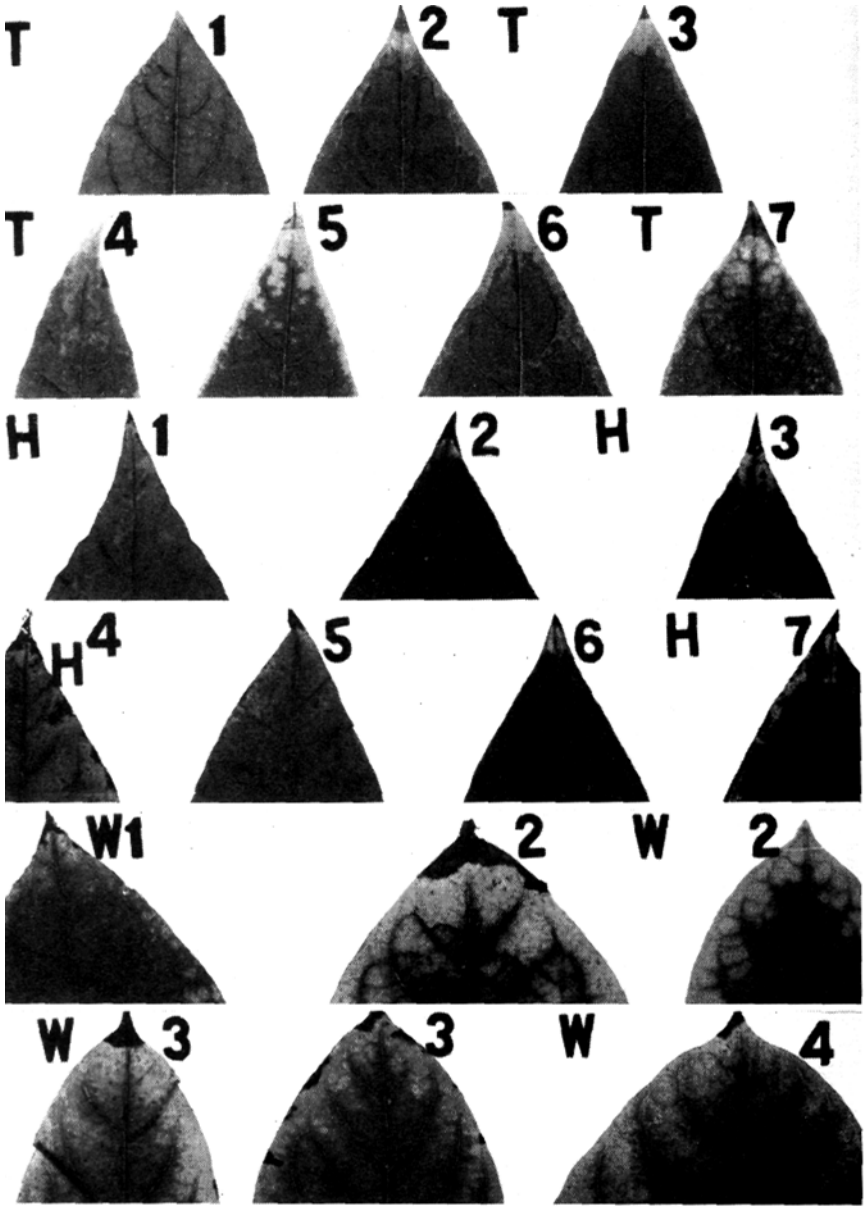

Fig. 2. *Leaf tips in the various cultures of avocado seedlings: (T, Topa Topa), Mexican; (H, Hass), Guatemalan, and (W, Waldin), West Indian races respectively. (See table II for culture treatment).*

SOIL CULTURES

A study was made of the effect on avocado seedlings of the three races when various concentrations of chlorine (as sodium chloride) were added to the nutrient solution applied to three gallon-capacity soil cultures. Soil was obtained at the Citrus Experiment Station and was diluted one-half with plaster sand in order to be assured of excellent drainage at all times. The seeds for this experiment were obtained through the kindness of Dr. F. F. Halma of the Los Angeles Campus of the University of California and the

supply of the Waldin seed was quite limited.

The seeds were germinated as previously described. The Topa Topa variety was used to represent the Mexican avocado race of seedlings; the Hass, the Guatemalan, and the Waldin, the West Indian races of avocado seedlings respectively. The soil cultures were started in April, 1948 and were grown in the glasshouse until October 21, 1949 when typical leaves were photographed (Fig. 2).

The culture solution consisted of distilled water containing (p.p.m.): Ca 318, Mg 54, K 185, NO_3 1211, SO_4 216, and PO_4 105, to which was added various concentrations of chlorine in the form of sodium chloride. The pH of the culture solution applied was 4.4.

Table II shows the composition of the most mature (lowermost) leaves that never came into contact with the applied nutrient solution. When the chlorine content of the leaves of the Waldin avocado seedlings are studied it is seen that the percentages are low when compared to similar cultures of the Hass or Topa Topa varieties. When the percentages of chlorine in the leaves were averaged for the three varieties at 0, 300, 400, and 500 p.p.m. of chlorine in the culture solution, the Waldin averaged 0.142 percent, the Hass .276 percent and the Topa Topa .385 percent chlorine respectively.

At 300 p.p.m. of chlorine in the culture solution the rootlets of the seedlings of the Waldin variety contained less chlorine than those of the Hass variety and these in turn less chlorine than those of the Topa Topa variety. At 400 p.p.m. chlorine a similar relationship holds in the rootlets, whereas at 500 p.p.m. chlorine in the culture solution, the difference between the varieties disappears.

In the leaves the greatest calcium percentages are present in the Hass variety. This is in agreement with the results on the calcium content of Fuerte avocado leaves of trees on Guatemalan and Mexican rootstosks, the data of which are contained in another article on avocado rootstock influence.

Average percentages of magnesium in the leaves of comparable cultures showed magnesium to be the lowest in the Topa Topa and the highest in the Hass variety. Average percentages of potassium in the leaves of comparable cultures showed the potassium to be lowest in the Topa Topa and highest in the Waldin variety.

TABLE II

Effect on the Leaf and Rootlet Composition When Various Concentrations of Chlorine Were Added as Sodium Chloride to a Nutrient Solution Applied to Soil Cultures Each Containing an Avocado Seedling of the Waldin (West Indian), Hass (Guatemalan), or Topa Topa (Mexican) Varieties Respectively

Culture and photo number	Chlorine in the nutrient solution (p.p.m.)	Percent in the dry matter				
		Cl	Ca	Mg	K	Na
West Indian seedling (Leaves)						
1	0	.110	2.982	.680	1.052	.043
2	300	.257	2.935	.760	.887	.059
3	400	.095	2.449	.662	1.211	.076
4	500	.105	2.596	.619	1.004	.060
West Indian seedling (Rootlets)						
1	0	.279	.644	.500	1.011	.147
2	300	.363	.702	.402	.822	.407
3	400	.461	.596	.377	.958	.287
4	500	.634	.726	.606	1.146	.567
Guatemalan seedling (Leaves)						
1	0	.088	3.604	.663	.678	.063
2	50	.057	3.657	.754	.870	.042
3	300	.217	3.101	.658	1.032	.029
4	100	.100	3.411	.684	.795	.027
5	400	.378	3.308	.964	.869	.038
6	200	.267	3.261	.896	1.178	.049
7	500	.412	3.106	.577	.869	.084
Guatemalan seedling (Rootlets)						
1	0	.375	.665	.371	1.173	.245
2	50	.237	.801	.491	1.027	.213
3	300	.457	.688	.441	.962	.343
4	100	.396	.738	.381	1.299	.224
5	400	.616	.684	.399	.851	.548
6	200	.409	.637	.435	.834	.475
7	500	.678	.664	.454	.941	.441

Culture and photo number	Chlorine in the nutrient solution (p.p.m)	Percent in the dry matter				
		Cl	Ca	Mg	K	Na
Mexican seedling (Leaves)						
1	0	.098	3.200	.706	.383	.036
2	50	.057	2.540	.544	.852	.037
3	300	.299	2.122	.527	.808	.035
4	100	.071	2.691	.715	.879	.038
5	400	599	2.766	.790	.626	.054
6	200	.298	2.377	.711	1.195	.013
7	500	.543	2.847	.789	.580	.018
Mexican seedling (Rootlets)						
1	0	.258	.809	.494	.961	.220
2	50	.261	1.130	.497	.577	.388
3	300	.594	.829	.392	.713	.608
4	100	.350	.665	.427	.800	.384
5	400	.880	.783	.432	.772	.802
6	200	519	.999	.428	.656	.566
7	500	.651	.633	.429	.640	.527

The sodium remained largely in the roots, very little being found in the leaves. The average percentages of sodium in the rootlets of comparable cultures showed Topa Topa as having the highest percentage.

SUMMARY

By means of pure silica sand cultures and Topa Topa (Mexican) variety seedlings, the effect of various concentrations of chlorine was studied in relation to the growth and absorption of chlorine. Calcium chloride was added to the nutrient solution in order to have the favorable element calcium accompany the injurious chlorine. Only at the highest chlorine concentration was the top growth greatly retarded, whereas the dry weight of the roots showed a decrease beginning with the second strength of chlorine (70 p.p.m.).

Excessive chlorine accumulation in avocado leaves results in leaf tipburn, whereas excessive concentrations of otherwise favorable nutrients results in marginal and interveinal leaf burn.

Chlorine accumulation in avocado leaves increases greatly with the increasing age of the leaves. Chlorine was not found to accumulate to any great extent in the trunk or in the roots of the seedling, but in previous studies was shown to accumulate in the fruit pedicel or fruit stalk.

A study was made of the effect on avocado seedlings of the three races when various concentrations of chlorine (as sodium chloride) were added to the nutrient solution

applied to soil cultures. The Topa Topa variety of avocado seedlings was used to represent the Mexican race; the Hass, the Guatemalan, and the Waldin, the West Indian races respectively.

The percentages of chlorine in the leaves of the Waldin variety were low when compared with similar cultures of the Hass or Topa Topa variety.

In the leaves the greatest calcium percentages were present in the Hass (Guat.) variety.

Sodium remained largely in the roots, very little being found in the leaves.

LITERATURE CITED

1. Cooper, W. C. Tipburn problem in avocados. Texas Avoc. Soc. Yearbook*1949:52-53,*
2. Eaton, F. W. Toxicity and accumulation of chloride and sulfate salts in plants. Jour. Agric. Res. *64:357-399.*
3. Haas, A. R. C. Chlorine in relation to ring-neck in avocado fruits. Calif. Avoc. Assoc. Yearbook *1936:60-62.*
4. Halma, F. F., and E. Frolich. Storing avocado seeds and hastening germination. Calif. Avoc. Soc. Yearbook *1949:136-138.*
5. Law, A. H., W. C. Cooper, and N. Maxwell. Report of the committee on rootstocks. Texas Avoc. Soc. Yearbook *1948:p. 39.*
6. Oppenheimer, C. The avocado industry in Palestine. Agric. Res. Sta. Rehovot, Palestine Bul. *44:59-82 (p. 60) 1947.*
7. Randle, J. H. Future avocado rootstock problems. Texas Avoc. Soc. Yearbook *1949:49-50.*
8. Ruehle, G. D. Avocado varieties for Dade County, Florida. Texas Avoc. Soc. Yearbook *1948:26-28.*