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SODIUM AND CHLORIDE INJURY OF FUERTE AVOCADO LEAVES

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SUMMARY

Tip burn of avocados may be caused by an accumulation of chloride within the mature leaf and the severity of the injury is proportional to accumulation.

Accumulation of sodium within the leaf causes a different type of burn where injury starts as necrotic spots within or along the leaf perimeter rather than at the tip of the leaf.

Soil salinity and levels of exchangeable sodium under affected trees are generally low but may be slightly higher than such levels under normal trees.

Leaf burn of avocados has been observed in groves of some southern California areas for many years. The severest injury has usually occurred in locations where the irrigation waters were high in chloride. In 1929 Haas (4) published a number of leaf analyses showing a correlation between high chloride in the leaves and leaf burn. As a result of these findings and the injury observed in the field when high chloride waters were used, the chloride content of an irrigation water has been used generally to determine its suitability for the irrigation of avocados. The importance of the sodium percentage on the infiltration of water into the soil has been recognized but the possibility that sodium may also accumulate in the leaf in toxic amounts has received little consideration.

Scorch or burning of mature avocado leaves was particularly noticeable in the fall of 1947, 1948, 1949, and 1950, years of lower than normal rainfall; and a number of leaves and some soils were sampled to determine their salt status. As a result of these studies it has been found that there are at least three types of leaf burn occurring in southern California. Two of the three types of burn which were observed occur as a result of the accumulation in the leaf of sodium or chloride in the leaf, but may occur as

a consequence of an inadequate water supply. Haas (4) recognized and described this latter type of injury which is similar to chloride injury but involves only a small portion of the leaf tip and produced it artificially in sand cultures maintained at lower moisture levels. Each burn has a characteristic pattern although the sodium injury and the injury due to moisture stress occur less frequently and may be partially masked by chloride damage. Leaf-scorch patterns, correlation of the severity of the injury with chloride and sodium levels in the leaves, and other associated factors are discussed briefly in this paper.

Chloride or Tip Burn.—The most frequent type of scorch is commonly described as "tip burn"; an example of which is shown in Figure 1. The scorch starts at the tip of the leaf and progresses down the blade and sometimes along the margins. This results in decreased functional leaf area of the individual leaf and an even more pronounced decrease in the leaf area of the tree for the severely affected leaves abscise prematurely.

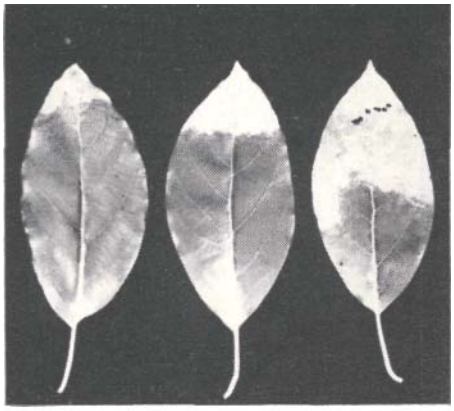

Fig. 1. *Tip burn of Fuerte avocado leaves typical of chloride injury.*

Analyses of affected leaves selected from a number of plantings in southern California show a close relationship between the total chloride as determined by a modification of the method of Clark *et al* (2) and the severity of the tip burn. The data shown in Table 1 are typical of results obtained for the Fuerte variety.

Mature leaves free from tip burn seldom contain as much as 0.5% chloride on the dry weight basis; but leaves having up to one-tenth of the blade affected may have as much as 0.5 to 0.75% chloride. When one-tenth to one-third of the leaf has been killed by the tip burn, the chloride in the remaining live part of the leaf usually ranges from 0.75 to 1.0%. Concentration of 1% or over are found only in the severely burned leaves. Haas (4) reported less than 0.4% chloride in the normal Fuerte leaves and over 0.54% in those evidencing tip burn. When he grew Mexican seedlings in the greenhouse in sand culture using nutrient solutions containing increasing amounts of calcium chloride, he observed little tip burn when leaves contained less than 0.85% chloride (5). Avers (1) also produced a similar tip burn pattern on small Fuerte avocado trees grown in the greenhouse in nutrient solution. He added chloride either in the form of calcium or sodium chloride, and found that the slightly burned mature leaves had a chloride

content of approximately 0.6%.

Sodium Scorch. — Second leaf-burn pattern which, has been observed is shown in Figure 2. In contrast to the previously described tip burn, it does not start at the tip of the leaf but usually as necrotic or scorched spots near the margin or in the interior area of the leaf. This type of leaf-burn is sometimes found to be the only one occurring on the leaf; but, more frequently, it is found in the field in conjunction with the tip burn pattern characteristic of chloride injury and for that reason has seldom been differentiated from it.

Fig. 2. *Leaf burn of Fuerte avocado leaves typical of sodium injury.*

Normal avocado leaves have very low sodium levels, and even though leaves exhibiting the typical symptoms of tip burn may have accumulated as much as one per cent chloride, there is frequently no corresponding increase in sodium. It is only when the interveinal or spot type of scorch is also present that appreciable sodium accumulations are found.

Table I Tip burn and chloride content of mature Fuerte avocado leaves

Tip Burn Symptoms	**Location**	**Percent Chloride[1]**
None	Riverside	0.19
None	Vista	0.33
Very slight	Vista	0.46
Slight	Lakeside	0.66

Slight	Fallbrook	0.70
Slight to Moderate	Solana Beach	0.89
Slight to Moderate	Oceanside	0.86
Moderate	Carlsbad	0.88
Moderate to Severe	Solana Beach	0.96
Moderate to Severe	Lakeside	0.98
Severe	Solana Beach	0.98
Severe	Oceanside	
Severe	Oceanside	1-36

[1] Oven-dry basis.

Table 2 Sodium and chloride contents of Fuerte avocado leaves showing tip or spot burn.

Leaf burn symptoms	**Location**	**% Na**	**% Cl[1]**
None	Riverside	0.02	0.19
Severe tip burn	Oceanside	0.04	1.30
Slight to moderate tip burn-	Escondido	0.36	0.78
Slight to moderate spot burn			
Moderate spot burn	Vista	0.67	0.42
Slight tip burn-	Escondido	0.67	0.57
Moderate spot burn			
Moderate tip burn-	Escondido	0.62	0.81
Moderate spot burn			
Moderate tip burn-	Ventura	1.05	0.54
Moderate spot burn			
Slight tip burn-	Escondido	1.14	0.78
Severe spot burn			
Severe tip burn-	Carlsbad	1.56	1.22
Severe spot burn			

[1] Oven-dry basis.

Table 2 gives some of the observed results pertaining to sodium injury. Sodium was determined by the use of a flame photometer (7) and a wet-ashing method (3).

Similar leaf burn has been produced in the greenhouse by growing small trees in culture solutions containing added sodium sulfate (1). Haas (6) has recently obtained and described this type of leaf burn on Mexican seedlings grown on sand culture where the nutrient solution was high in sodium nitrate and low in calcium.

Whereas, the greatest accumulation of chloride occurring in any part of the tree was found in the leaf, sodium accumulation in the small branches or twigs was as high or higher than that in the leaves (1). This has been observed in field material as well as in that grown in the greenhouse.

As reported elsewhere (1), avocado trees grown in culture solutions are more sensitive than most other plants to concentrations of either chloride or sodium salts. It is also interesting to note that the salt content of the soil found under trees suffering from leaf burn is generally low and would seldom place that soil in a saline classification. The conductance of the saturation extracts were usually less than four millimhos per centimeter, although it was not unusual for readings to be two or more in some part of the soil profile. Likewise, the exchangeable sodium of soil taken from under a limited number of affected trees was not above the normal range, but was slightly higher than that from under normal trees. This suggests that over a period of years the avocado may accumulate toxic levels of Cl and Na ions from soils which would not be regarded as saline or high in sodium.

The data reported in this paper have been confined to the Fuerte variety, the principal one grown in southern California. However, the chloride type of injury or tip burn has been noted in the field on numerous varieties such as Puebla, Dickinson, Hass, etc., and the sodium type injury has been observed on Fuerte, Itzamna and Anaheim. As yet, there have been no systematic investigations in the field of sodium and/or chloride injury as such injury relates to varietal, race, or rootstock differences.

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