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Hints on irrigating citrus with saline water

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Irrigating Citrus with Saline Water

Senior Soil Research Officer S. T. Smith describes glasshouse experiments which have given some useful guides to minimising "salt" damage in citrus trees irrigated with low-quality water.

By S. T. SMITH, B.Sc. (Agric.), Senior Soil Research Officer

In the past few years a number of citrus orchards near Perth have shown signs of damage caused by excess "salt" (chloride) uptake. All have been irrigated either from the Canning River or from private bores or dams.

SYMPTOMS
While some of the affected trees have shown slight leaf tipping (scorching) the main symptom has been an accentuated leaf fall, particularly in the spring. Some trees became almost leafless.

Brown rot (Phytophthora) and zinc deficiency were the first suspected causes of this trouble. However, in some cases treatment for these was unsuccessful and chemical analysis later revealed abnormally high salt contents in the leaves of affected trees in one orchard.

A survey showed that many of the trees in the worst affected orchards had four or five times the normal salt content in their leaves. This strongly suggested that salt was the cause of excessive leaf drop and unthriftiness in some trees.

The health of many trees has improved and leaf drop has lessened with the use of better water or better irrigation techniques.

CAUSE OF SALT UPTAKE
Few of the citrus orchards affected by salt in Western Australia suffer from saline seepage or shallow water tables, or from an accumulation of salt in the soil.

Excess salt in citrus trees can, however, come from irrigation water, even though accumulation in the soil is prevented by good soil permeability and high winter rainfall. This uptake may be either through the roots or the leaves.

Quality of Water
As citrus is fairly sensitive to salt injury it is important to use the best quality irrigation water available.

It is also important to know the likely effect of water of any given quality on citrus, and the irrigation techniques needed to minimise damage resulting from its use.

Detailed glasshouse experiments on young Washington Navel orange trees have shown that water salinity is a prime factor in determining salt uptake, and that method of watering can also have a strong influence on whether or not damage results from its use.

SOIL WATERING—EFFECT OF ROOT-STOCK
Plants can be watered with fairly saline water if the water does not contact the foliage. When the water is applied to the soil it is important to make sure that drainage is good and enough water is used to prevent salts accumulating in the soil.
Accumulation of salt is not common in the well-drained soils of the heavy winter rainfall districts where citrus is grown in Western Australia. However, citrus trees are fairly sensitive to salt uptake and can be damaged as a result of root absorption if the irrigation water is sufficiently saline. Rootstocks vary in their ability to withstand poor quality water. The two main rootstocks now used in Western Australia are Citronelle and Trifoliata; these were used in glasshouse experiments to test the effect of rootstocks on salt uptake.

Rootstock Experiment

Washington Navel oranges on Citronelle and Trifoliata rootstocks were watered by soil application during two months of the summer of 1960-61. At the end of this period mature leaves were analysed to assess the uptake of salt.

The results of this experiment—illustrated in Fig. 1—clearly show the difference in the ability of the two rootstocks to control chloride uptake. Plants on both Citronelle and Trifoliata rootstocks were irrigated with waters with salt contents ranging from 0 to 100 grains of total soluble salts per gallon. (Sodium chloride made up 75 per cent. of the total).

Salt entering the leaves of plants on Citronelle rootstock showed no significant increase as the salt content of the water rose from 0 to 100 grains per gallon.

On Trifoliata rootstock, however, there was a constant and significant increase in leaf salt content with increasing water salinity over the same range. After two months of watering, trees given water containing 100 grains of total soluble salts per gallon had a leaf chloride content three times as high as those watered with fresh water.

These results clearly show the difference in susceptibility of these two rootstocks to salt uptake and consequent injury. If poor quality water is to be used for irrigation this difference should be added to the factors taken into account in deciding which rootstock to use.

SPRINKLER IRRIGATION—EFFECT OF TECHNIQUE

In most plants salt injury occurs more readily when the foliage is wetted during spray irrigation than when only the soil is wet. Despite this, the sprinkling technique can influence the amount of leaf injury which results from use of saline water.
To investigate this, detailed sprinkling experiments were carried out on Washington Navel orange trees on Citronelle rootstock, under glasshouse conditions.

The factors affecting leaf absorption of salt are—

(1) The salinity of the water used.
(2) The time of day that sprinkling takes place.
(3) The method of sprinkling.

Results of the sprinkling experiment are discussed in relation to each of these.

**The Effect of Water Salinity**

It is to be expected that the uptake of salt into the foliage of a plant will increase as the salinity of the water used increases.

This is shown in Fig. 2, which illustrates the results of one spraying experiment. In the experiment the foliage was watered during sprinkling. This “irrigation” was given on five occasions, to give a total of six hours in which leaves were in contact with water.

The salinity of the water used ranged from 0 to 80 grains per gallon total soluble salts. None of this water contacted the soil so that the entry of salt could only be through the leaves or stems.

As the salinity of the water used increased the salt uptake by the leaves also increased. Leaves sprayed with fresh water contained 0.06 per cent. chloride while those sprayed with water containing 80 grains of total soluble salts per gallon contained 0.19 per cent. chloride.

While this higher level of salt in the leaves is not regarded as damaging it must be remembered that the foliage had only six hours contact with the water in this experiment. Had the period of contact been longer the levels would presumably have been much higher.

**Time of Day**

The entry of salt into leaves can be affected by the time of day during which the plants are sprinkled. There are two possible reasons for this:

- **Fig. 2.** The effect of water salinity on salt uptake by leaves. Absorption increased as the water salinity increased.
"when water flows the earth will yield"
"Walk across the thirsty land. Your heels kick up the hot sand. You see only the stunted desert growth, fighting hard to hold its place. But wait till water comes. That will be a paddock ... flowing milk and honey. For \textit{when water flows the earth will yield}.

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If plants are sprinkled when temperatures are high evaporation may increase the salt concentration in the water droplets on the leaves. For this reason it is better to irrigate on cooler days or at cooler times of the day.

Physiological factors such as the degree of openness of the leaf pores (stomata) or the metabolic activity of the leaves may affect the entry of salt into leaves. These vary between day and night.

The difference between salt uptake when sprinkling was done during the day and when it was done during the night is shown in Fig. 3.

In this experiment the salt content of water used for sprinkling again ranged from 0 to 80 grains per gallon total soluble salts and the five waterings gave a total of six hours during which leaves were in contact with the water.

Sprinkling during the day caused a much higher uptake of salt than identical sprinkling during the night.

The highest leaf salt contents in this experiment were not dangerously high but it could be expected that the levels of salt could increase with longer periods of spray irrigation.

It should also be noted that the difference in leaf absorption of salt from day sprinkling compared with night sprinkling became greater as the salinity of the water increased.

The Method of Sprinkling

There are many types of sprinklers available, but these can be grouped into two general types: those which give a continuous spray in all directions, and those (such as the knocker or rotary type) which rotate slowly to give intermittent wetting.

When poor quality water is used intermittent wetting is likely to allow a concentration of the water droplets remaining
on the leaves between rotations. This more saline water could cause leaf damage. Obviously this type of damage is more likely to occur if irrigation is done in the hottest part of the day or during hot weather. This is shown in Fig. 4, which gives the results of an experiment in which the salt content of leaves was studied after sprinkling by different methods with waters ranging from 0 to 80 grains per gallon total soluble salts.

In this experiment concentration by evaporation caused a higher leaf absorption of salt where intermittent sprinklers were used.

SUMMARY AND IMPLICATIONS

1. There is a marked difference in the susceptibility of rootstocks to salt uptake. When watered with the same water Citro-
nelle rootstock absorbs far less salt than Trifoliata rootstock.

2. A good deal of salt is absorbed through the foliage when sprinkling water contacts the leaves of citrus.
   - More salt enters the leaves as the salinity of the water increases.
   - Salt absorption is higher when sprinkling is done during the day than when it is done at night.

   - In hot weather salt uptake is often higher when intermittent or knocker type sprinklers are used than when continuously wetting sprinklers are used.

   These factors should be considered if poor quality irrigation water is to be used. While it may not always be possible or desirable to use Citronelle rootstock, the type of sprinkler which minimises leaf wetting should be used if possible. A sprinkler which gives continuous wetting should be selected rather than one which gives intermittent wetting.

   Sprinkling should be done during the cooler part of the day, or, if the water is of very poor quality, during the night.

   Water containing more than 50 grains per gallon of total soluble salts should be regarded as poor quality water for citrus orchards near Perth. With water of this quality poor irrigation techniques can allow some leaf damage to occur.

   Damage is more likely if poor quality water is used regularly and often. Many citrus orchards show damage from regular watering with water containing between 50 and 60 grains per gallon total soluble salts. Other orchards receiving water containing perhaps only one supplementary watering a season with water of 80 to 90 grains per gallon total soluble salts appear to be relatively unaffected.
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