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Sprinkler irrigation in windy conditions

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SPRINKLER IRRIGATION IN WINDY CONDITIONS


THOSE summer winds—be they cooling afternoon breezes or scorching easterlies—are no help to the irrigationist.

Where sprinklers are used wind can result in uneven irrigation, reduced yields and spoilt produce.

A case history

The adverse effects of wind became prominent when fixed overhead irrigation was introduced into the Donnybrook area in the early 1960’s. Trees in some orchards showed symptoms of salt burn on leaves and some trees lagged in growth and production.

Water Supplies

Analysis of the water supplies used on affected trees revealed that, in many instances, the water being used was of good quality by Western Australian standards. In contrast, some check orchards revealed no damage with much poorer quality water.

Orchard Location

Almost invariably, the orchards showing damage were in exposed positions and undamaged orchards were well protected. This was not true where very poor quality water containing over 60 grains per gallon (857 milligrams per litre) of salt was used and damage occurred in most situations.

Damage with good quality water was confined to areas at Donnybrook, Bridgetown and East Manjimup that were subject to hot dry winds during the middle of the day. Late afternoon, night and early morning irrigation was recommended but did not overcome the problem completely.

Meteorology

A closer look at meteorological records for damage-liable and safe areas revealed many differences which apparently account for the variation in damage patterns.

<table>
<thead>
<tr>
<th></th>
<th>Susceptible (Donnybrook)</th>
<th>Safe (Manjimup)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual rainfall</td>
<td>39.79 in.</td>
<td>41.81 in.</td>
</tr>
<tr>
<td>Summer rain (Nov.-March)</td>
<td>3.79 in.</td>
<td>5.63 in.</td>
</tr>
<tr>
<td>Temperatures over 90° F.</td>
<td>35 days</td>
<td>14 days</td>
</tr>
<tr>
<td>Temperatures over 100° F.</td>
<td>4 days</td>
<td>1 day</td>
</tr>
<tr>
<td>Annual evaporation</td>
<td>50 in.</td>
<td>40 in.</td>
</tr>
</tbody>
</table>

Winds

<table>
<thead>
<tr>
<th></th>
<th>Time winds were within each velocity range (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 a.m.</td>
<td>0-4 knots</td>
</tr>
<tr>
<td>5-9 knots</td>
<td></td>
</tr>
<tr>
<td>10-14 knots</td>
<td></td>
</tr>
<tr>
<td>over 15 knots</td>
<td></td>
</tr>
<tr>
<td>3 p.m.</td>
<td>0-4 knots</td>
</tr>
<tr>
<td>5-9 knots</td>
<td></td>
</tr>
<tr>
<td>10-14 knots</td>
<td></td>
</tr>
<tr>
<td>Over 15 knots</td>
<td></td>
</tr>
</tbody>
</table>

(1 knot = 1.15 m.p.h.)

Donnybrook is an average 6° to 7° F. hotter than Manjimup in summer, has stronger winds and higher annual evaporation.

Although the wind velocities shown are only for 9 a.m. and 3 p.m., periods of calm conditions are relatively short at Donnybrook making damage much more liable, even at night.

A further complicating factor is the low relative humidity at Donnybrook and the greater potential for evaporation. The 3 p.m. humidity reading on an average summer day is only about 28 per cent compared to 46 per cent at Manjimup.

Wind effects

As a water droplet travels through the air it evaporates. Evaporation increases in dry air or if the droplet remains airborne for an appreciable period. Wind prolongs the time that the droplet remains airborne.
If a droplet starts at 30 grains per gallon (428 milligrams per litre) and dries to half volume, the salt concentration increases to 60 grains per gallon (857 milligrams per litre). In many cases, this is more than enough to cause damage. If a droplet becomes more concentrated before it strikes a leaf the likelihood of damage is greater.

The smaller the droplet the greater the surface area in proportion to volume and the faster it evaporates. As droplets evaporate they become lighter and travel further in the air, allowing further evaporation and increase in salt concentration.

Effects on plants

If the leaves are kept dripping wet with continuous irrigation, some of the salt will run off and there will be no large build up in salt concentration in the water on the leaf surface. If the water dries then a layer of salt accumulates on the leaf. Further layers of salt are added with each application of water and this salt is absorbed into the leaf, killing the tissues. This damage reduces the effective leaf cover and thus affects tree health and production and increases the possibility of sunburnt fruit.

Sprinkler types

Sprinklers placed above the trees or crop are more liable to wind effects by virtue of their position. Added to this, these sprinklers are often widely spaced, low application rate types with intermittent wetting patterns. The wind has full effect on the droplets as well as causing complete drying on the leaf.

In contrast, sprinklers placed on or near the ground are partially protected from the wind and usually have a greater application rate.

The following steps can be taken to reduce the likelihood of damage from overhead sprinklers—

- Make sure water quality is suitable for an overhead system (less than 25 grains per gallon or 357 milligrams per litre total salts) and check water quality frequently during summer.
- Drain out dams each year and discard the early winter flows as they are usually higher in salt than mid winter flows.
- Increase the rate of application to avoid slow watering and fine droplets.
- Endeavour to avoid windy weather and hot weather when irrigating and try to water at night. If possible, grow wind breaks to give some protection to the planted area.
- In orchards, if possible, shift to one of the under tree watering systems or, if using portable piping, use low angle sprinklers to keep the water off the foliage.

Distribution patterns

Figure 1 shows the effect of a moderate wind on a sprinkler distribution pattern. The amount of wind-free time in the South West is relatively small, and if sprinklers are to be used in windy conditions the spacing must be adjusted accordingly. Sprinklers with a precipitation diameter of 80 feet give an effective coverage in still air at about 50 feet spacing. When the wind speed rises to 4 m.p.h. the effective diameter may be only 45 feet. At 8 m.p.h. effective coverage may fall to 40 feet and at 12 m.p.h. to 30 feet or less.

If no adjustment is made uneven watering, variable yield and quality, and waste will result. A few dollars for extra sprinklers will more than repay the outlay.

Where the winds are above 8 or 10 m.p.h. effective cover at an economical cost may not be possible with sprinklers. Special low trajectory sprinklers may be used, but another method of irrigation should be investigated.

Figure 1. — The effect of a wind of about 5 m.p.h. on sprinkler distribution pattern.