Vignerons offered better ways to water

THERE is room for improvement in the way Australians water their crops, says Dr Elizabeth Heij, Adelaide-based chief of the CSIRO Division of Horticulture.

'Better management is the first big area that we've got to tackle,' Heij says. 'We could make probably a third or a half reduction in the amount of water used just by management alone. There's considerable wastage.'

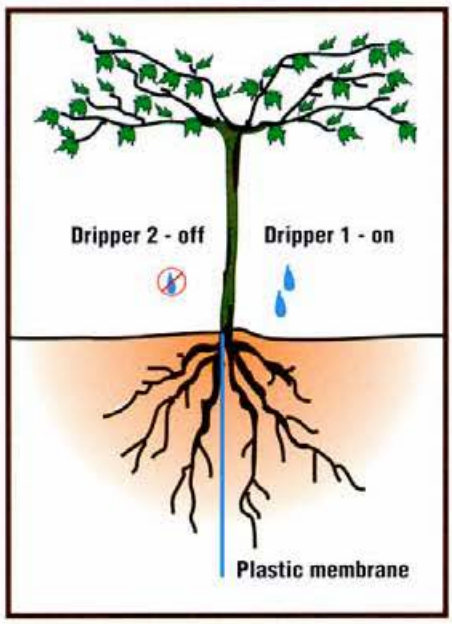
Heij says work carried out in her division and overseas shows how plants cope with water stress. A collaborative project, funded by the Grape and Wine Research and Development Corporation, between CSIRO's Dr Brian Loveys and Peter Dry from the University of Adelaide has shown that these mechanisms can be employed to boost the efficiency of water use by plants.

Loveys and Dry started out trying to reduce vigour in cool-area grapevines. Excess vigour produces too many leaves. These shade the fruit, affecting its quality. They can also make disease control more difficult, and reduce yields in subsequent years.

Their research focused on understanding the hormonal mechanisms that control vine growth, and hence, vigour. Previous work had shown that photosynthesis and transpiration in vine leaves was controlled by the plant hormone abscisic acid (ABA). The role of this compound in controlling vigour therefore came under scrutiny.

Increased concentrations of ABA in the leaves causes the stomata to close, preventing further leaf gas exchange. Stomatal closure can also result from increased ABA concentrations in the sap that carries water and nutrients from the roots to the shoots. Once the hormone has delivered its message, it is broken down in the leaf into inactive compounds. The normal, or 'steady state' concentration of ABA in shoots is determined by the balance between import from the roots, synthesis in the leaves and metabolic breakdown.

'The effect on vine vigour was dramatic, with pruning weights reduced by 29%'



Novel irrigation techniques can be used to manipulate natural hormonal mechanisms in grapevines. In an experiment that tested the effects of watering only half the vine's root zone, it was discovered that leaf and shoot vigour could be reduced without affecting fruit yields or quality. Irrigation systems are being developed that will enable growers to achieve the same result .

Given this relationship between ABA and photosynthesis, Loveys and Dry speculated that increased ABA production may reduce vine growth, and that the ABA could be manipulated by using irrigation techniques to create wet and dry roots on the same plant.

To test their idea, they tried watering only half of each vine's root zone. Vine cuttings were sawn in half longitudinally at their base, and each root system planted in a separate pot. The performance of these vines was then compared with that of fully-watered and unwatered vines.

Within a few days, the leaf gas exchange, photosynthesis and growth of both the half-watered and unwatered vines had slowed compared with the fully-watered ones. But their overall responses were not the same. Unlike the unwatered vines, the leaves of the half-watered ones did not wilt. Their water status actually remained similar to that of a well-watered plant. Thus it was possible to separate the physiological effects of water stress from the potentially damaging physical effects such as loss of leaf turgor (wilting) and shoot death.

Loveys and Dry believe that a chemical signal (probably ABA) is transmitted from the drying roots to the shoot, triggering the reductions in leaf gas exchange and growth. At the same time, however, the water status of the vine is maintained by the other half of the root system which has been fully watered.

'You're tricking the vine into thinking that it's water stressed, but it's not,' Loveys says. 'There's no penalty in terms of yield. We're actually making the vines much more water-use efficient.'

Having shown the effect of partial root drying in potted plants, Loveys and Dry applied a number of wetting and drying cycles to the roots of field vines grown with their roots separated by a plastic membrane. The irrigation was planned so that one root system received normal irrigation for about two weeks while the other was allowed to dry. Then the situation was reversed.

The effect on vine vigour was dramatic, with pruning weights being reduced by about 29% and number of lateral shoots by 47%. A more open canopy with better bunch exposure was produced and there was no significant effect on yield or fruit quality.

Loveys and Dry believe the plant growth mechanisms observed under trial conditions will also occur in vines grown under normal irrigation regimes. For example, under drip irrigation, roots outside the normally wetted zone will become dry and capable of transmitting a signal to the canopy. Water applied by furrow irrigation may reach a

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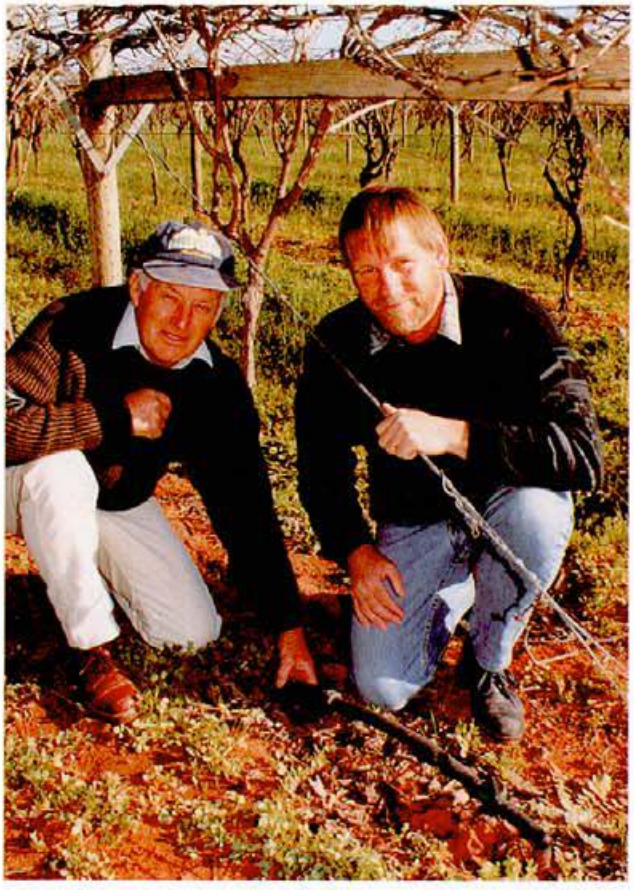

Joe Pasquale

Above: Furrow irrigation, a traditional method of watering grape vines.
Right: CSIRO's Peter Clingeleffer (hatted) and sultana grape grower Brian Cox with the sub-surface irrigation system that has saved time, money and water at the Coxes' Red Cliffs property.

different proportion of the roots on different occasions, especially if water is applied to alternate rows, resulting in a varying proportion of wet and dry roots.

Loveys believes the technique could be adapted to help boost water-use efficiency in other irrigated crops that have extensive root systems, such as irrigated pome and stone fruit. In the meantime, irrigation systems that can be readily adopted by growers are being developed. These will encourage the grapevine's own hormonal mechanisms to control of vigour in a reproducible manner.

Sub-surface savings

Research by Peter Clingeleffer from the Division of Horticulture's Merbein office in Victoria is also helping horticulturists to irrigate efficiently. He started out, with funding from the Dried Fruit Research and Development Council, to test a new irrigation system.

Clingeleffer replaced open irrigation furrows with slotted agricultural pipe buried about 15 centimetres underground. With his sub-surface system, and careful selection of root stocks, clones and trellis, he is looking to quadruple water-use efficiency.

'We've had five seasons, and we've got some pretty nice figures there,' he says. 'The implications of what we're finding are much wider. There's a lot of grower interest.'

Supporters of Clingeleffer's system are Brian and Mick Cox of Red Cliffs, just south of Mildura in north-western Victoria. The Coxes grow sultana grapes for the dried-fruit market (and some mandarins) on their 30-hectare property which, until last year, was irrigated with the flood/furrow system.

In 1994, Brian and Mick sought alternatives to furrow irrigation because it was too labour-intensive. They investigated switching to a dripper system, but were deterred by the hefty installation cost of $4400/ha. At only $1210/ha, Clingeleffer's sub-surface system was more affordable. Since going 'sub-surface', however, the Coxes have saved water as well as money, and lifted the overall efficiency of their vine-management.

'We used to use all of our annual 275-megalitre water allocation,' Mick Cox says. 'But with the sub-surface system, this past season we used only 119 megalitres.

'In saving water, we're saving money because if we don't use all our water rights, we don't have to pay for the whole allocation. We would have had to spend an extra $6000 if we were still relying on the furrows.'

Other advantages of the sub-surface system according to the Coxes, are:

- its adaptability to the existing supply infrastructure;
- no need for filtering or backwashing ;
- less water leaching and evaporation;
- existing furrow system can still be used;
- the vines can be accessed from tractor to apply sprays while irrigating or after rain;
- no pumping cost;
- no more need for cultivation;
- less tractor time and less labour (two to three weeks a year) required; and
- water can be regulated more efficiently.

Already Clingeleffer is wondering what other crops his system may work for: wine grapes, probably, and perhaps citrus and 'row' crops such as tomatoes and asparagus. He says one big advantage is that growers don't need to change over their whole system at once: they can test it on part of their block first.

'We know the future of the dried-fruit industry relies on efficient water use, efficient use of labour and efficient use of our other natural resources,' Clingleffer says.

David Mussared and Bryony Bennett