Factsheet

May 2012

Cover crops and vineyard floor temperature

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Introduction

One of the main reasons cover crops are grown is to protect the soil from raindrop impact and thereby prevent erosion. Rolling or mowing the cover crop in spring will effectively protect the soil, but will it also impact on soil and canopy temperatures, particularly in relation to frost prevention and summer heat waves.

Cover crops and frost

Frost can be devastating to vines in some seasons, and cover crops have traditionally been thought to play a role in reducing its incidence and severity in the vineyard. However, the impact of cover crops on frost incidence and severity needs to be understood so that the good (and expensive) work in growing cover crops to improve the soil is not needlessly undone.

An excellent electronic extension package that explains the development of frost and mechanisms of passive frost control has been developed by the University of California Cooperative Extension, and can be viewed directly via the web (University of California Department of Land, Air and Water Resources 2010). Another very useful but locally produced resource has been produced by Jones and Wilson (2010).

Ice-nucleating bacteria and frost sensitivity

In order for ice to form on a leaf surface, supercool water and a nucleating substance must both be present to initiate the process. The ice-nucleating material may be mineral (e.g. clay and dust particles) or organic (e.g. bacteria). Lindow (1983) recognised the capacity of ice-nucleating bacteria (*Pseudomonas syringae*) to determine the frost sensitivity of plants, as in the absence of these bacteria on the leaf surface, plants can be cooled to −7°C for several hours with no apparent damage. In the field, frost sensitivity seems to be more closely correlated with the presence of ice-nucleating bacteria than it is with the presence of mineral nucleating agents, which are inactive at temperatures warmer than −10°C. It therefore seems obvious that reducing the population of ice-nucleating bacteria on the leaf surface should decrease a crop's susceptibility to frost. It has been shown that both high populations of antagonistic micro-organisms and the presence of bacterial inhibitors such as copper, zinc and cationic detergents can significantly reduce ice-nucleating bacteria populations and thus the damage from frost in some situations (Lindow 1983).

Figure 1: A standing barley cover crop is almost at cordon height, increasing the vines' susceptibility to a frost event. The rolled barley and clean undervine zone provide the same frost mitigation as discing.

Figure 2: Frost on grape leaves. (Photo courtesy Hans Loder).

Frost mitigation effects of cover crop choice and management

Another approach to frost mitigation has involved reducing the levels of ice-nucleating bacteria at their source. Grasses in general produce higher levels of ice-nucleating bacteria than do broadleaf species, which tend to have a thick, waxy cuticle (McGourty & Christensen 1998). It was therefore suggested that in frost-prone areas, the use of grasses as cover crops should be avoided so as to reduce the potential for frost to occur. However, recent research trials suggest that targeting ice-nucleating bacteria will not provide reliable reductions in frost incidence or severity (N Scarlett 2011, pers. comm.). This also means that while there may be a higher population of ice-nucleating bacteria associated with grasses, the cover crop composition is unlikely to influence the incidence of frost in the vineyard. This is an important outcome because it means that cover crop selection does not have to be influenced by the likelihood of a frost event at a particular site.

Of greater importance is the management of cover crops in those areas that are prone to frost. Mowing the cover crop, then discing or rotary hoeing, followed

Figure 3: A frost fan in the Niagara region of the US. (Photo courtesy of Hans Loader).

Figure 4: A thick mulch derived from a rolled barley cover crop will protect the soil over the summer period without increasing the frost risk in spring, compared to that from a disced mid-row.

by rolling to lightly compact the soil, remains common practice in some regions that are frost-prone. This is aimed at using the soil as a heat bank that releases warmth at night to increase air temperatures up to cordon height. However, cultivation of the soil causes soil moisture to evaporate and creates air spaces, which reduce the soil's capacity to store heat for release in the evening as the temperatures decrease (Donaldson et al. 1993). It is also deleterious to soil structure and leaves the soil exposed over the summer period. Increased levels of dust, and weed invasions following rain are commonly observed in cultivated vineyards. But is cultivation beneficial in frost reduction, compared to simply mowing the mid-row sward?

No studies on the impact of vineyard floor management on cordon temperatures have been reported in Australia. However, in the Sonoma and Napa counties of California, Donaldson *et al.* (1993) investigated the impact on cordon temperatures of three floor management treatments on four vineyards over three years. The vine mid-rows were either kept bare over the late winter/spring period with glyphosate herbicide, disced in spring or mown to 8 cm height. This research showed that cordon temperatures following herbicide application were the same or slightly higher than those measured after cultivation, while the effect of mowing was generally similar to that of the cultivation treatment. A similar conclusion was reached by McCarthy *et al.* (1992) in their review of literature on the topic. It is therefore recommended that in frost-prone areas, the best practice for vineyard floor management will involve planting the cover crop most suited to the vineyard's requirements and mowing it low prior to budburst, while leaving the disc in the shed.

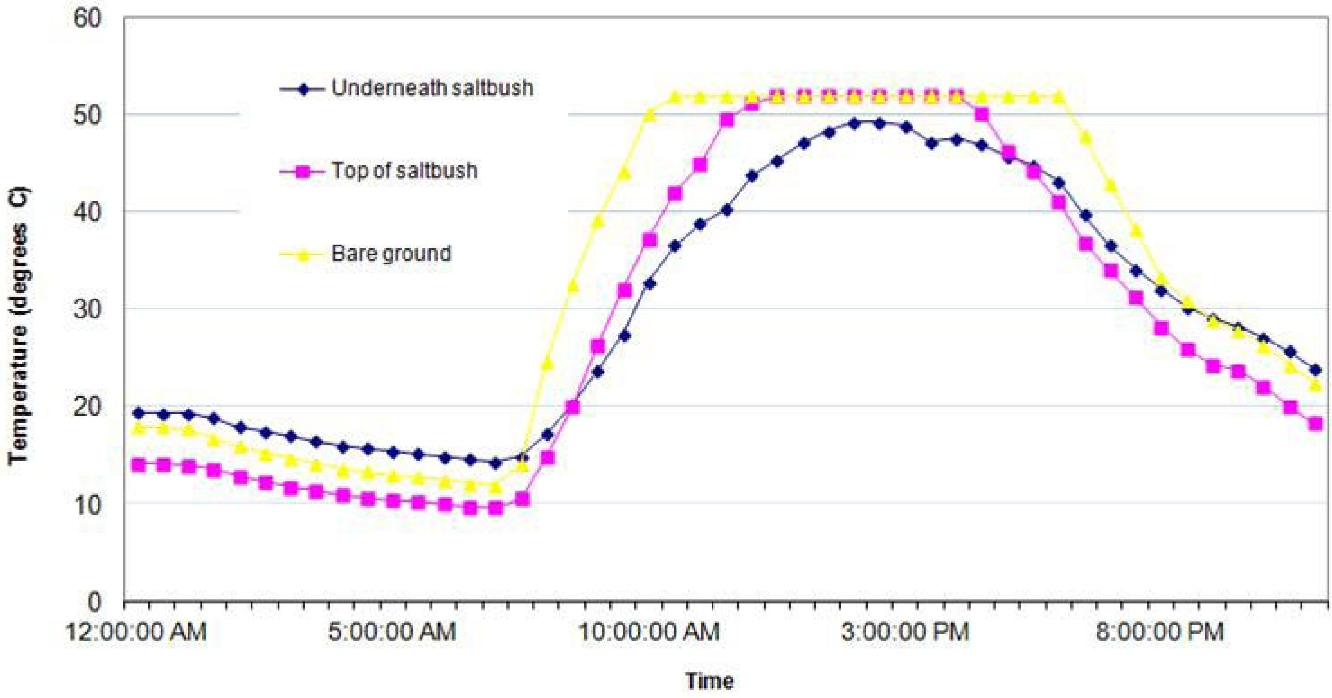

Figure 5: **Vineyard floor temperatures are influenced by soil cover, as shown in this 24-hour period during a heatwave at Loxton, South Australia, March 2008.**

Vineyard floor management and canopy temperatures

Cover crops may be either perennial or annual and consist of either native or exotic species. The robust nature of the native species allows them to survive the harsh Australian summers, providing a perennial option for the hot-dry wine zones. In the hot-wet, warm-wet and cool wine regions, all with growing season rainfall over 300 mm, exotic species may also provide living soil cover over the summer period. Alternatively, cover crops that have been mown or rolled in spring may also provide a mulching effect and could influence canopy temperatures. To investigate some of the above scenarios and their impact on vine canopy temperatures, Tiny Tag® temperature-sensing data loggers were placed on the ground and on the cordon wire of vines growing in the Barossa and Loxton regions of South Australia during the summer of 2008.

In the hot-dry environment of Loxton, creeping saltbush (*Atriplex semibaccata*) performed superbly as a cover crop, with high biomass production and strong suppression of caltrop (*Tribulis terrestris*). This living soil cover had a considerable impact on vineyard floor temperatures at ground level (Figure 5). Predictably, the bare soil heated to above 50˚C more rapidly and stayed above that threshold for much longer than immediately above the saltbush, or in the shade below the plant. While benefits of living cover were evident on or directly above the soil surface, they did not translate into lower canopy temperatures. This was not surprising, given the relatively small plot area compared to the large hot air mass, which would mask any local effects of groundcover.

Despite the lack of temperature differences measured in the canopy, providing soil cover over the summer is still important in preventing erosion, maintaining trafficability, reducing dust and providing habitat for beneficial insects for which shade is important.

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This factsheet was first published in May 2012.