Introduction
The 1994/95 season has been a challenging one for Australian grapegrowers. Many vineyards were affected by a range of growth-related problems, resulting in a severe reduction in grape yields across South Eastern Australia. The first of these problems was the appearance of unusual vine growth symptoms, now known as restricted spring growth (RSG). It is also now known that similar problems have occurred in other years.

When the severity and widespread nature of the restricted growth symptoms became apparent, a national task force was established in October 1994 to investigate the problem and provide feedback to industry. Membership consisted of representatives from Victorian, South Australian and New South Wales Departments of Agriculture, CSIRO, the wine industry and the CRC for Viticulture (see References).

The following information summarises many of the findings of the task force.

Symptoms
RSG can be characterised by uneven budburst, and the presence of a large number of buds failing to burst at all. Where buds did burst, shoot growth was retarded with small leaves and short internodes. In some cases canes and cordons died back and in isolated situations, the whole vine died (Figures 1a and 1b). There was also strong shoot growth from within the crown or low down on the trunk. For particularly badly affected vines, it was only possible to stimulate shoot growth by cutting the vine back either at crown height or lower.

Another characteristic symptom of RSG is the apparently random distribution within a vineyard, with one vine growing in a normal manner, whilst an adjacent vine can be badly affected with RSG. This apparently random spread can occur throughout the whole vineyard, however in other cases symptoms may be confined to a group of vines in a particular area, generally related to particular soil types. Young vines (i.e. 2–4 years) were more badly affected than older, more mature vines.

A part from those that died, most of the affected vines were able to grow out of the condition, although yields for 1995 were significantly reduced. The new season growth appears to be healthy and at this stage there is an expectation that yields should return to normal next year.

The symptoms of RSG are not new, with examples of similar disorders in Australia as long ago as 1940 (Walters and Ludbrook 1940). More recently, similar symptoms referred to as ‘vine decline’ have been observed in Sunraysia and the Riverland in 1982, 1972 and 1967. While they have been considered as separate disorders it is likely that the causes of ‘vine decline’ and RSG are closely linked, if not the same.

Grower survey
In November 1994, the task force conducted a survey of growers in Victoria, South Australia and NSW to assess the extent of the problem and to find a common link, if any, between those vineyards showing RSG symptoms. Of the 143 responses, 68% had observed RSG symptoms with 55% regarding the problem as low (1–40% affected), 15% medium (41–70% affected) and 29% high (71–100% affected).

While the survey collated information on a wide range of management practices, it supported the hypothesis that RSG was caused by a combination of factors. The key areas to emerge as contributors to the problem are summarised as follows.

Soil
While RSG symptoms were reported on all soil types, it was more common on heavier (clay, clay loam) soils. This association may be confounded with low lying sites where heavier soils tend to predominate. These heavy soils often have poor structure and are poorly drained.
<table>
<thead>
<tr>
<th>Variety</th>
<th>Total responses (%)</th>
<th>Total affected (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chardonnay</td>
<td>21</td>
<td>87</td>
</tr>
<tr>
<td>Colombard</td>
<td>7</td>
<td>90</td>
</tr>
<tr>
<td>Gordo</td>
<td>13</td>
<td>50</td>
</tr>
<tr>
<td>Sultana</td>
<td>31</td>
<td>68</td>
</tr>
<tr>
<td>Other</td>
<td>29</td>
<td>56</td>
</tr>
</tbody>
</table>

Varieties
Over 20 varieties were reported to show symptoms with Chardonnay recorded most frequently (Table 1). This does not mean it is more susceptible to RSG, rather that the largest area of young vines consist of Chardonnay.

Pruning
Minimally and cane pruned vines showed RSG symptoms more frequently (87% and 73% of responses) compared with hedge and spur pruning (43% and 45% respectively). It is possible that the more vigorous individual shoot growth of spur and hedge pruned vines may compensate for the RSG problem.

Irrigation
The drought conditions that prevailed across most vine growing districts of South Eastern Australia during 1994 was one common link in the occurrence of RSG. A lesser incidence of RSG occurred where growers had applied irrigations in July, August and September. Examination of tensiometer data from a Red Cliffs vineyard which did not apply irrigations during July – September shows just how dry soils became (Figure 2). The years 1982, 1972 and 1969 when “vine decline” symptoms appeared in Sunraysia and the Riverland were also dry during the winter months.

A more detailed summary of the survey results has been published on behalf of the RSG Taskforce by Mattscho (1995).

Figure 2. Tensiometer data from a Red Cliffs vineyard 1994.

Likely causes of restricted spring growth
From the literature reviewed and information gained from the survey, it is apparent that there is no single cause of RSG such as a new fungal or viral disease. While in some instances pathogens have been identified as the cause of growth problems, they are distinct from RSG. All the evidence points to a combination of unusual climatic, cultural and perhaps disease factors resulting in immature wood and insufficient starch reserves being accumulated before the onset of winter, making the vines less able to cope with the unusually dry and cold weather that prevailed before and during budburst.

Starch reserves
For their early growth, young shoots and bunches that emerge in spring are entirely dependent on starch stored before winter in the woody parts (roots, trunks, arms and mature canes) of the vines. If the level of starch reserves is inadequate, new spring growth will be slower and less vigorous.

The amount of starch stored by a vine depends on the amount produced by the vine during the growing period, the size of the vine framework and its starch storage capacity.

Most of the starch used for early shoot growth in the spring is produced from sugar generated by the leaves after harvest. Therefore it is important that the vine leaves remain active after harvest, and that shoot extension ceases to ensure that a build up of starch reserves will occur.

A sign that starch reserves are inadequate is when the new canes do not mature and harden off properly before winter.

Factors preventing normal maturation of starch growth include:
- Maintenance of vigorous growth into late autumn, caused by excessive nitrogen fertilisation and readily available soil moisture.
- A late flush of growth promoted by rain after dry conditions.
- Premature defoliation of late growth, caused by insects or disease.
- Lack of potash.
- Development of disorders, such as virus diseases, that upset the annual cycle of the vine.

Winter injury
Fully dormant vines of all varieties grown in Australia will withstand winter temperatures as low as -12°C. However, vines with poorly matured wood may be severely damaged or killed at less extreme (higher) temperatures. Winter chilling injury is most severe when the cold temperatures are preceded by periods of mild weather.

Temperatures in the Sunraysia and Riverland regions were well below average in 1994 with Loxton and Mildura having minimum July soil surface temperatures of -10°C (Figure 3) and -7°C respectively. The average soil surface minima for July and August in Loxton and Mildura were more than 2°C lower than the long term average (Figure 4). The number of days with negative soil temperatures were also higher than the long term average (Figure 5).

Compared to the cold July and August, June was relatively mild. This may have increased the susceptibility of the vines to cold injury in July and August. The buds and vascular conducting tissue are part of the vine most sensitive to cold damage. Often the damage will be confined to those vines in low-lying areas or vines with immature wood or low starch reserves.

Figure 3. Lowest monthly soil surface minima (Loxton).
Injury is often only found at ground level where temperatures are lowest. On such vines shoot growth may appear normal for much of the season. The first sign of injury occurs during February–April, when the shoots wilt and die. This is the result of the damaged vascular system supplying insufficient water needs to meet the increasing evaporative demand of the vine.

Vines with trunk injury often produce a large number of suckers. These suckers can be used to rebuild the vine framework. Grafted vines may be killed right down to the bud union and regrafting will be necessary. If the rootstock was strongly disbudded during propagation the whole vine will die.

Soil and root pathogens

Root pathogens can cause a range of similar growth related problems to RSG. Several root pathogens have been isolated from the roots of affected vines. However, no consistent pattern has yet been identified. While these pathogens may accentuate the RSG symptoms, they are not the prime cause. Further research into soil biology and mycology, and the interactions of various root pathogens and their relationships with RSG are to be carried out.

Mites

Bud mites in particular are known to kill basal buds and restrict growth on new shoots which subsequently results in fewer bunches. Rust mites can create similar symptoms. However, the significance of mites in causing RSG is unknown.

Recommendations

The key factors to avoiding or minimising the effects of RSG are to ensure that:

- Healthy leaves are maintained on the vine after harvest to lay down starch reserves.
- Vines are not defoliated in autumn by outbreaks of downy mildew and vine moth which may adversely affect carbohydrate production.
- The wood is well matured by avoiding autumn growth flushes. A growth flush may occur if an irrigation is delayed until after the soil is very dry. High levels of fertiliser application will also encourage new growth.
- Adequate soil moisture levels are maintained during winter.

Conclusion

The results of investigations and observations support the theory that RSG has been caused by a combination of factors that have contributed to an overall disturbance of the vine physiology. In particular, the unusual climatic conditions that were experienced throughout 1994 were likely contributors to RSG.

The symptoms of RSG have been observed in the past and undoubtedly will be seen again. The long-term effect of such conditions does not appear to be significant on those vines that have survived and produced adequate new growth.

It is not recommended that growers remove affected vines. However to minimise or prevent the problem of RSG occurring, it is critical for growers to maintain soil moisture levels during the dormant months if it appears to be a dry winter.

Editor’s Note: At the time of printing (July 1995) the areas affected by RSG in 1994 had experienced good early season rainfall, reducing the likelihood of RSG symptoms in 1995/96.

References


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Figure 4. Average monthly minimum soil surface temperature (Murray, 1994).

Figure 5. Number of days with negative soil temperature (Murray, 1994).