Figure 3. Multiple control measures are needed when botrytis risk is high. Based on the concept of P.A.G. Elmer (pers. comm.)

ACTION POINTS

The following ‘actions’ can aid selection of cost-effective control measures for a particular site:

1. Measure botrytis severity at harvest objectively and obtain winery feedback on the impact of the botrytis level on wine making.

2. Establish a systematic process at each crop stage to identify site-specific factors contributing to botrytis risk.

3. Set targets for acceptable botrytis control (zero tolerance or less than 5% severity?). If these targets cannot be met consistently in particular areas of a block, then review management or consider removing vines or changing grape variety.

4. Implement cost-effective control measures that address the key factors that increase botrytis risk at a particular site. Production of high quality grapes to target yields requires appropriate canopy management and judicious use of inputs for vine balance. These viticultural practices alone will contribute significantly to the management of botrytis bunch rot.

References


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Botrytis bunch rot, or botricolosis, is a weather-induced disease that can cause significant losses of grape yield and quality, even after application of a full program of fungicides. This fact is a direct threat to the viability of many grape-growing regions. Biologists have discovered that botrytis is caused by a common environmental fungus, Botrytis cinerea. Effective prevention of this disease can be achieved by implementing cultural practices to lower disease pressure in the vineyard, and then reducing disease pressure at flower and fruit stages. Factors that promote botrytis development

How does botrytis invade grape tissue? Botrytis infections occur at wounds or natural openings, including microfissures in the berry skin and wounds caused by insects, powdery mildew, berry splitting, loose pedicels or other physical damage. Spore penetration is stimulated by wounds and wounds initiate exit wounds from opening berries. The fungus secretes enzymes to help it to penetrate tissue in order to colonise the infection site and absorb nutrients from the dead tissue. Any developing injury, especially damaged berries, deceased fruit and crop debris, is a prime target for botrytis colonisation at subsequent open wounds. How then, can the first infections of sour grapes or green bunches be avoided?

Symptom development and types of epidemic

When ‘latent’ botrytis lesions mature into a visible bud rot, they can spread between berries in bunches, often rapidly in compact bunches of thin-skinned varieties.lesions, the increase in disease severity after symptom appearance shows distinct patterns that allow predictions of the future course of the epidemic. Predictions models, under development, can aid decisions about in-season management and harvest date.

Pathogens Factor Types of infection

Factors that promote botrytis development

Table 1 summarises the main pathogen, vine and environmental factors that are correlated to botrytis severity at harvest. Asymptomatic infections resulting in botrytis symptoms are correlated to the duration of immature berry.-

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Botrytis bunch rot, or ‘botrytis’, is a weather-driven disease that can cause significant loss of grape yield and quality, Botrytis bunch rot, or ‘botrytis’, is a weather-driven disease that can cause significant loss of grape yield and quality, and is a prime target for botrytis control on hides, however it is also affected by surface wetness, provided by rain, fog, dew or mist. Frequent rainfall, or prolonged periods of wet bunches, can provide significant additional control when timed well. Fungicides can also be applied at veraison and pre-harvest, if disease severity is still low and there are no restrictions on the fungicide selected. If the flowering period is extended, then spray before veraison.

Pathogens/factors
- **Botrytis** severity in the previous season and the amount of botrytis tissue at harvest when weather favours the disease. Disease severity can increase by 1-2% per day near harvest, highlighting the importance of management decisions made early in the season.
- **Environmental factors**
  - Temperature, relative humidity and wind speed in the fruiting zone microclimate
  - Leaf layer number in fruiting zone
  - Excessive vigour
  - Bunch crowding
  - Variety susceptibility to berry splitting & loose pedicels

**CONTROL POINTS**
- **Limit re-growth of latent infections**
  - Remove leaves around bunches when leaf layer number is high and fruit exposure is suboptimal.
  - Minimise berry wounding by controlling LBAM and powdery mildew.
- **Reduce spore load**
  - Avoid planting highly susceptible varieties in thin-skinned varieties with compact bunches in humid canopies carrying high crop loads.
  - Consistent and effective botrytis management to reduce the level of spores in the vineyard floor.

**How does botrytis invade grape tissue?**
Botrytis infests grape tissue via wounds and natural openings, including microtissues in the berry skin and wounds created by insects, mycelia, powdery mildew, berry splitting, loose pedicels or other physical damage. Spore penetration is stimulated by sugars and amino acids exuded from opening berries.

**Symptom development and types of epidemic**
- **Wet** (latent) botrytis means its incidence is widespread, it can spread throughout the bunch and is a prime target for botrytis control on hides, however it is also affected by surface wetness, provided by rain, fog, dew or mist. Frequent rainfall, or prolonged periods of wet bunches, can provide significant additional control when timed well. Fungicides can also be applied at veraison and pre-harvest, if disease severity is still low and there are no restrictions on the fungicide selected. If the flowering period is extended, then spray before veraison.

**Factors that promote botrytis development**
Table 1 summarises the main pathogen, site, and environmental factors that are correlated to botrytis severity at harvest. The key weather variables are temperature and the duration of surface wetness. Disease development can be correlated to the interaction of these factors, with the optimal temperature in the range 18-21°C. Longer wetness periods are needed to achieve the same level of infection at sub-optimum temperatures. The interaction between the temperature and duration of surface wetness on botrytis development is described by the Biomec or_Biomec Biomec (Boswell 1998; Boswell et al. 2007).

**Integrated botrytis management**
Integrated botrytis management is about manipulating the bunch microclimate for minimal relative humidity and rapid drying of bunches. It is more effective to target the fruit zone after harvest, than to attempt to increase the timing of the infection. The interaction between the temperature and duration of surface wetness is the key factor in determining the amount of disease.

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Botrytis infects grape tissue via wounds and natural openings, including microtissues in the berry skin and wounds created by insects, mycelia, powdery mildew, berry splitting, loose pedicels or other physical damage. Spore penetration is stimulated by sugars and amino acids exuded from opening berries. The fungus secretes enzymes to kill plant tissue in advance of its growth. Spores constitute the grey (brown) tissue at the tip of the torus is exposed, providing an entry point for botrytis. After entry, fungal growth is stopped by a high concentration of ethanol produced by the fungus. The fungus then ceases to grow and loses its vegetative state. At this time, the concentration of fungal spores begins to slowly decline, allowing botrytis to colonise the dead and damaged tissue.

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Botrytis bunch rot, or ‘botrytis’, is a weather-driven disease that can cause significant loss of grape yield and quality, even after application of a full program of fungicides. This fact alone testifies to how Botrytis develops; critical control points and integrated management measures needed for high risk situations.

**Sources of infection**

Botrytis is caused by the common environmental fungus, Botrytis cinerea. Important sources of spores that initiate infections in Botrytis cinerea Botrytis is caused by the common environmental fungus, even after application of a full program of fungicides. This Botrytis bunch rot, or ‘botrytis’, is a weather-driven disease or other physical damage. Spore germination is stimulated Botrytis infects grapevine tissue via wounds and natural entry points for Botrytis. (Photo: M. Longbottom, University of Adelaide)

**Factors that promote botrytis development**

Table 4 summarises the main pathways, view and environment factors that are correlated to Botrytis severity. The key weather variables are temperature and the duration of surface moisture. The ability of the fungus to germinate on the grape berry after latency and not all infections lead to a rotten berry. The proportion of latent infections is correlated to botrytis severity at harvest. The severity can increase by 1-2% per day near harvest, highlighting the importance of harvest date as a management tool.

**Integrated botrytis management**

Integrated botrytis management is about manipulating the bunch zone microclimate for reduced humidity and rapid drying of bunches in humid canopies carrying high crop loads. Figure 4 illustrates the level of sunburn.

**Botrytis severity in the previous season and the amount of botrytis carried over to the next season**

**Pathogen factors**

Botrytis severity in the previous season and the amount of spores in the vicinity of susceptible grapevine tissue.

**Environmental factors**

Temperature, relative humidity, wind speed and wind direction that determine the duration of surface moisture.

- **Leaf exposure**
  - Temperature: low temperatures increase exposure to leaf burn.
  - Humidity: high humidity favours the development of leaf burn.
  - Wind speed: high wind speeds reduce leaf burn by removing moisture from the leaf surface.

**Bunch zone microclimate**

- **Temperature:** low temperatures increase exposure to leaf burn.
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**CRITICAL CONTROL POINTS**

The key control points for managing botrytis. Each control point is vital for both physical management measures (all of which may only apply to certain regions and/or grape varieties). Selection of a management strategy will depend on objectives for grape yield and quality, the level of control in relation to the price of grapes.

- **Reduce spore load**
  - Consistent and effective fungicide management to reduce botrytis spores from season to season.
  - Minimal de-rosetting of ane defects that reduces spore production/bunch pollution.

- **Reduce flower & infection**
  - Avoid planting highly susceptible varieties in low lying areas with drainage or near water bodies.
  - Drip store areas for good drainage down the rows.
  - Preventive fungicides can be applied at seedling stages.
  - Critical application times for preventative fungicides are at 80% BCP and at seedling stage, the best opportunity for good coverage inside the bunch.

- **Botrytis risk**
  - High disease risk can also be assessed at veraison and pre-harvest, if disease severity is still low.
  - Rain impact on spray efficacy. Implement a fungicide resistance management strategy and pay attention to maximum residue limits and withdrawing periods.

- **Botrytis severity in the previous season and the amount of botrytis carried over to the next season**

**Symptom development and types of epidemic**

When latent ‘botrytis’ becomes evident as a population, it can spread faster though the berry, with rapid development of bunch infections in the vineyard. Injury,

**How does botrytis invade grape tissue?**

Botrytis enters grapefruit tissue through natural openings, including microscars in the berry skin and wounds inflicted by moths, pink bollworm larva, blister psyllid or other physical damage. Spore penetration is stimulated by sugars and amino acids exuded from opening berries. The fungus secretes enzymes to kill plant tissue in advance of its colonisation and absorbs nutrients from dead tissue. Any decaying grape tissue, especially damaged berries, decalculated petals or malformed bunches, is a prime target for Botrytis colonisation at susceptible entry points in the grape berry. Spores are released from wounds, decaying floral parts: caps, infected, damaged leaves or other plant parts, and can also be dispersed as a result of antifungal compounds. How then, can the first infections of such scores green flowers and green, hard berries?

**Spore conidia**

Cluster of spores on green grapes (widely dispersed on immature fruits).

**Spore conidia**

Clusters of spores on grapes (widely dispersed on immature fruits). Spore conidia are formed and dispersed on mature leaves and stems when temperature and humidity are high. Free water is needed for the spore to germinate and high relative humidity may be sufficient to cause condensation of water inside tissues such as flowers. 'Botrytis' infections occur, with the optimum temperature in the range 16-21°C. Longer winter periods are needed to achieve the same level of infection at sub-optimal temperatures. The interaction between the temperature and duration of surface water on botrytis severity is described by the Brooks or Buchan model (Broce et al. 1995; Etten et al. 2007).

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Figure 3. Multiple control measures are needed when botrytis risk is high. Based on the concept of P.A.G. Elmer (pers. comm.)

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Production of high quality grapes to target yields requires appropriate canopy management and judicious use of inputs for vine balance. These viticultural practices alone will contribute significantly to the management of botrytis bunch rot.

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