

Botrytis management

Integrating site-specific measures at critical control points

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Outline

1. How does botrytis develop?
2. Critical control points
 - What's in the tool box?
3. Integrated botrytis management
 - Monitor, Analyse, Plan, Act
 - Actions by crop stage

What causes botrytis?

- *Botrytis cinerea*
- A common environmental fungus
- Infects many flowering plants
 - inter-row weeds, shelter belts



Other fungi damage bunches

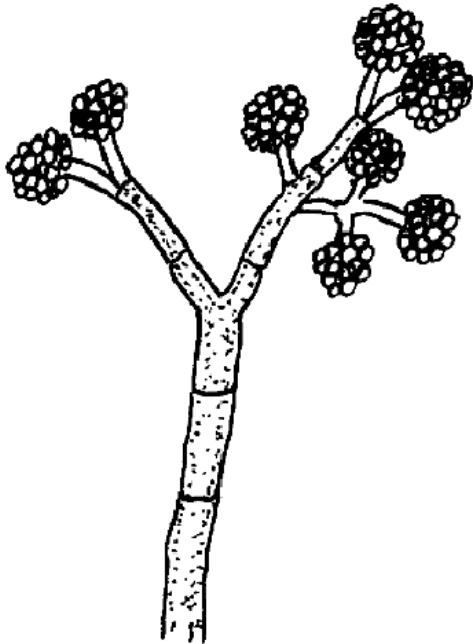
- *Alternaria*
- *Aspergillus*
- *Cladosporium*
- *Colletotrichum*
- *Greenaria*
- *Penicillium*
- *Rhizopus*
- and more



Penicillium & Botrytis
on Riesling berries

Is the rot botrytis?

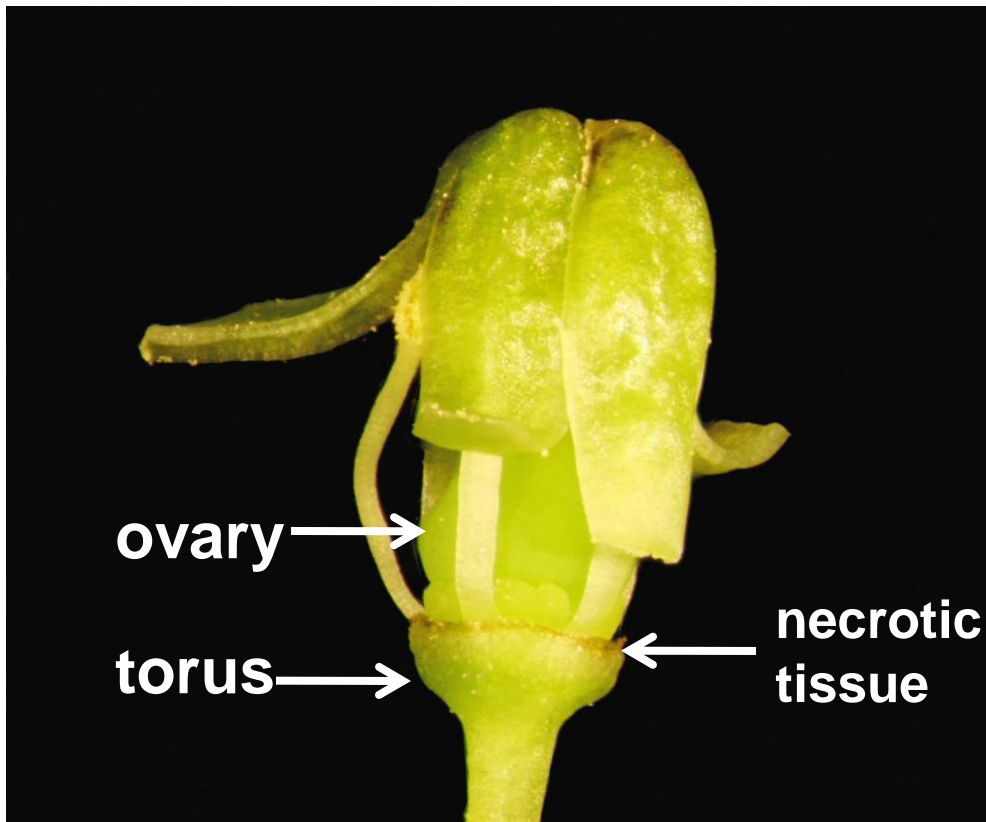
Branched dark stalks bearing clusters of colourless or grey spores called conidia



How does botrytis infect?

- Berry cuticle an effective barrier
- Via wounds & natural openings
 - microfissures in berry skin
- Secretes enzymes to kill plant tissue
 - absorbs nutrients from dead tissue
- Colonises decaying tissue
 - floral parts, leaves, tendrils, petioles, canes
 - ripening berries, bunch remnants

Flower infection



- Natural spore trap in the gap between the ovary and torus (receptacle)
- Necrotic tissue at the tip of the torus exposed when cap falls

Latent infection

- Occurs in flowers or green, hard berries
- After entry, fungal growth is stopped
 - by high concentrations of antifungal compounds
- Fungal growth resumes during berry ripening
- Latent infections established during flowering and berry development

When does botrytis grow fast?

- Low concentration of antifungal compounds
 - ripening berries
 - cap scar region of flower
 - decaying tissues
- High sugar content
 - ripening berries



Green fruit rot “rare”



Extraordinarily high botrytis risk
Hunter Valley 2007-2008

Major sources of spores

Within vine canopy & vineyard floor

Previous season	Current season
cane debris bunch remnants tendrils leaf petioles & blades	damaged leaves floral parts: caps, aborted berries rotting berries



Spore dispersal

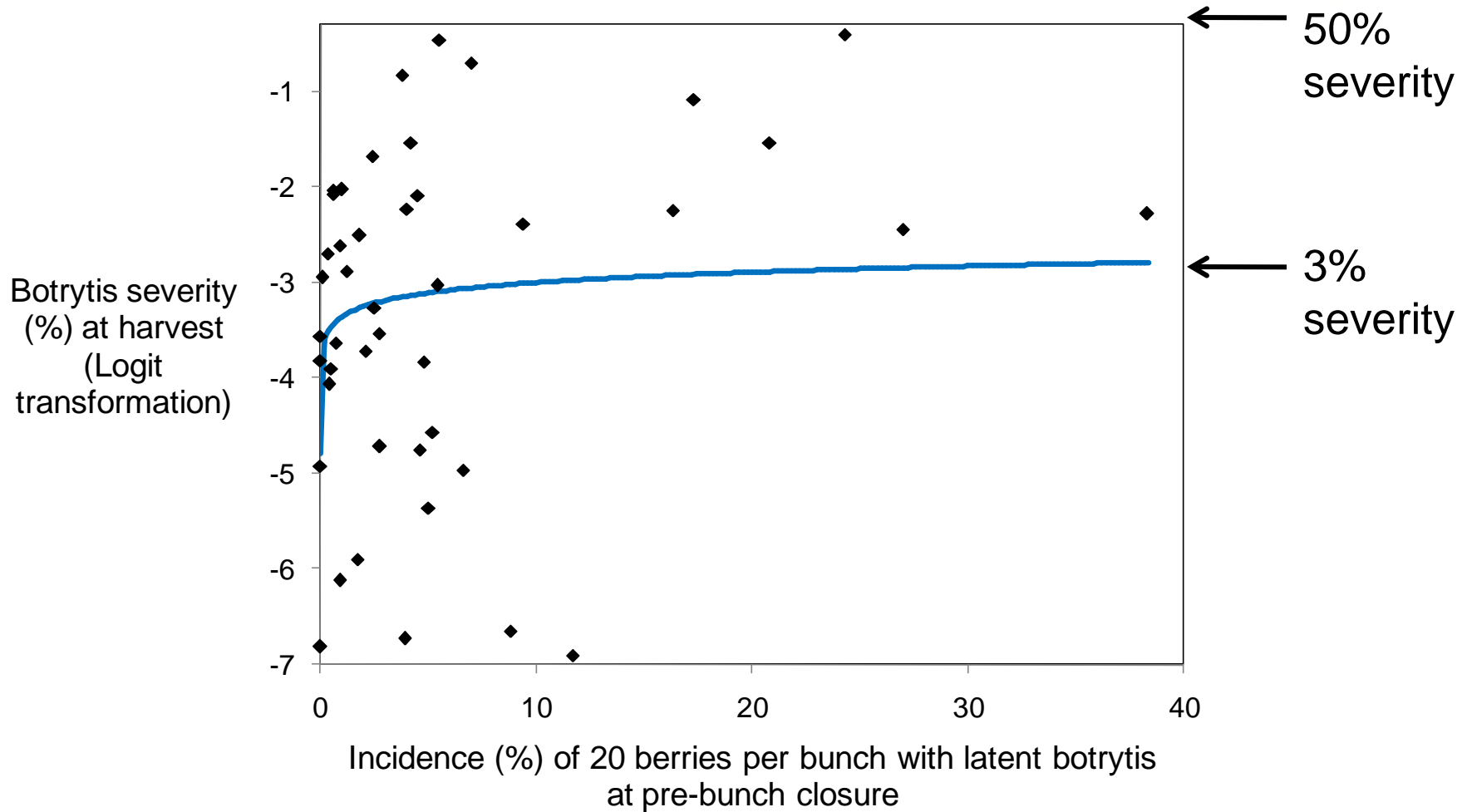
- Windborne spores
- Rain splash
- Light brown apple moth (LBAM) and other insects transport spores between berries/bunches



Spore germination

- Optimum: 18 – 21°C
- A film of free water on plant surface
 - rain, dew, mist, fog
 - condensation in flowers at high humidity
- Sugars, amino acids exuded from plant tissue
 - promotes spore germination
 - berries become ‘leaky’ as they ripen

More latents = more botrytis?



Data from non-treated plots in New Zealand, Tasmania & Yarra Valley, Victoria. ¹⁴

Re-growth after latency

- Not all latent infections lead to rotten berries
- The proportion of latent infections in which botrytis resumes growth is poorly characterised, but is correlated to
 - high relative humidity
 - high soil moisture (pot trials only)

How does botrytis spread?

- Berry to berry
 - after latency or after direct berry infection
 - thin skins and more pores where berries touch in compact bunches
- Bunch to bunch
 - direct contact (bunch crowding)
 - secondary spread of spores from mouldy bunches

Compact bunches: rapid spread



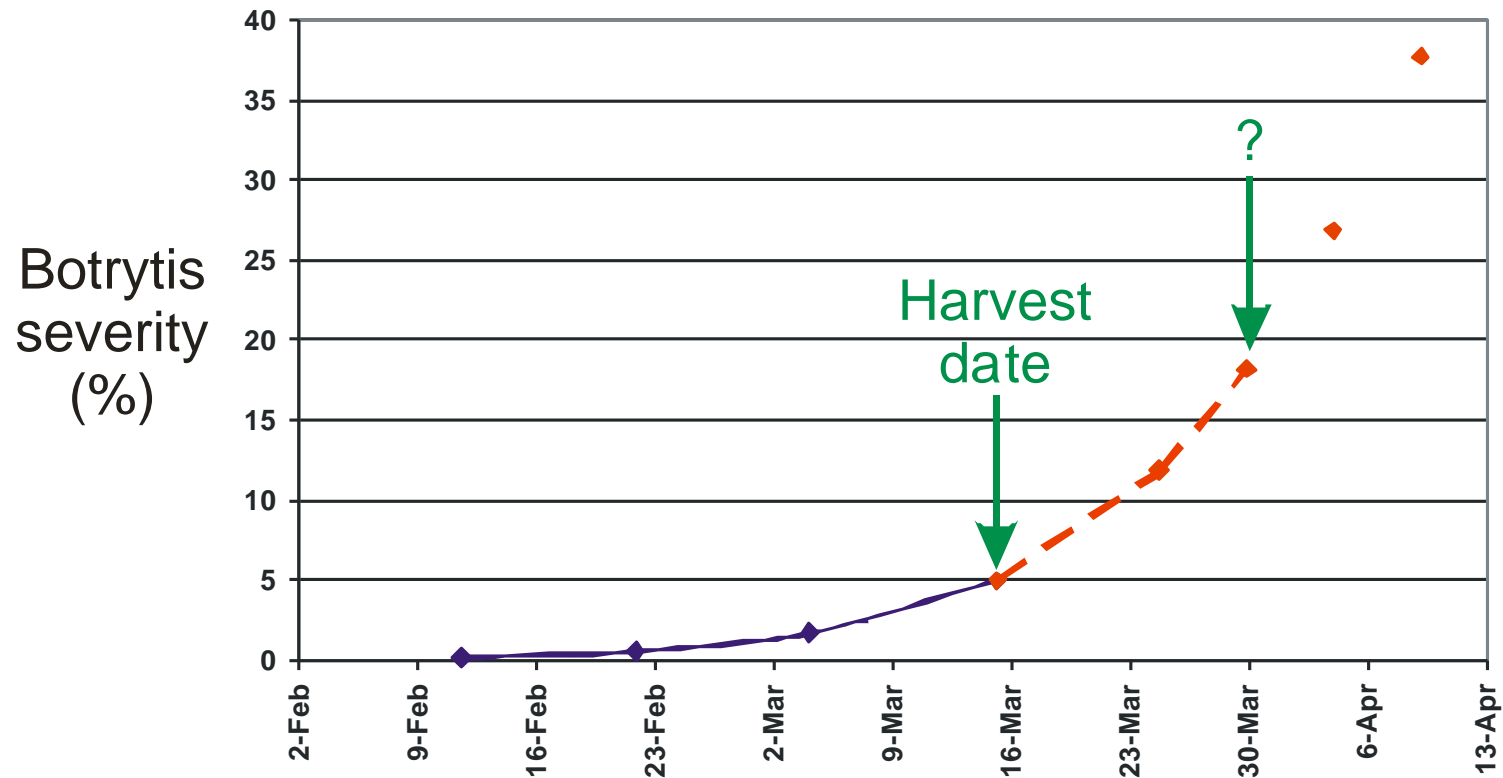
Schematic representation of a rotten berry with botrytis in a compact (Sultana) bunch (left) and an open (Sun muscat) bunch (right). Botrytis moves quickly from berry to berry in compact bunches.

Crowded bunches: rapid spread



Riesling, Tasmania

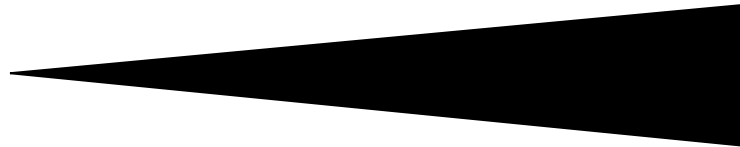
Severity determined by harvest date



Summary: botrytis development

veraison

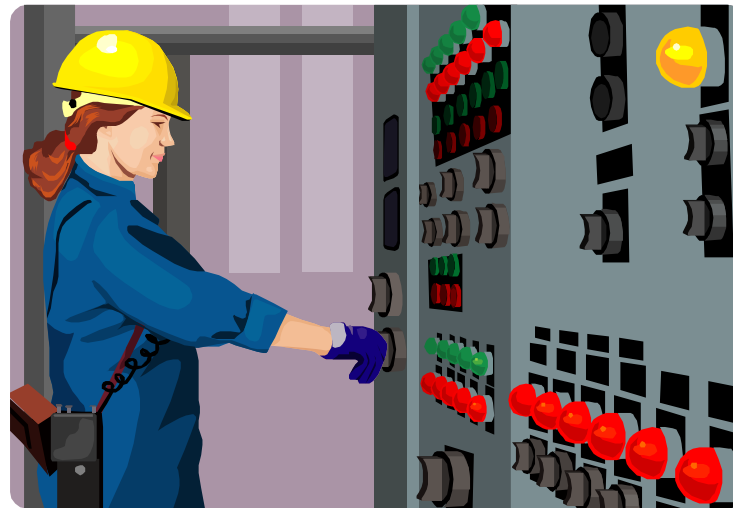
harvest



1. Latent *B. cinerea* resumes invasion of grape berry
2. Direct berry infection
3. Berry-to-berry spread
4. Bunch-to-bunch spread

Critical control points

What's in the tool box?

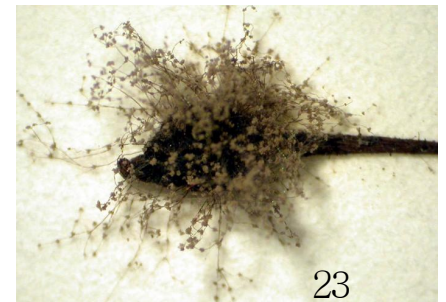


Critical control points

1. Reducing spore load
2. Minimising flower & fruit infection
3. Limiting botrytis re-growth after latency
4. Limiting spread when symptoms appear

Reducing spore load

- Microbial decomposition of vine debris
NZ trials with mulch:
 - reduced spore production on vine debris
 - increased soil biological activity
- More open bunches that trap less trash
 - spore source for fruit infection



Minimising flower infection

- Apply protective fungicide at 80% capfall
 - when most cap scars are exposed
- Extended flowering – more sprays?
 - monitor capfall & weather to aid timing
 - apply fungicide before a rain event
- Improve spray coverage of inflorescence
 - reduce sprayer air speed?



Reducing fruit infection - I

Variety x site, & row orientation

- Avoid planting highly susceptible varieties in
 - low lying, sheltered areas with poor air drainage
 - next to large bodies of water
- Orientate rows for
 - good airflow down the rows



Reducing fruit infection - II

Minimise wounding

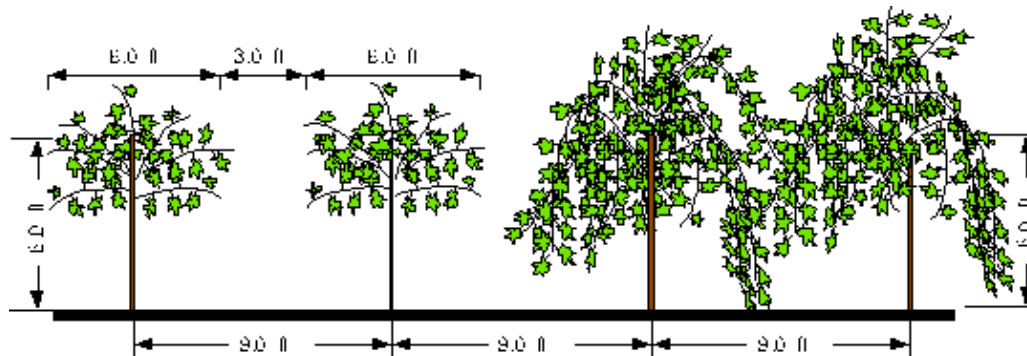
- Control light brown apple moth
 - especially important when weather conditions are 'marginal' for botrytis
- Control powdery mildew
- Prevent berry split
- Lift wires carefully



Reducing fruit infection - III

Reduce excessive vigour

- Alter microclimate in fruiting zone
- Check vine balance
 - e.g. yield to pruning weight ratios
- Adjust node number at pruning
- Review trellis type
 - if replanting, consider low vigour rootstocks



Reducing fruit infection - III

Reduce excessive vigour (continued)

- Fertiliser & water inputs
 - use nutritional analyses & moisture monitoring
- Remove water shoots (desucker)
- Prevent excessive lateral growth
- Plant competitive inter-row crops
 - Caution: crop height can influence frost risk



Reducing fruit infection - IV

© Leaf removal around bunches

- when leaf layer number is high
- 70% fruit exposure often appropriate
 - can be achieved without any leaf removal
- timing & extent can also influence
 - berry sugar, pH and titratable acidity
 - phenolic concentration in white grapes
 - level of sunburn (sudden exposure of shaded fruit)



Reducing fruit infection - V

What's in the tool box?

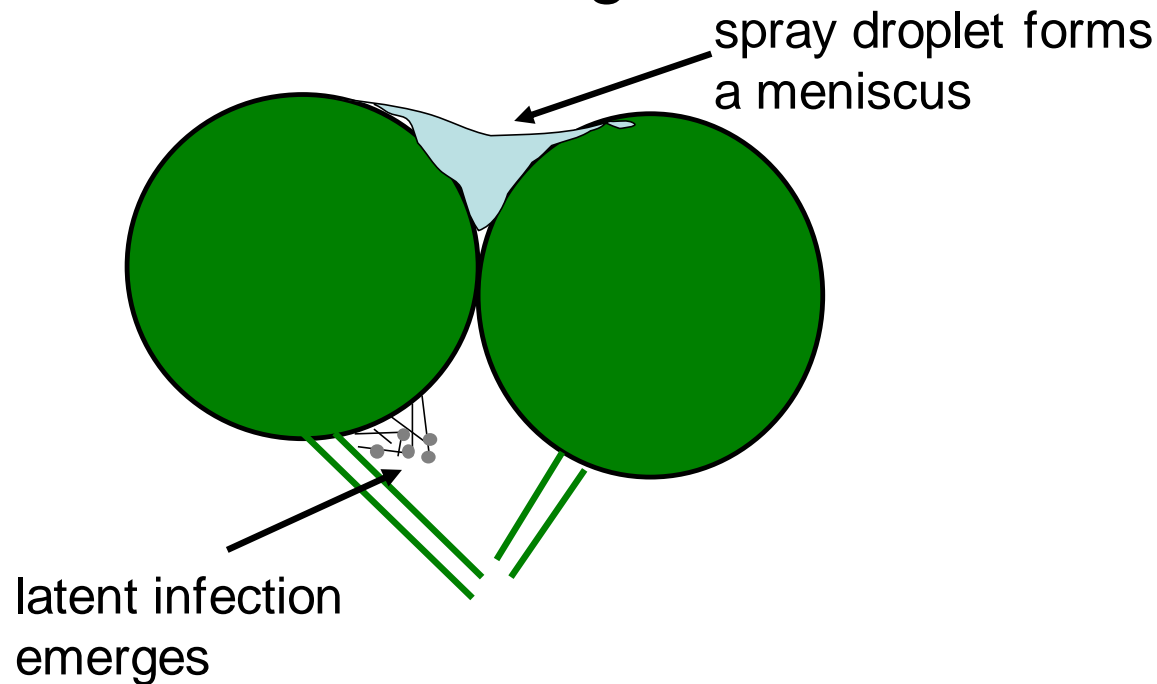
Timing protective fungicides after flowering

- Pre-bunch closure (see next slide)
 - a critical spray time in many regions
- Veraison
 - at high risk sites
 - before berries become increasingly susceptible
- Pre-harvest
 - if botrytis risk is high but severity is still low



Good coverage at PBC

Pre-bunch closure is the last chance for good spray coverage inside the bunch where latent infections often emerge



Latents: limiting re-growth

Risk factors

- high relative humidity
- high soil moisture?



Pre-veraison berries
frozen & moist incubated
to force growth of
latent botrytis

Latents: limiting re-growth

- Prevent excessive soil moisture
 - adequate drainage
 - vineyard floor management
 - appropriate irrigation
- Lower humidity in the fruiting zone
 - canopy management
 - prevent pooling of water in wheel ruts



Limiting disease spread - I

Reduce bunch compactness

- Minimal pruned vines versus mechanical hedging and cane pruning
 - smaller, less compact bunches
 - bunches dispersed through more open outer canopy
 - reduced congestion in bunch zone
 - Caution: when bunch numbers per vine are lower than average, bunches may be larger & more compact



Limiting disease spread - I

Reduce bunch compactness (continued)

- In dry climates, control berry size by deficit irrigation
- © reduce fruit set if high berry number expected
 - leaf removal during early berry development
- © chemical flower ‘thinning’ or rachis lengthening?



Limiting disease spread - II

Reduce bunch crowding

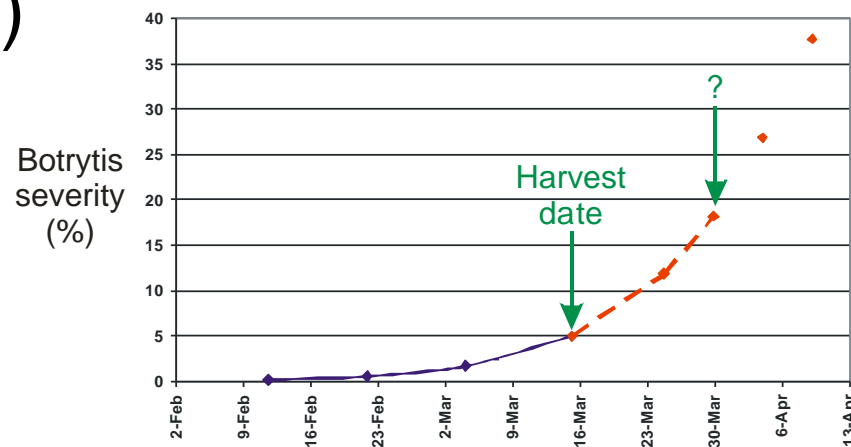


- Measure & manage yield potential
 - estimate bud fruitfulness to set pruning level
 - reduce bud number if vine balance maintained
- ©shoots can be thinned pre-flowering
 - Caution: remaining shoots may grow more vigorously
 - remove shoots in congested areas: crown, trellis posts, uneven spacing.
- ©bunch thin, if necessary

Limiting disease spread - III

Monitoring & harvest date

- Monitor for botrytis symptoms
- Harvest early if botrytis risk high
- Future tool: a model that predicts botrytis severity at harvest (updated daily from capfall)



Harvest date & crop load

- An early harvest can help ‘escape’ autumn rains and severe botrytis
- © Reducing crop load can advance harvest date
 - berry sugar reaches a higher level earlier

CAUTION:

Botrytis severity may be higher, not lower, if ‘early’ rainfall occurs at a high sugar content

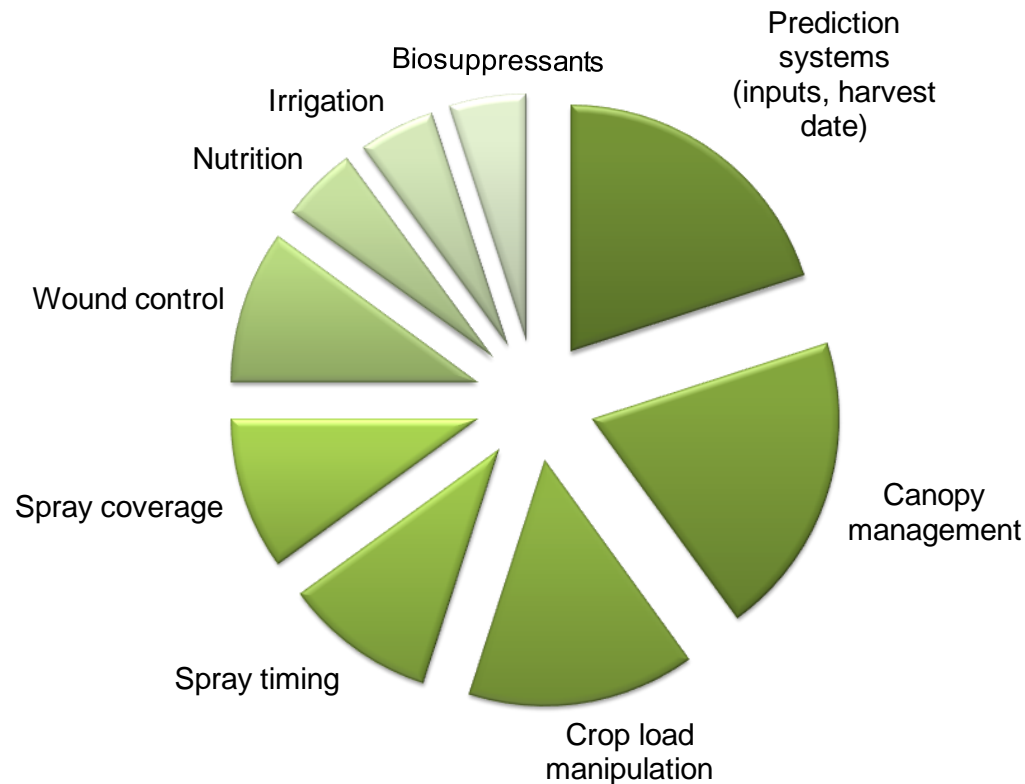
- interactions between berry sugar, weather & botrytis development are complex

Summary: control points

- Manipulating bunch zone microclimate
 - many ways to achieve the same end result
 - reduces reliance on fungicides
 - open canopies improve coverage
- Fungicides provide additional control
 - pre-bunch closure a critical spray time
 - limited options for late season control
 - pay attention to coverage, MRLs, resistance mgmt
- Wounding & bunch crowding worsen situation
- Monitor & harvest early if botrytis risk high

Integrated botrytis management

Selecting the right tools from the tool box



Integrated botrytis management



- Monitor
 - evaluate botrytis management
- Analyse
 - systematic process to identify risk factors
- Plan
 - set targets for acceptable control
 - make cost-effective selections from the tool box
- Act
 - check action required for each crop stage

Winter

- Botrytis severe last season?
- Excessive vigour last season?
- Other contributing factors?
- Plan botrytis management
 - winery specifications?
 - high or low input?
 - powdery mildew & LBAM
 - vineyard floor, drainage
 - nutrition & soil moisture
 - estimate bud fruitfulness to set pruning level



Bud burst to pre-flowering

- Estimate yield when inflorescences visible
- Remove water shoots (desucker)
- Monitor level of leaf damage
 - source of botrytis spores
- Excessive vigour?
- Calibrate sprayer & check coverage



Capfall

- Monitor duration of flowering & capfall stages
- Long flowering periods:
 - monitor weather, spray before it rains
- If spraying at 80% capfall, don't miss it!
- Lower sprayer airspeed



Fruit set to pea-size berries

- ©Bunch thin, if necessary (yield potential)
- Note amount of trash trapped in bunches
- Start monitoring for berry damage



Pre-bunch closure

- Last chance for good spray coverage inside the bunch
 - use you best fungicide
 - ©leaf removal? If yes, do it before spraying
- Continue monitoring for berry damage



Veraison

- Spray if botrytis risk is high
 - Continue monitoring for berry damage
- © If bunch thinning, aim to reduce bunch congestion



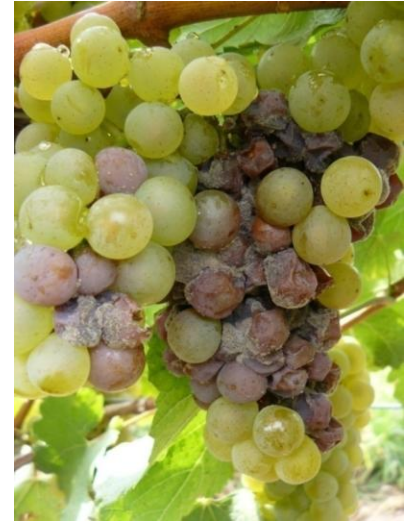
Pre- and post harvest

Pre-harvest

- Assess botrytis severity
- Remove bunches with grey mould

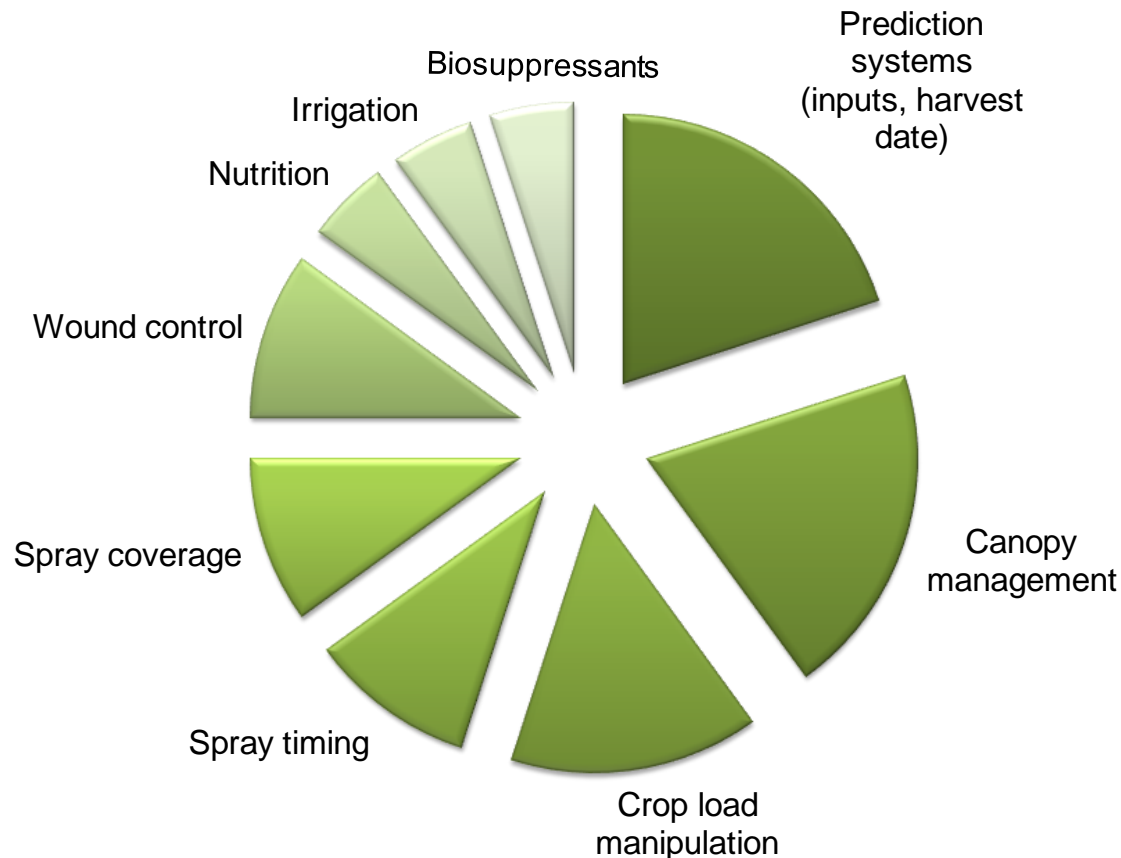
Post harvest

- Obtain feedback from winery
- Identify causes of botrytis 'hot spots'
- Review site history
 - one-off failure or a consistent problem?
 - remove vines in consistent problem areas?



Integrated Botrytis Management

Multiple measures needed for high risk seasons



Based on the vision of P.A.G. Elmer (pers. comm.)

Take home messages

- Botrytis risk is highest in thin-skinned varieties with compact bunches in humid canopies carrying high crop loads
- Monitor, Analyse, Plan, Act for
 - balanced vines, target grape yield & quality
 - strategic fungicide use and market access
- Very favourable weather for botrytis can undo your best efforts
 - track disease progress & harvest early

Finally.....

The END is the beginning....

“If you do not change direction you may end up where you are heading”

Lao Tzu, 600-531 BC

Acknowledgements



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