

# Management Responses to Frost Damage in Vineyards

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# Spring Frost Damage

# Spring Frost – Cultivar and Pruning

Early budbreak cultivars are most susceptible to Spring frost damage

- Examples:
  - i. Viognier
  - ii. Grenache

Climate change may be leading to earlier budbreak than before

- Strongly influenced by winter temperatures  
'Quiescence'





# Changes in Phenological Timing

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In Central Europe the impact of warming climates has been documented in Bernáth et al. 2022 (pre-print)

Between 1985 and 2018

- Budbreak: 5-7 days earlier
- Flowering: 7-10 days earlier
- Berry maturity: 18 days earlier
- Harvest: 8-10 days earlier



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# Spring Frost – Damage Assessments

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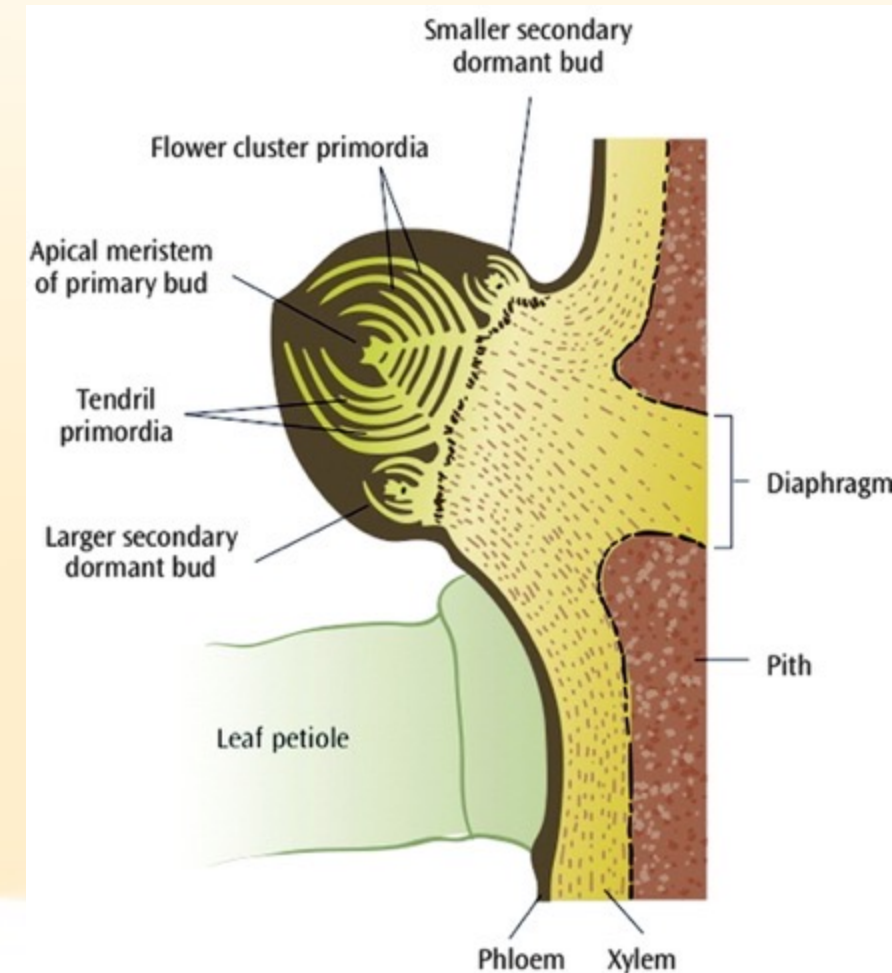
## Affected Tissue Types

- Green tissues most impacted
  - i. Dormant Buds
  - ii. Shoots
- Permanent wood can also be impacted, but less common
  - i. Typically occurs in cold-sensitive cultivars
  - ii. Influenced by diseases (i.e., Crown Gall)

# Assessing bud injury impact

## Dormant Buds

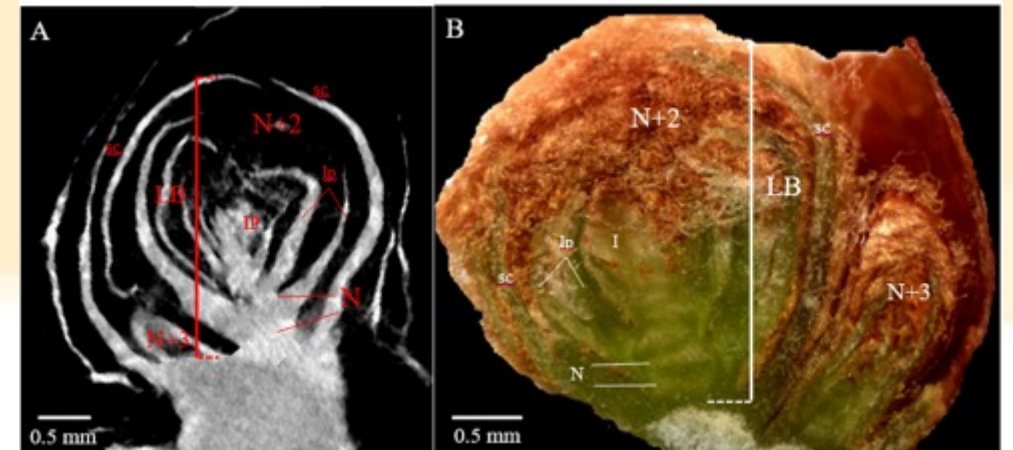
- Three buds within each dormant bud
  - i. Primary (1°)
  - ii. Secondary (2°)
  - iii. Tertiary (3°)
- Clusters and shoots are *preformed* in these buds
- Bud-dissections can help determine the viability of each bud
- Recommended = 60-100 buds/acre/cultivar



# Assessing bud injury & potential impact

## Dormant Buds

- This method can be used in a *preventative* or *responsive* way
  - i. Preventative – Help determine how many buds to leave in case of frost
  - ii. Responsive – Estimate remaining crop after late-spring frosts





# Assessing shoot damage

## Active Shoots

- Frost results in visible damage
  - i. Browning of shoots
  - ii. Wilting
  - iii. May take a few days to show
- Impact
  - i. No shoots = no clusters
  - ii. Reduces annual vigor of the vine





# Spring Frost – Damage Assessments

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## Permanent Wood (Trunk/Cordon)

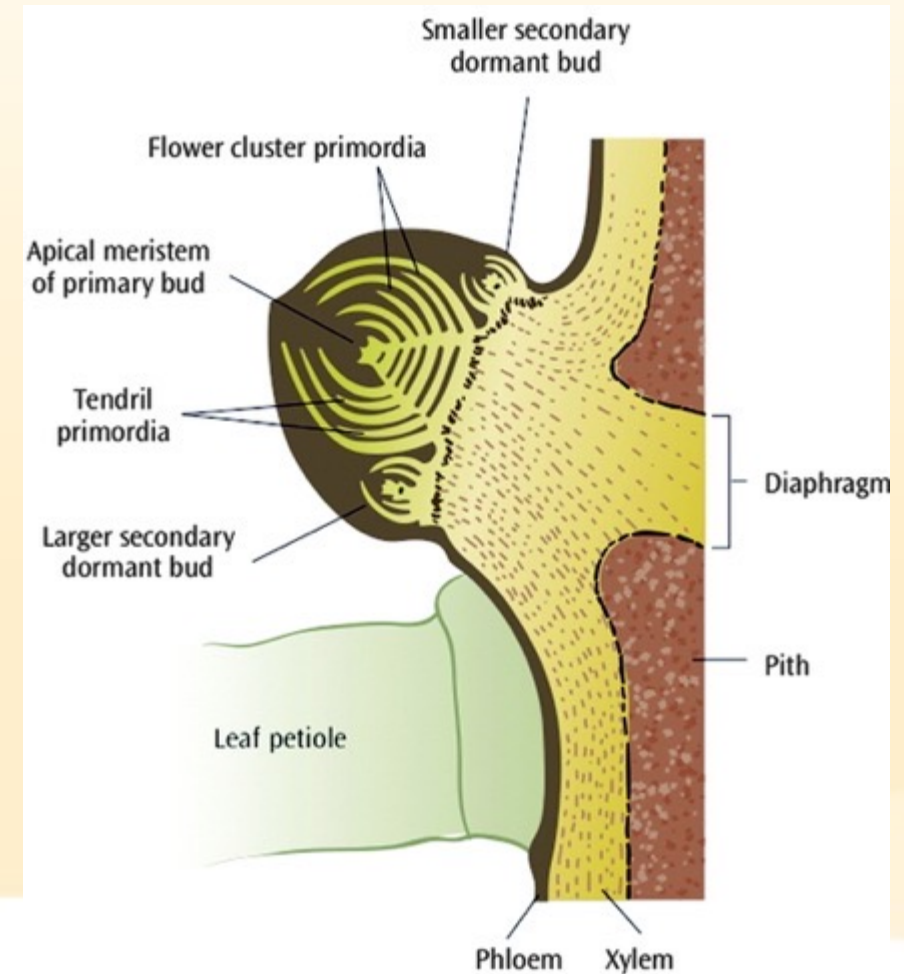
- Often not as visible in the field
  - i. Phloem might be damaged
  - ii. Results in low vigor in subsequent years
- Trunk or Cordon Splitting may occur
  - i. Hard freezes can result in splitting
  - ii. Creates a point of infection for diseases

# Managing Frost Injury

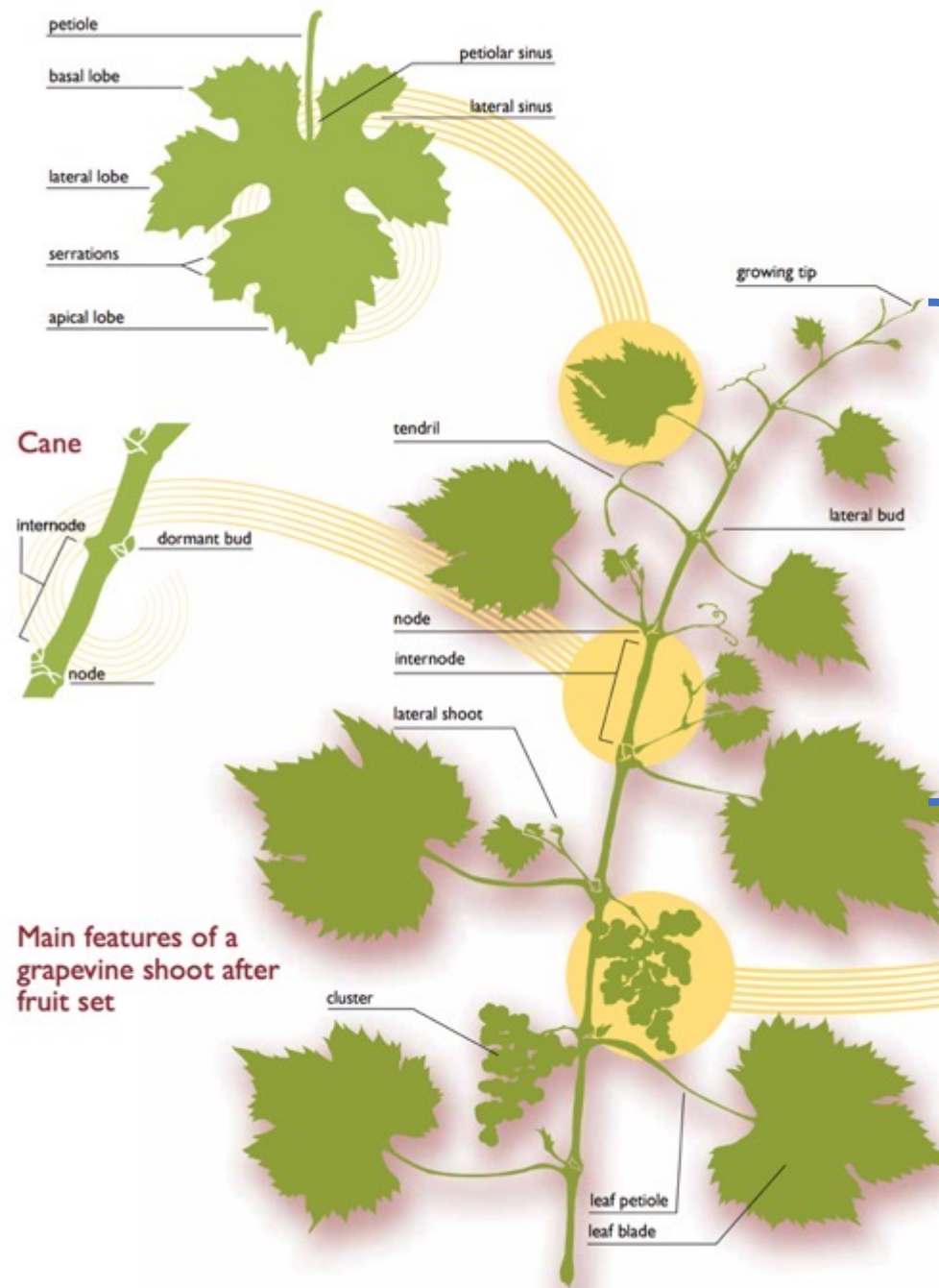
Sometimes inaction can be beneficial

- Some cultivars can still produce fruit
- Some buds may still be intact
- Shoots may not be complete loss

Overcompensating with severe pruning can result in stressed vines and reduce overall vine performance in subsequent years.



Typical vinifera grape leaf with five lobes

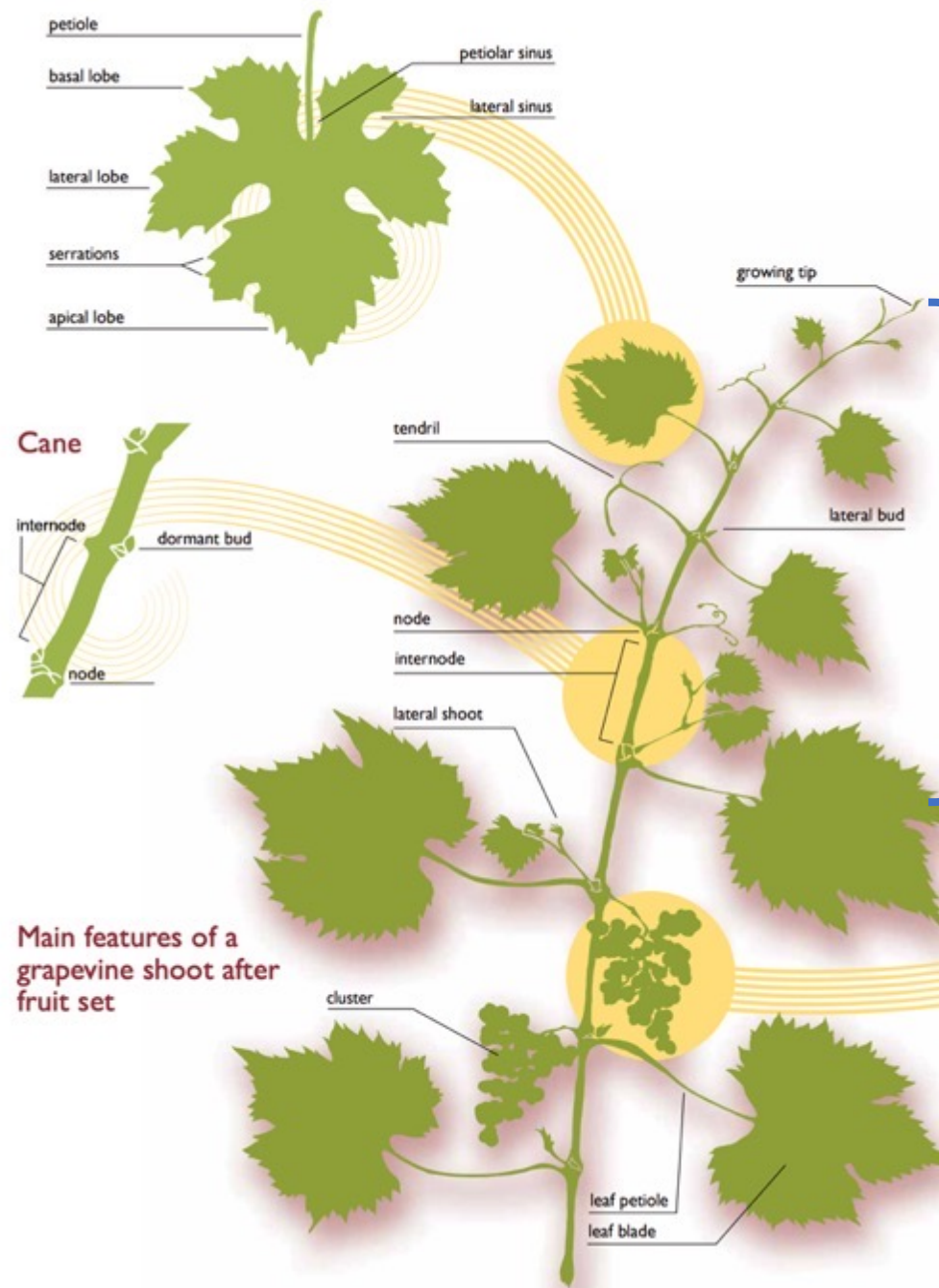


# Managing Frost Injury – No Action

## No Action

- If shoot damage stops before fruiting-nodes the shoot will likely recover.
- If the shoot is not entirely killed by frost it might recover
- Clusters are preformed in the dormant bud between nodes 4-6 (typically)

Typical vinifera grape leaf with five lobes

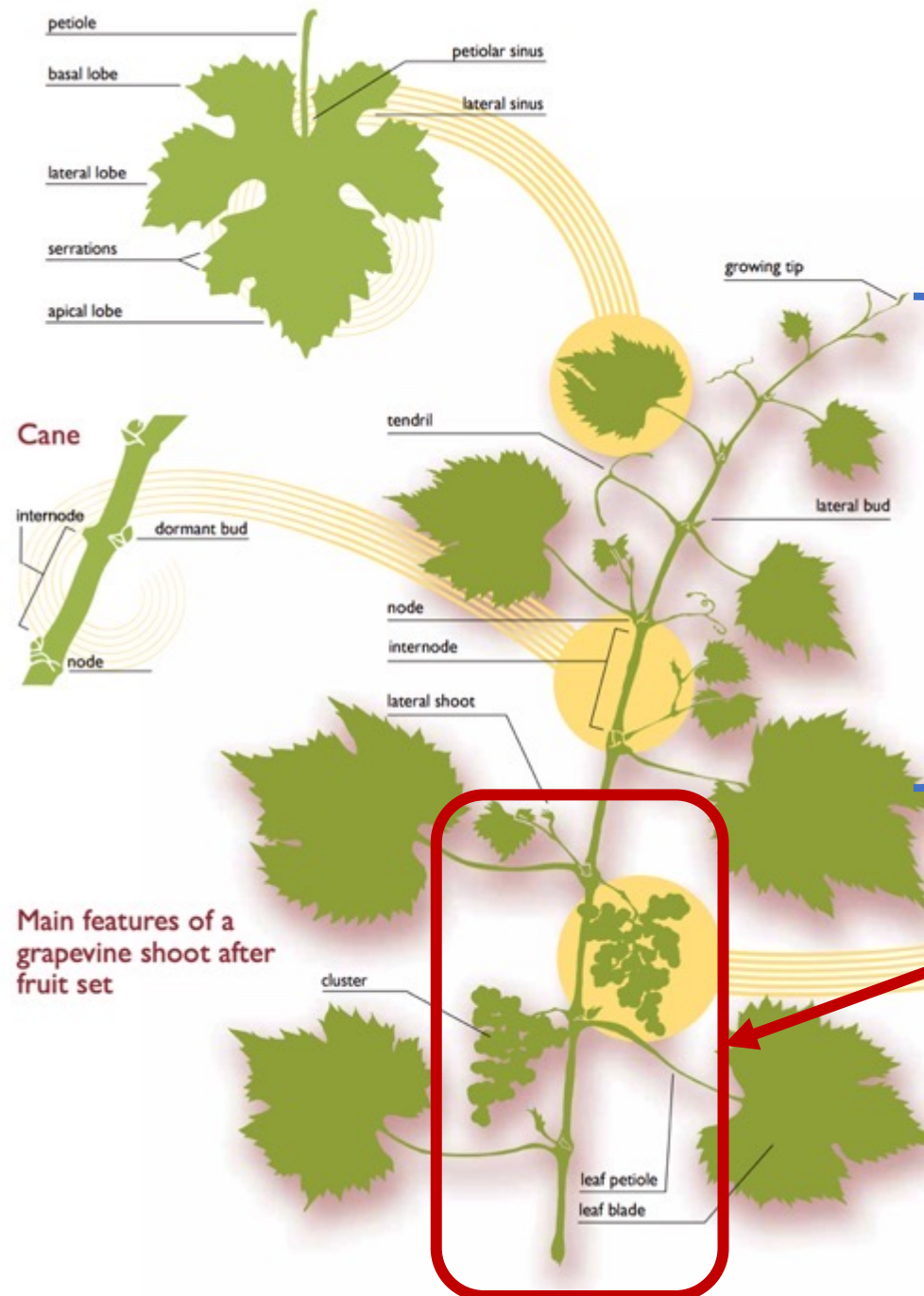


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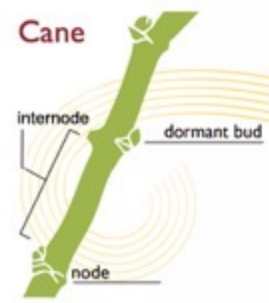
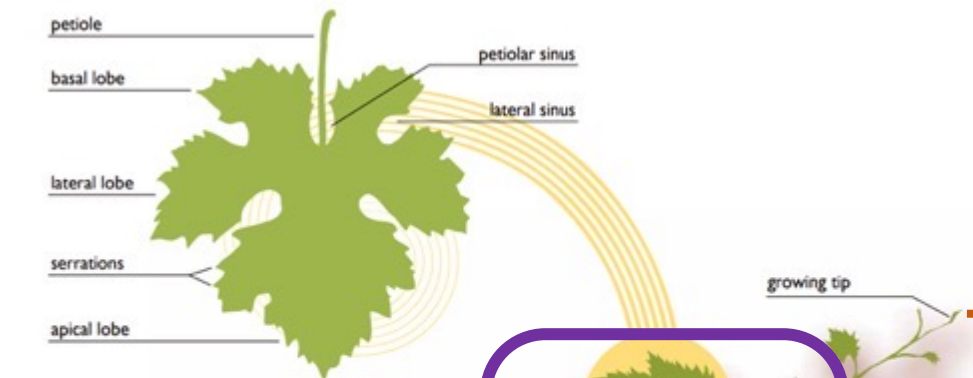


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Main features of a grapevine shoot after fruit set



# Managing Frost Injury – No Action

## No Action

- Retaining **dead material** can increase risk of diseases (dead tissue acts as inoculum)
- Damage following **full expansion** of preformed buds (6-10 nodes) should result in no action

# Managing Frost Injury – Taking Action

## Removal

- If shoots are  $\leq 4$  inches (only first few leaves emerged and separated), the grower can force 2° or 3° shoot growth by removing the damaged shoot.
- Avoid removing shoot tips if possible, unless visibly damaged.
  - This encourages lateral growth as apical dominance is broken
  - Leads to more 2° crop which can be an issue at harvest.





# Managing Frost Injury – Taking Action

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## Removal – Latent buds

- Removing damaged shoots can force latent buds in the arms or cordons to burst and grow this year.
- These latent buds result in lower yields than buds from 1 year-old wood, such as on the spurs.
- However, it will likely provide better canes for pruning for the subsequent Winter.



# Managing Frost Injury – Taking Action

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## Pruning Wood or Yields?

- Frost-Damaged shoots are likely to grow less vigorously than non-stressed shoots.
- This might result in canes that are shorter or smaller in diameter in Winter and limit options when pruning.
- This is particularly important with Cane-Pruned systems



# Cultivar Choice

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Different grape cultivars break bud at different times

- Avoid damage from Spring Frost on new shoots by selecting a cultivar that doesn't break bud until after the threat passes.

Go for a late-start cultivar if you expect Spring Frost in your region.

- Early Cultivars = Chenin blanc, Chardonnay, Pinot(s)
- Late Cultivars = Carignan, Sauvignon blanc, Cabernet



# Time of Pruning

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Pruning later typically means budbreak is later

Prune later if you think Spring frost will be an issue

Double-prune to avoid late Spring frost

- Apical dominance means the buds that are highest-up on the cane will break first
- Double-pruning allows those buds to serve as ‘sacrificial’ frost-damage shoots come Spring.



# Winter Injury



# Preparing for Winter

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Following harvest, vines continue to photosynthesize

As they prepare for winter-dormancy, they will remobilize carbohydrates

Continuing to irrigate during this timeframe is essential to **harden** the vines to cold-temperatures.



# Preparing for Winter

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Different cultivars become winter-hardy at different times.

- Cabernet sauvignon is typically slow to do so and can suffer late-Autumn/early-Winter freeze damage easier than other cultivars

**De-acclimation** can occur given a Winter warm-spell and lead to **Winter injury**



# Identifying Winter injury

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Winter injury typically hits the vascular tissue and prevents xylem and phloem from supporting a full canopy come Spring.

In early Spring this may be noticed by observing a lack of shoots in the canopy-region and more suckers near the base of the vine.

Vascular tissue might be browned inside





# Responding to Winter injury

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Due to lack of shoots from growing positions, the remaining shoots may become ‘Bull-canes’ and be less fruitful than normal canes would.

This also limits pruning options next Winter

Retraining from the basal suckers just above the graft union may be the best option.

# Fall Frost Damage



# Fall Frost – Cultivar and Pruning

Early ripening cultivars will help avoid any frost in Autumn (prior to harvest)

White-grape cultivars are often good for this purpose

- Chardonnay
- Sauvignon blanc

‘Cold-climate’ reds are also early (e.g., Pinot noir)



# Fall Frost – Avoidance

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Overhead frost-protection irrigation isn't an option

- Excessive free-water will lead to fungal diseases
- Especially true when sugars are high in grapes

Cultivar choice and time of pruning are best tools to avoid Autumn frost scenarios

# Summary – Frost Damage Responses

## Spring Frost Damage

1. Assess the extent of damage (bud-dissections; whole-shoot removal)
2. Decide on your goal for the year
  - Significantly-reduced yields with better pruning wood for next year
  - Slightly less yields but worse canes for pruning in the subsequent Winter
3. Decide if you want to act or let the vine grow as-is

## Winter Injury

1. Assess the extent of the damage (starting in spring)
2. Can the vascular system still support the vine's canopy?
3. If not, consider retraining from a sucker at the base of the trunk

# Summary – Frost Damage Responses

## Fall Frost

1. Avoid this one as much as possible
2. Cultivar choice is important here
3. Early-ripening scions are your best bet

## All Scenarios

1. Select your scion cultivars with seasonal freezes in mind
2. Cultivars that break bud late are better for avoiding Spring frost damage
3. Early-ripening cultivars are better for avoiding Fall frost damage
4. Pruning later and double-pruning prevent frost on fruiting buds

# Additional Sources

1. Hoffmann, M., Lockwood, D., and Barclay, P. (2021). Prevention and Management of Frost Injury in Wine Grapes. (*AG-899*).
2. Kamas, J. (2018). Identifying and Managing Winter Injury in Vineyards. *Viticulture & Enology*.