

Assessing damage after a frost event



Introduction

When frost occurs in a vineyard, the damage caused is often variable across the vineyard. Delineating frost-affected from non-frost-affected areas can assist in both quantifying the potential level of yield loss and informing management options post-frost. This fact sheet provides information on assessing frost damage to quantify potential impacts to a vineyard block. Additional information about frost management in vineyards, including a fact sheet, webinar recording and video, can be found on the climate and weather page of the AWRI website (https://www.awri.com.au/industry_support/viticulture/climate-weather-tools/).

Vine response to frost

While woolly buds on a grapevine can tolerate air temperatures down to -3°C , the greatest susceptibility to low temperature is shown by young rapidly growing shoots, which may be injured at -1°C . When grapevine foliage is damaged by frost, the vine will attempt to replace this foliage as a means of survival. This commonly occurs through the vine pushing lateral shoots from partially frost-damaged shoots, pushing primary buds that did not originally burst, and pushing secondary buds where primary shoots are damaged. While new inflorescences may arise in each of these situations, the fruitfulness of the secondary buds is approximately 30% of that of the primary buds (Dal Zotto et al. 2022). If a block is subjected to a moderate or severe frost, the resulting yield will be substantially lower than if the frost had not occurred.

The growth stage at which a vine is frosted will determine its capacity to support new shoot growth and influence the choice of management options post-frost. During early-season rapid shoot growth, a grapevine uses its stored carbohydrate reserves to facilitate development of new shoots. After this time, new shoots should have sufficient functional leaf area to become the primary supporter of canopy development. A late frost can have particularly detrimental impacts on a vine in both the current and following season if new growth is damaged.

Assessing and recording the damage

Mapping and quantifying frost-damaged areas in a vineyard can assist in evaluating the potential impact of a frost and informing management actions for the remainder of the season. Depending on the extent of frost damage to the block, it may be possible to identify discrete management zones and use these for activities such as agrochemical application, crop forecasting, harvesting, nutrition and bud fruitfulness assessment for the following season.

Quantifying the frost damage

Quantifying the area of frost-damaged foliage is best undertaken up to two weeks after the frost event. Depending on the growth stage of the vines at the time of the frost, different assessment options can be used to understand the severity of the damage. It's important to note that the number of assessments to undertake is a balance between time and accuracy. The more variable the impacts of the frost, the more assessments are needed to ensure an accurate assessment. If the frost damage appears to be extremely variable across a block, the whole block should be treated as the assessment area for estimating the damage level. Alternatively, if there are distinct zones of the block which look to have been damaged to quite different extents, it may make sense to undertake separate formal damage assessments in these sections.

Post-frost assessment 1 – Inflorescences not clearly visible at the time of the frost

Before inflorescences are clearly visible, an assessment of frost damage can be undertaken to broadly assess the damage to the early shoot growth and inform a very general level of crop loss. Secondary buds are expected to burst where shoots have been frost-affected early. Where primary shoots have been damaged by frost, 30% of yield potential from the primary buds can be expected on the secondary shoots. Once the bunches on the secondary shoots have completed flowering, assessments to formally estimate yield are recommended. This includes undertaking bunch counts and an evaluation of bunch size, as the true impact of frost on both the size of inflorescences and success of flowering will become evident.

The following points and the table on the next page are used to assess frost damage at this time:

- Vine growth stage at time of frost: between E-L 4 (budburst) and prior to E-L 12 (shoots 10 cm)
- Observation unit: vine
- Number of observations: up to 50 vines in a block or zone

Category rating	Description	Damage severity	Estimated yield loss ¹
1	<30% buds and/or shoots damaged per vine	Mild	Up to 20%
2	30 – 60% buds and/or shoots damaged per vine	Moderate	Between 20 and 40%
3	>60% buds and/shoots damaged per vine	Severe	At least 40%

¹ assuming a 30% yield potential on secondary shoots

See Appendix 1 for a blank and example completed assessment sheet for this type of frost assessment.

Post-frost assessment 2 – Inflorescences clearly visible at the time of the frost

If a frost occurs after inflorescences are clearly visible, an assessment of damage is largely aimed at evaluating yield loss. In addition, this assessment will also assist in determining if there are zones of unaffected or minimally affected area for selective harvesting. The 'estimated yield loss' arising from this assessment reflects a worst-case scenario perspective and is only provided for indicative use. Yield from secondary shoots likely to push post-frost is not included here.

The following points and the table below are used to assess frost damage at this time:

- Vine growth stage at time of frost: from E-L 12 (shoots 10 cm) onwards
- Observation unit: vine
- Observations required: up to 50 vines in a block or zone

Category rating	Description	Estimated yield loss
0	No visible damage OR visible damage to leaf and/or growing tip only on a vine	0%
1	Full or partial visible damage to up to 25% inflorescences on a vine	25%
2	Full or partial visible damage to between 25 and 50% inflorescences on a vine	50%
3	Full or partial visible damage to between 50 and 75% inflorescences on a vine	75%
4	Full or partial visible damage to between 75 and 100% inflorescences on a vine	100%

See Appendix 2 for a blank and completed example assessment sheet for this type of frost assessment.

Acknowledgement

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References

Del Zozzo, F., Canavera, G., Pagani, S., Gatti, M., Poni, S., Frioni, T. 2022. Post-spring frost canopy recovery, vine balance, and fruit composition in cv. Barbera grapevines. *Aust. J Grape Wine Res.* 2022: 6596021.

Gladstones, J.S. 1992. *Viticulture and Environment*. Adelaide: Winetitles: 322 p.

Contact

For further information, please contact the AWRI helpdesk.

Phone 08 8313 6600 Email helpdesk@awri.com.au Website www.awri.com.au

Address Wine Innovation Central Building, Corner of Hartley Grove & Paratoo Rd, Urrbrae (Adelaide), SA 5064

Appendix 1: Post frost assessment 1 – Inflorescences not clearly visible at the time of the frost (BLANK)

Block name (area): _____

Date: _____

Unit: vine

			Category						Category		
Samples	Row #	Vine #	1	2	3	Samples	Row #	Vine #	1	2	3
1						26					
2						27					
3						28					
4						29					
5						30					
6						31					
7						32					
8						33					
9						34					
10						35					
11						36					
12						37					
13						38					
14						39					
15						40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					
Total						Total					

KEY

Category rating	Description	Damage severity	Estimated yield loss
1	<30% buds and/or shoots damaged per vine	Mild	Up to 20%
2	30 – 60% buds and/or shoots damaged per vine	Moderate	Between 20 - 40%
3	>60% buds and/shoots damaged per vine	Severe	At least 40%

RESULT

Severity categories	1	2	3	Total sample number
Sum per category				
Incidence (sum per category/total sample number*100) %				

The highest category total (sum) relates to the severity category... [1/2/3]	
Therefore, the damage severity is rated as... [mild/moderate/severe]	
And the estimated yield loss is... [up to 20%/between 20-40%/at least 40%]	

Appendix 1: Post frost assessment 1 – Inflorescences not clearly visible at the time of the frost (EXAMPLE)

Block name (area): Front block
Unit: vine

Date: 25 Sep 2024

			Category						Category		
Samples	Row #	Vine #	1	2	3	Samples	Row #	Vine #	1	2	3
1	1 N	10	x			26	29 N	35	x		
2	2 N	40	x			27	28 N	80	x		
3	1 N	70		x		28	29 N	130		x	
4	2 N	110	x			29	35 S	24	x		
5	5 S	5		x		30	36 S	56		x	
6	6 S	30		x		31	35 S	73		x	
7	5 S	60	x			32	36 S	105	x		
8	6 S	80		x		33	40 N	30		x	
9	10 N	20			x	34	41 N	55			x
10	11 N	50	x			35	40 N	82	x		
11	10 N	80	x			36	41 N	120	x		
12	11 N	120	x			37	43 S	5	x		
13	15 S	35	x			38	44 S	36	x		
14	16 S	70	x			39	43 S	75	x		
15	15 S	100		x		40	44 S	100		x	
16	16 S	130		x		41	48 N	28			x
17	20 N	10		x		42	49 N	45		x	
18	21 N	40		x		43	48 N	67		x	
19	20 N	70			x	44	49 N	90			x
20	21 N	110			x	45	52 S	22			x
21	24 S	5		x		46	53 S	46		x	
22	25 S	30			x	47	52 S	77			x
23	24 S	60	x			48	53 S	105	x		
24	25 S	80	x			49	55 N	30	x		
25	28 N	10	x			50	55 N	60	x		
Total			12	9	4	Total			12	8	5

KEY

Category rating	Description	Damage severity	Estimated yield loss
1	<30% buds and/or shoots damaged per vine	Mild	Up to 20%
2	30 – 60% buds and/or shoots damaged per vine	Moderate	Between 20 - 40%
3	>60% buds and/shoots damaged per vine	Severe	At least 40%

RESULT

Severity categories	1	2	3	Total sample number
Sum per category	24	17	9	50
Incidence (sum per category/total sample number*100) %	48%	34%	18%	

The highest category total (sum) relates to the severity category... [1/2/3]	1
Therefore, the damage severity is rated as... [mild/moderate/severe]	Mild
And the estimated yield loss is... [up to 20%/between 20-40%/at least 40%]	Up to 20%

Appendix 2: Post frost assessment – Inflorescences clearly visible at the time of the frost (BLANK)

Block name (area): _____

Date: _____

Unit: vine

			Category								Category				
Sample	Row #	Vine #	0	1	2	3	4	Sample	Row #	Vine #	0	1	2	3	4
1								26							
2								27							
3								28							
4								29							
5								30							
6								31							
7								32							
8								33							
9								34							
10								35							
11								36							
12								37							
13								38							
14								39							
15								40							
16								41							
17								42							
18								43							
19								44							
20								45							
21								46							
22								47							
23								48							
24								49							
25								50							
Total								Total							

KEY

Category rating	Description	Estimated yield loss
0	No visible damage OR visible damage to leaf and/or growing tip only on a vine	0%
1	Full or partial visible damage to up to 25% inflorescences on a vine	25%
2	Full or partial visible damage to between 25 and 50% inflorescences on a vine	50%
3	Full or partial visible damage to between 50 and 75% inflorescences on a vine	75%
4	Full or partial visible damage to between 75 and 100% inflorescences on a vine	100%

RESULT

Severity categories	0	1	2	3	4	Total sample number
Sum per category						
Incidence (sum per category/total sample number*100) %						

The highest category total (sum) relates to severity category...[0/1/2/3/4]	
Therefore, the estimated yield loss is...[0%/25%/50%/75%/100%]	

Appendix 2: Post frost assessment – Inflorescences clearly visible at the time of the frost (EXAMPLE)

Block name (area): Back block
Unit: vine

Date: 21 Sep 2024

			Category								Category				
Sample	Row #	Vine #	0	1	2	3	4	Sample	Row #	Vine #	0	1	2	3	4
1	1 N	10	x					26	29 N	35	x				
2	2 N	40			x			27	28 N	80			x		
3	1 N	70				x		28	29 N	130				x	
4	2 N	110				x		29	35 S	24				x	
5	5 S	5				x		30	36 S	56				x	
6	6 S	30				x		31	35 S	73				x	
7	5 S	60					x	32	36 S	105					x
8	6 S	80					x	33	40 N	30					x
9	10 N	20					x	34	41 N	55		x			
10	11 N	50					x	35	40 N	82		x			
11	10 N	80		x				36	41 N	120					x
12	11 N	120	x					37	43 S	5	x				
13	15 S	35	x					38	44 S	36	x				
14	16 S	70	x					39	43 S	75	x				
15	15 S	100	x					40	44 S	100	x				
16	16 S	130			x			41	48 N	28			x		
17	20 N	10		x				42	49 N	45		x			
18	21 N	40				x		43	48 N	67				x	
19	20 N	70				x		44	49 N	90				x	
20	21 N	110					x	45	52 S	22					x
21	24 S	5			x			46	53 S	46			x		
22	25 S	30					x	47	52 S	77					x
23	24 S	60					x	48	53 S	105					x
24	25 S	80					x	49	55 N	30					x
25	28 N	10	x					50	55 N	60	x				
Total			6	2	3	6	8	Total			6	3	3	6	7

KEY

Category rating	Description	Estimated yield loss
0	No visible damage OR visible damage to leaf and/or growing tip only on a vine	0%
1	Full or partial visible damage to up to 25% inflorescences on a vine	25%
2	Full or partial visible damage to between 25 and 50% inflorescences on a vine	50%
3	Full or partial visible damage to between 50 and 75% inflorescences on a vine	75%
4	Full or partial visible damage to between 75 and 100% inflorescences on a vine	100%

RESULT

Severity categories	0	1	2	3	4	Total sample number
Sum per category	12	5	6	12	15	50
Incidence (sum per category/total sample number*100) %	24%	10%	12%	24%	30%	

The highest category total (sum) relates to severity category...[0/1/2/3/4]	4
Therefore, the estimated yield loss is...[0%/25%/50%/75%/100%]	100%