

Fruit splitting

of wine grape berries



Background to problem

Fruit splitting is the bursting, cracking or rupturing of the berry skin. It is typically associated with rainfall events that occur during berry ripening.

Splitting is an important industry issue because it impacts on both grape yield and quality. When there is significant rain during the harvest season splitting and disease have a major impact on the volume and quality of the fruit crushed, and as a result can dramatically reduce financial returns.

Fruit splitting alters the flavour profile of the grape as the decomposition can produce compounds such as ethyl acetate and acetic acid. These compounds are undesirable for winemaking.

The absorption of abnormally large amounts of water in the absence of splitting dilutes solutes, thereby affecting sugar concentrations and potentially delaying harvest dates.

When fruit is split, the resulting moist, open surface also provides an ideal surface for a potential *Botrytis* fungal infection.

It is difficult to put a dollar value on the effect of fruit splitting for wine makers as there are so many variables involved.



A split Shiraz grape berry.

Photograph: Simon Clarke

The value of the affected fruit can be measured in a number of ways, including:

- Loss of saleable wine (reduced production)
- Loss of customer loyalty if a consumer is unable to buy their preferred product and
- Cost of replacement wine.

Typically viticulture crop insurance is only available for hail, frost and fire, and excludes rain damage. Vineyard management is the only way growers can manage the risk and consequences of fruit splitting.

Understanding the factors that lead to fruit splitting and fungal infection will assist in determining potential preventative actions that could be

undertaken to reduce losses in the value of the crop.

Water balance in a ripening grape berry

There are three major influences on the inflow and outflow of water into ripening grape berries (*Table 1*).

Under ideal berry growing conditions, these three flows are very balanced and there is only a small net increase in berry water content each day.

If the increase in the net water content of the berry becomes too large, the increasing pressure stretches the grape skin. Once the stretching capability of the skin is exceeded, the fruit will split.

Table 1 Flow of water into and out of ripening grape berries.

Inflow	Outflow
<i>via the phloem</i> : sugary water transported from the leaves to the fruit.	<i>via transpiration</i> : water lost from the berry surface.
<i>via the xylem</i> : small amount of water under some conditions.	<i>via the xylem</i> : small amount of water flows back to the vine.

Case Study: McWilliams Wines, MIA, New South Wales

Splitting is estimated to occur approximately once every five years in the Murrumbidgee Irrigation Area (MIA), and probably more often in other regions, such as Tumbarumba on the southern slopes of NSW due to environmental conditions during ripening.

Split berries (often 10 to 30%) cause a drop in yield because they can dry up and drop off if there is no further rain. Fungal infection (Botrytis) is also common, especially if conditions remain damp. A 5% infection can result in a complete crop rejection by the winery. Growers will therefore try and harvest immediately after a splitting event.

Geoff McCorkelle, Technical Viticulturist, McWilliam's Wine Group, Hanwood, New South Wales

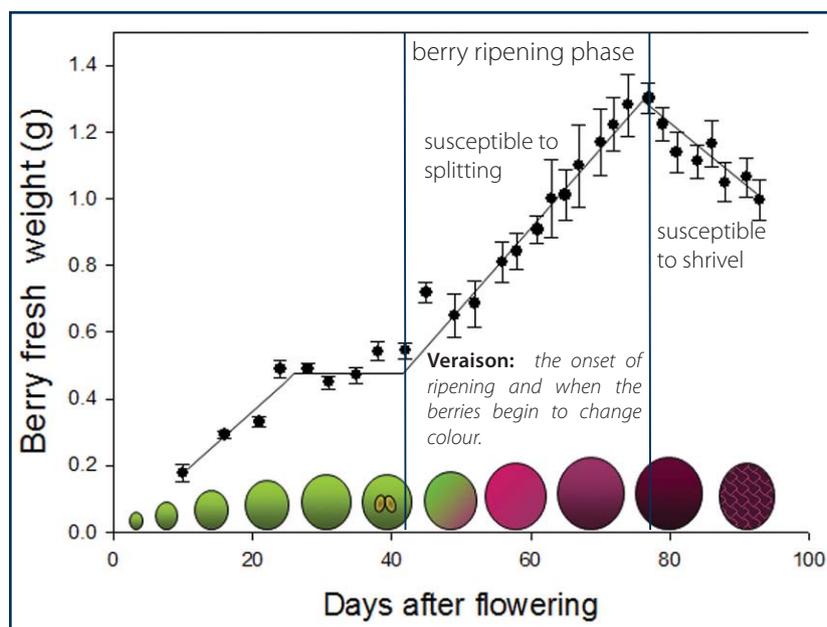


Figure 1 Fruit splitting most often occurs early in the ripening phase, when berries rapidly accumulate sugars, skin pigments develop and water content of the berry increases. Splitting is less likely to occur once berries start to shrivel. Figure 1 illustrates the development of Shiraz berries in the Riverina relative to flowering date.

Case Study: De Bortoli Wines, MIA, New South Wales

De Bortoli Wines in the Murrumbidgee Irrigation Area (MIA) in NSW experienced significant losses due to fruit splitting and subsequent loss of yield and fruit downgrading in both the 2011 and 2012 harvest.

In the 2011 season:

- 11% was downgraded due to splitting and disease; and
- 1.5% was not harvested.

In the 2012 season:

- 7% was harvested for downgraded products; and
- 11% was not harvested due to splitting, excessive disease, and inability to access vineyards. If it had been possible to access the vineyard and harvest the fruit it would have been downgraded.

The financial cost of this was:

- Loss of (potentially) 4.5 million litres of saleable product; and
- Reduction in value of the downgraded material of approximately 50%.

Julie Mortlock, Senior Winemaker, De Bortoli Wines Pty Ltd, Bilbul, New South Wales

Influences on splitting

There are a number of factors that determine the susceptibility of fruit to splitting (Table 2). They can be ranked in order of importance (highest to lowest):

- Water on fruit stalk and surface
- Berry ripeness
- Berry cultivar
- Air drying potential
- Berry temperature.

Current thinking is that grape purpose (e.g. wine vs table, largely corresponds to seeded vs seedless) and the precise time when rains fall during the post-veraison period are the most important intrinsic determinants of susceptibility.

Factors that influence berry splitting vary in the degree that can be manipulated by viticultural practices. A limited number of tactics can be strategically applied to minimise fruit splitting (Table 3).



In February 2010, heavy rainfall and hail fell in the Canberra region and vineyards experienced grape splitting after the event. These Riesling grapes were on the western side of the canopy which was protected from the worst of the hail. The split berries have shrivelled and some have become infected with Botrytis.

Photograph: Shane Hackett

Strategies to reduce the incidence of splitting

It is difficult to identify strategies or treatments for managers to reduce splitting in their vineyard. Rainfall events are unpredictable and managers are unable to influence the relative humidity and ambient temperature of the vineyard.

However reducing the susceptibility of grapes to splitting may be assisted

by the incorporation of management tactics such as (Table 3):

- harvesting fruit prior to meteorological events that are likely to induce splitting;
- promoting water loss from the berry tissue or berry surface; and/or
- in the long term, planting or grafting less splitting-susceptible cultivars.



Shiraz berries exhibiting berry shivel. At this stage of berry development susceptibility to splitting is very low.

Photograph: Bruno Holzapfel, NWGIC

Table 2 Factors that determine susceptibility of ripening grape berries to splitting (ranked in order of importance: highest to lowest).

Factors	Description of process	Reason splitting may occur
Water on fruit stalk and surface	There is a large increase in water flowing into the berry when water on the surface of the stalk (pedicel, receptacle, and receptacle/berry junction) and berry is absorbed by the berry cells (Becker <i>et al.</i> 2012).	Water on the surface of the stalk and berry results in a net increase in berry water content that is greater than the normal inflow.
Berry ripeness	During ripening, berry cells bounded by intact membranes import sugar and water from leaves via the phloem (see Table 1). Recent research has shown that many of the cell membranes in wine grape berries degrade late in the ripening process. This ultimately leads to the phenomenon of berry shivel (see above photograph) and cessation of sugar import because the flow of sugar-rich water into the berry is reduced.	Intact cell membranes are essential to the process of water uptake by berries during rain and condensation events. Intact cell membranes allow the absorption of water by berry cells through the process of osmosis. Without intact membranes only a small amount of water is absorbed by the berry very slowly. The progressive degradation of cell membranes during ripening reduces the ability of the berry to osmotically absorb rain and water droplets. This makes the berries less susceptible to splitting in the later stages of maximum sugar accumulation. See page 5 for further information on relevance to decision making with regard to harvest.
Berry cultivar	Susceptibility is related to strength of the berry skin, which greatly varies between cultivars. In practice differences are of little relevance. Grape varietal choice responds to winery and consumer demands. As a result any genetically determined differences are not a primary concern for many growers.	Splitting susceptibility is determined by the strength of subepidermal cells. An increase in subepidermal cell layers also increases the resistance to splitting (Meynhardt 1964).
Air drying potential	Cool, humid conditions cause the air around the berry to be saturated with moisture and therefore no transpiration occurs.	If air drying potential is low, the net increase in berry water content far exceeds the normal increase per day.
Berry temperature	Warm temperatures cause: 1. lowering of berry skin strength; 2. slight expansion of berry; and 3. large decrease in skin surface area ie shrinkage. (Lang and Düring 1990) The rate at which pressure builds inside the berry is an important determinant of splitting.	Berry skin is weakened and pressure increases within the berry. A rapid increase of berry temperature may cause splitting, especially if the berry water content is high. Shaded berries may warm less quickly and be less susceptible to splitting.

Becker, T., Grimm, E. and Knoche, M. (2012). Substantial water uptake into detached grape berries occurs through the stem surface. *Australian Journal of Grape and Wine Research* **18**: 109–114.

Considine, J.A. and Kriedemann, P.E. (1972). Fruit splitting in grapes: determination of the critical turgor pressure. *Australian Journal of Agricultural Research* **23**: 17–24.

Meynhardt, J. T. (1964). A histological study of berry-splitting in some grape cultivars. *South African Journal of Agricultural Science* **7**: 707–716.

Lang, A. and Düring, H. (1990). Grape berry splitting and some mechanical properties of the skin. *Vitis* **29**: 61-70.

Table 3 Strategies to reduce the incidence of splitting.

Strategy	Method	Further information
Harvest fruit before an imminent fruit splitting event	Assess the current and expected optimal value of the crop for wine production. Assess whether this difference is greater than the depreciation expected from a fruit splitting event. Evaluate how much of the crop to pre-emptively harvest based on the relative size of the potential loss and your attitude towards risk.	In 2010 a Canberra districts grower estimated that summer storms produced splitting in 20% of Shiraz and 10-15% of Pinot Noir bunches. The combined losses were approximately \$3,000 for nearly two tonnes of fruit. This equated to approximately \$30,000 in lost (contracted) wine production. In this instance the crop (20°Brix or less) was unsuitable for pre-emptive harvest because the fruit was not expected to be useful for winemaking until March.
Promote water loss (evaporation) from berry tissues or berry surface	Manipulate the drying potential of the air surrounding the grapes by encouraging air movement through the canopy. Promote mixing of moist air within the canopy with drier air above.	There have not yet been any specific trials testing the incidence of splitting in a more open canopy. It can be hypothesised that a reduction in shoot number or vigour, or a trellis design that minimises bunch shading, would reduce the degree of fruit splitting. These factors will also promote bunch drying and prevent Botrytis from taking hold.
Switch to cultivars less prone to fruit splitting	The first step in this strategy is to identify cultivars whose berries are resistant to splitting. In the context of Australian wine grape viticulture, this information is not readily available. The assessment must be based largely on personal observations and anecdotal evidence. An alternative approach is to target varieties whose ripening period is relatively short to minimise the duration the ripening crop is exposed to rainfall events. Having identified potentially suitable cultivars, the step prior to planting/grafting is cultivar assessment in terms of all viticultural demands (marketability, disease resistance, suitability to terroir, etc).	Obtaining reliable information on cultivar susceptibility to splitting will require a dedicated research effort that pays particular attention to the interaction between berry ripeness and rainfall events. Such research is likely to be of greatest relevance to cool climate vineyards where the protracted ripening period increases exposure of the fruit to rainfall events.

Fruit-splitting



research undertaken by the National Wine and Grape Industry Centre

Project	Shiraz berry ripeness and fruit splitting
Where	Wagga Wagga, NSW
When	2008 and 2009
Collaborators	Simon Clarke, Suzy Rogiers and Jim Hardie, NWGIC
Funding	Grape and Wine Research and Development Corporation-funded Wine Growing Futures program of the National Wine and Grape Industry Centre

Aims

1. Identify a stage at which the susceptibility of the ripening grape berry to splitting diminishes.
2. Identify attributes of the berry responsible for the changes in susceptibility to splitting.

Method

Two experiments were undertaken using ripening Shiraz berries (clone 1654).

1. Ripening berries (field grown fruit) were immersed in a graduated series of sucrose solutions and monitored for the number of days until splitting occurred.
2. Ripening berries (glasshouse grown fruit) were immersed in deionised water, monitored for splitting and assessed for cell vitality.

Summary of results

Berries were susceptible to splitting from veraison to 90 days after flowering (30 days after veraison).

(Note: *Veraison is the onset of ripening and when the berries begin to change colour.*)

Susceptibility to splitting remained very high over the first 30 days of ripening. Once berries had visibly

begun to shrivel they took a very long time to split or did not split.

Berry maturity fell in the window between these two stages. Susceptibility to splitting decreases dramatically as berry maximum fresh weight is approached.

A decline in cell vitality is more effective than a decrease in osmotic gradient at reducing the susceptibility to splitting.

Outcomes for industry

Assuming results for Shiraz are broadly applicable to other wine grapes:

- varieties harvested prior to maturity, perhaps for 'green' characteristics (e.g. Chardonnay or Sauvignon Blanc), will have berries that are always susceptible to splitting.
- varieties harvested very late in the season (e.g. shrivelling Shiraz or Botrytis Semillon) are unlikely to split once their maximum sugar content has been reached.

The findings of this study are of greatest relevance to the scheduling of harvest for those varieties picked close to maximum berry fresh weight.

When berries are at maturity (maximum fresh weight) the decision

making with regard to splitting is difficult. With an impending rainfall event there is no test that can be done sufficiently quickly to determine whether grapes are susceptible to splitting. The ultimate decision will still depend on the risk strategy of the vineyard manager and winemaker.

Future research

There is a need for research on the interaction between soil moisture content and fruit splitting. Anecdotal evidence exists for less splitting in vineyards with grapevines that are consistently well irrigated (see *Further information* below).

Why this strategy might work is not clear. It is possible that during a rain event berries on well-watered plants do not increase in volume as much or as quickly as berries on water-stressed plants. A smaller rain-induced volume increase would be expected to generate less stress on the berry skin. Alternatively, a slow volume change may provide sufficient time to allow the skin to accommodate an increase in berry volume without splitting.

If soil moisture plays a role in reducing splitting grape, growers could irrigate prior to forecast rain events to reduce their losses. This is a simple strategy worthy of future research.

Further information

www.nwgic.org

Clarke, S.J., Rogiers, S.Y. and Hackett, S. (2009). The frustration of fruit splitting. *The Australian and New Zealand Grapegrower and Winemaker* **542**: 37–39.

Clarke, S.J., Hardie, W.J. and Rogiers, S.Y. (2010). Changes in susceptibility of grape berries to splitting are related to impaired osmotic water uptake associated with losses in cell vitality. *Australian Journal of Grape and Wine Research* **16**: 469–476.



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Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (November 2012). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the National Wine and Grape Industry Centre or the user's independent adviser.

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