

# Understanding and Preventing Sweet Cherry Fruit Cracking



Photo: Clive Kaiser, © Oregon State University

Freestanding water on ripening fruit can cause stem bowl cracking.

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Sweet cherries grown in the Pacific Northwest are vulnerable to cracking, a problem that occurs when the surface of the fruit splits under pressure. Fruit cracking can have severe economic impact. Growers can minimize cracking by understanding its causes and the role cultural practices play.

Historically, a cracking rate as low as 20–25 percent would render a crop unmarketable. With advances such as new optical sorters, it is now possible to profitably harvest a crop with a cracking rate of up to 40 percent. It is to the grower's advantage to understand and reduce cracking.

Fruit cracking has two causes: external, free-standing water on the surface of the fruit, and the plant's internal water relations independent of water on the surface of the fruit. Some cherry scion cultivars are more crack-resistant than others due to their genetic makeup, which controls the form, composition, and thickness of the cuticle, the fruit's outer layer of cutin and waxes.

Plant internal water relations are directly influenced by soil water content, which can also play a key role in

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preventing fruit cracking. Irrigation and plant nutrition are linked to fruit cracking and must be carefully managed. Other factors include:

- **Crop load.** Light crops of larger fruit are more prone to fruit cracking than heavy crops with smaller fruit.
- **The application of hormones.** Gibberellic acid ( $GA_3$ ), which is used to regulate plant growth, can cause increased fruit cracking if applied at straw color under high rainfall.  $GA_3$  reduces transpiration at the time of application; however, transpiration rates recover within 48 hours of application. This increase in plant water content can result in more fruit cracking.
- **Rain.** Excessive rainfall events (more than 1.5 inches of rain), especially if occurring when soils are near field capacity, can lead to an increase in cracking.

- **Training systems.** Any training system that provides better leaf cover over the fruit can reduce rain cracking. Examples of this would be the Upright Fruiting Offshoot (UFO) and Kym Green Bush (KGB) training systems.

Advances in cultural practices can limit fruit cracking. Let's review these cultural practices and examine how growers can incorporate them into their production systems.

## Genetics

Cherry cracking is closely linked to cultivar selection. Both scions (Table 1) and rootstocks differ in their susceptibility. 'Bing', the standard in the Pacific Northwest, is highly susceptible to rain-induced fruit cracking.

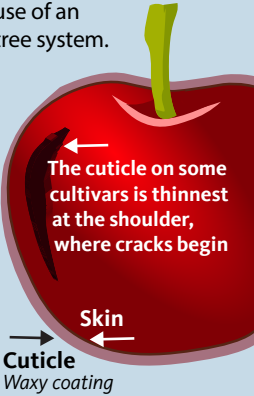
Rootstock impact on cracking varies with the scion grafted to it. Cultivar x Rootstock trials conducted in The Dalles, Oregon, beginning in 2008 have found that 'Mahaleb' is generally the most susceptible, followed by 'Mazzard', 'Gisela 5', 'Gisela 6', 'MaxMa 14', 'Krymsk 5', and 'Krymsk 6'. Each rootstock has unique attributes, which are detailed in *Sweet Cherry Rootstocks for the Pacific Northwest* (PNW 619).

### Causes of cherry fruit crack

Sweet cherries crack because of free-standing water on the ripening fruit or because of an imbalance in water within the soil-tree system.

#### Water relations within the tree

Trees growing in soils saturated from precipitation or over-irrigation take up excess water. As the fruit matures, sugar concentrations rise, establishing a large osmotic potential. Excess water is partitioned within the fruit. The resultant increase in pressure within the fruit causes the skin to crack.



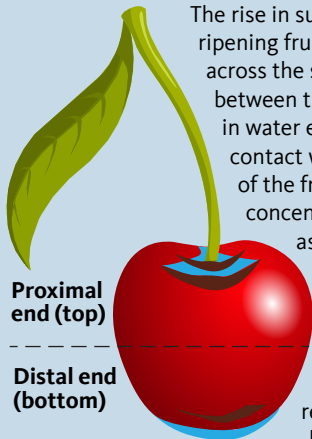
The cuticle on some cultivars is thinnest at the shoulder, where cracks begin

Cuticle  
Waxy coating

Skin

#### Free-standing rainwater on ripening fruit

The rise in sugar concentrations in ripening fruit sets an osmotic gradient across the surface. Prolonged contact between the cuticle and water results in water entering the fruit. Prolonged contact with rainwater at the bottom of the fruit results in cracking in concentric rings. In cultivars such as 'Bing', these rings are the first cracks to form. Fruit of other cultivars develops a star-shaped crack at the base. Pooling of rainwater in the stem bowl may also result in half-moon cracks below the shoulders.



Proximal end (top)

Distal end (bottom)

**Table 1. Sweet cherry cultivar susceptibility to fruit cracking, based on natural rainfall events in The Dalles, Oregon (2008–2018).**

High susceptibility	High to moderate	Moderate	Low
Bing	Early Robin	Attika	Big Star
Brooks	Radiance Pearl	Benton	Black Pearl
Early Robin	Sandra Rose	Chelan	Black Star
Rainier	Selah	Coral Champagne	Blaze Star
Royal Edie	Sweetheart	Cristalina	Burgundy Pearl
Royal Helen	Tieton	Ebony Pearl	Suite Note
Santina		Lapins	
Selah		Regina	
Skeena		Royal Hazel	
Utah Giant		Samba	
Van		Tamara	



Photo: Lynn Long, © Oregon State University

Retractable row covers have been erected over the trees in this cherry orchard.

## Covers

**Retractable row covers** shield fruit from rain. They can be highly effective but are costly and labor-intensive. Row covers must be drawn back when the sun is shining to prevent excess heat buildup, encourage airflow and optimize photosynthesis. Automated systems are available, but expensive. Wooden structures used in Norway and other European countries are susceptible to breakage in high winds; steel pole and cable structures are less susceptible to wind damage if well-engineered and anchored. During significant rainfall events, water running off the row cover can saturate soil in the root zone, resulting in fruit cracking due to internal water relations. Growers can prevent excess water from accumulating by planting tree rows on ridges or raised beds or by installing tile drainage in the tractor alleys.

Relative humidity under covers has little effect on fruit cracking; trees grown under covers in high humidity regions did not develop cracking when soil moisture was kept just below field capacity compared to uncovered control trees.

**High tunnels, such as Haygrove tunnels,** can also prevent cracking by shielding fruit from rain, but are not without challenges:

- Although the increase in relative humidity that can develop under the cover does not usually affect fruit cracking, it may increase the incidence of powdery mildew and brown rot, requiring more intensive fungicidal management prior to harvest.
- If heavy snowfalls are prevalent, or if the cover's capacity to trap heat would prevent adequate cold acclimation, covers must be removed in the fall and reinstalled in the spring after pollination, another labor-intensive consideration.
- During significant rainfall events, water running off the tunnel cover can saturate soils beneath the tunnels, leading to cracking of up to 60 percent of the crop, despite an absence of freestanding water on the fruit surface. Growers can address saturation by installing a tunnel gutter or soil drainage system in the tunnel leg rows to direct water away from the root zone. They can also plant tree rows on ridges or berms.

If covers are in place at the time of flowering, place beehives at least 15 feet from the tunnel, with the hive entrance oriented toward the morning sun, and with no barriers between the hive and the sun. Hives should be elevated 3 feet above the ground on stacked pallets;

you can place up to six hives per pallet. A 50 percent glucose solution placed at the far end of the tunnel will encourage bees to traverse its full length.

High tunnels are popular in some cherry-producing regions of Europe. They have also been evaluated by horticulturalists at Michigan State University. These tunnels have shown good potential for cherry production. However, it can take several years for growers to recoup their investment on tunnels in newly established orchards, particularly if rain causes cracking.

## Foliar sprays

The skin of a cherry is a semi-permeable membrane. During ripening, the sugar concentration of the flesh increases rapidly, reaching as high as 24 degrees Brix. In contrast, rainwater has a low solute concentration. This difference in concentration between the fruit flesh and the rain sets up an osmotic differential. Pure rain can cross the fruit cuticle and exocarp, or the skin, reducing the differential by diluting the sugar concentration inside the cherry. Water is absorbed through the fruit cuticle.

When rainwater is in contact with the skin for extended periods of time, as when rainwater drips from the blossom end of the fruit, concentric cracks form in the cuticle. Water moves into these cracks rapidly, and when sufficient water has been taken up, the cracks expand and collapse, leading to cracking of the distal, or bottom, end of the fruit.

Similarly, when free-standing rainwater collects in the stem bowl, or proximal, end of the fruit, concentric cracks form on the shoulder of the fruit where the cuticle is thinnest.



Photo: Richard Bastias, Universidad de Concepción. Used with permission

These cherries show three types of fruit cracking. The cherry on the left shows stembowl cracking, the center cherry shows distal end cracking, and the cherry on the right shows side cracking.



Photo: Clive Kaiser, © Oregon State University

Gutters added to high tunnels remove rainwater from the orchard and prevent water from soaking into the ground beneath.

Some spray surfactants can increase cuticle solubility, further thinning the cuticle on the shoulders of the fruit and promoting cracking.

Iron III chloride (1–4 percent  $\text{FeCl}_3$ ) has been shown to decrease fruit cracking when applied between 55 and 91 days after full bloom.

It is also possible to reduce rain cracking with multiple applications of Ca throughout a rainfall event. A spray solution of calcium chloride may increase the integrity of the fruit cuticle and increase the solute concentration of rainwater, thereby lessening the potential for water to pass through the cuticle. Calcium chloride can be applied prior to rain events, but residues may damage the leaves or accumulate on the fruit, reducing fruit luster and possibly requiring postharvest cleaning. To increase cell wall integrity and reduce rain cracking, make six applications of Ca beginning at pit hardening. Apply 100 gallons per acre of a 0.1–0.15 percent solution of Ca as amino acid or organic acid chelated calcium products.

Continuous tractor spraying has been successful. Calcium chloride can also be applied during rainfall events by injection into overtree sprinkler irrigation lines operated automatically by a computerized controller connected to a tipping rain bucket.

## Cuticle protectants

In recent years, cuticle supplements have been developed that help to protect fruit. In light to moderate rains, these products typically reduce rain cracking by up to 50 percent. This reduction of cracking can make the difference between harvesting or not harvesting a crop.

These products prevent the uptake of water through the epidermis. Apply cuticle protectants according to label directions, making sure to cover the entire fruit surface for good control. To achieve this, keep tractor speed under 2 miles per hour; spray nozzle apertures should result in droplets greater than 150 microns in diameter. Airblast sprayer pressure should be high enough to ensure that the spray penetrates the entire tree but does not drift more than one row over. Prevailing winds should not exceed 5 mph.

Protective coatings include:

- **RainGard** is an inelastic cuticle protectant coating. Over time, fruit growth creates microcracks in the coating, so up to three additional applications are required to fill these microcracks and protect the fruit. Apply RainGard according to label directions. The first application should be made approximately four weeks prior to harvest, at straw color, with repeat sprays every seven to 10 days thereafter. Additional applications before anticipated rain events, with at least two hours drying time, improve protection. No less than 24 hours should elapse between applications. The first application of Raingard may be combined with GA<sub>3</sub>; subsequent applications should occur at least two hours prior to a rainfall event. RainGard was developed by researchers at Washington State University.
- **Parka** is a cuticle protective coating that stretches as the fruit grows. One application of Parka at straw color and another 10 days later is sufficient to protect fruit. Additional benefits of Parka include up to 1 percent greater sugar concentrations at harvest and increased stem pull force. GA<sub>3</sub> may be added to the first application of Parka, but only if there is a 48-hour window of dry weather. Parka was developed by researchers at Oregon State University.



Photo: Clive Kaiser, © Oregon State University

Plastic soil covers can be used to control soil moisture by reducing the infiltration that can cause fruit crack.

- **Vapor Gard is an antitranspirant;** it is not recommended as an anticracking protective coating, although it is sometimes used in that way. Several studies across Washington and Oregon found Vapor Gard ineffective, or in some instances, likely to increase cracking, possibly due to effects on internal water relations under some weather conditions. Vapor Gard can leave a sticky residue and renders fruit unsightly at harvest. Cracked fruit treated with Vapor Gard cannot be diverted to a brine market, as the coating reacts with the brine.

Note that in heavy rains or storms of long duration, no product applied to the epidermis will effectively reduce rain cracking. Water will enter through the roots, travel through the vascular system, and put internal pressure on the fruit, causing rain cracking. This type of cracking has been known to take place even in greenhouses, when the fruit is completely dry.

## Soil moisture exclusion techniques

Like row covers, soil moisture management works by exclusion: a physical barrier that keeps moisture from the tree roots. Water-impermeable soil covers keep excess rainfall from the root zone and reduce fruit cracking by up to 25 percent.

Soil moisture management may be one of the most effective tools for preventing or reducing fruit cracking, particularly when used in combination with techniques to prevent rainwater from accumulating directly on the fruit. Growers must install drip lines under soil covers to ensure adequate moisture supply to the roots.



Photo: Clive Kaiser, © Oregon State University

A helicopter is used to dry fruit after a rainfall in Milton Freewater, Oregon.

Irrigation requires careful management. Drip irrigation is less likely to cause saturation, especially if the nozzle delivery rate is reduced to 0.50–0.75 gallons per hour. Excess soil drying followed by excess irrigation can increase fruit cracking.

Shortening the irrigation interval to no more than seven days will maintain soils near field capacity. Maintaining field capacity without saturation (such as through drip irrigation) from straw color through harvest results in less fruit cracking and larger fruit at harvest. Where rainfall can be extreme, plant trees in berms to improve drainage and reduce saturation around the feeder roots.

Mulching and increased soil organic matter also promote drainage, although sustained improvement requires repeated applications.

## Helicopters and wind machines

Another way to reduce fruit cracking is through turbulence created by helicopter blades. Helicopters physically remove rain from the surface of the fruit by increasing localized air movement through the orchard. This can be an expensive option, but helicopters may be economical compared to a crop loss.

To prevent wind damage, helicopters should fly approximately 15 feet above the orchard and travel at walking speed. Recruit a ground-based spotter to ensure that water is removed from the stem bowl and that cherries are not damaged by excessive wind.

Generating winds with a helicopter is ineffective during a rain event; growers must wait for the rain to end,

which is often difficult to predict. In general, helicopters effectively prevent fruit cracking when a rainfall event lasts less than four hours.

Wind machines are also effective at removing water from the fruit bowl, but their range is limited. Nevertheless, in orchards where wind machines are installed for frost control, it is worth operating the fans until the fruit is dry. Three to four acres of fruit can be protected in this way.

## Conclusions

Preventing cherry fruit cracking requires planning and effort. Freestanding water on the surface of the fruit and internal plant water relations cause fruit cracking. Growers should be aware of the cracking susceptibility

of each scion and cultivar as well as interactions with rootstock cultivars and should monitor weather and soil moisture conditions, as well as regulate irrigation at critical times. Physical structures, plant coatings, and mechanical efforts (such as helicopters or wind machines) to remove water from fruit can reduce the incidence of cherry fruit cracking.

## Reference

Weichert, H., C. von Jagemann, S. Peschel and M. Knoche, 2004. Studies on water transport through the sweet cherry fruit surface. VIII Effect of selected cations on water uptake and fruit cracking. *J. Amer. Soc. Hort Sci.* 129 (6): 781-788.



Photo: Clive Kaiser, © Oregon State University

Excess soil moisture induces side cracking of cherry fruit.

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