



UNDERSTANDING BROWN ETCH OF PUMPKINS

What does brown etch look like?

Brown etch almost always starts where the fruit is in contact with the ground, a stem, or another pumpkin. A reddish brown stain spreads across the skin, developing as a series of concentric rings or irregular, blotchy patches. Only the skin colour changes; etched areas remain firm. With time, the etched tissue dries out, developing a whitish appearance reminiscent of petrified wood. Fungal spores can sometimes appear in the centre of these dead areas.

Symptoms of brown etch are always superficial. The underlying flesh is unaffected and there is no impact on eating quality. Despite this, even a small amount of etch can lead to rejection by retailers.



Figure 2. Symptoms of etch usually start from a contact point with the soil, a stem or another pumpkin.



Figure 1. Variable symptoms of etch in the field, showing concentric rings (left) blotchy appearance (centre) and the whitish “petrified wood” appearance of old, dried out etch (right).



Microscopic examination reveals that cells in etched areas have massively thickened cell walls. This is largely due to accumulation of lignin. Lignin strengthens cells and is a key component of wood and bark. It is also often produced in response to physical or biological stress. As the wall thickens the cell contents are squashed, deformed and disrupted. Eventually they die, leaving behind the whitened skeletons of their cell walls.

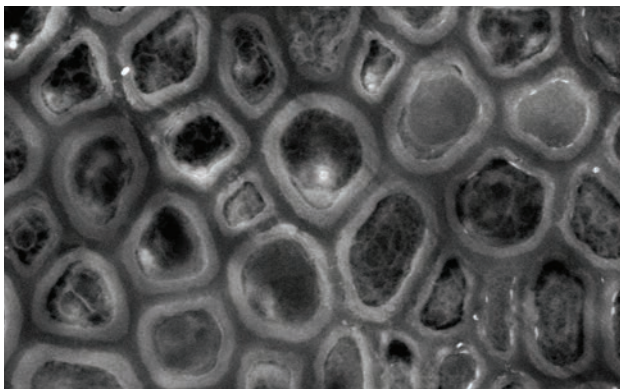
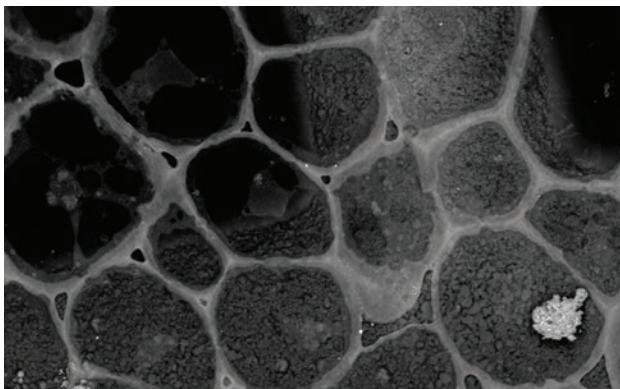


Figure 3. Normal (top) and etched (bottom) cells. Etched cells develop grossly thickened cell walls and their contents are squashed and disrupted. Scanning electron microscope image by the University of Sydney.

What types of pumpkins are affected?

Etch primarily affects butternut pumpkins (*Cucurbita moschata*) and, occasionally, related hybrids such as Kent. Etch does not generally affect long storing pumpkins such as Queensland blue or kabocha (*Cucurbita maxima*).

Is it a disease?

There appears to be an association between infection by gummy stem blight (*Stagonosporopsis cucurbitacearum*) and appearance of etch. Immature pumpkins that are wounded and then artificially infected with this disease often develop symptoms of etch. It is possible to re-isolate the fungus from the etched areas, suggesting that the fungus has caused the observed symptoms. There is some evidence that *Fusarium* also produces this response.

However, etch can also occur where plants and fruit appear totally disease-free. No fungal mycelia are seen growing through the plant tissue in microscope images of etched or borderline areas. Moreover, molecular analysis found similar amounts of DNA in etched and non-etched tissue, suggesting no fungus is present.

It therefore seems likely that although gummy stem blight can trigger etch, it is not the sole cause of the disorder.

What else causes etch?

There is a good correlation between development of etch and weather. High (>90%) relative humidity (RH), or wet conditions due to rain or dew are strong predictors of whether etch will develop in the crop. The period when pumpkins are maturing, turning from cream to orange, appears to be the most critical.

The graph in Figure 4 shows this relationship. Each point represents results from a single trial or survey of a commercial crop. The total time spent wet has been estimated using dewpoint. In actual fact pumpkins are likely to stay wet a lot longer, especially where they are in contact with the ground. This may explain why etch usually starts from these areas. This model suggests that if plants are wet for a cumulative total of 2 to 4 days during the fortnight before harvest, then 5-10% of the pumpkins will develop etched areas. If plants are wet for 5 days or more during this period, then at least 20% of fruit are likely to have etch.

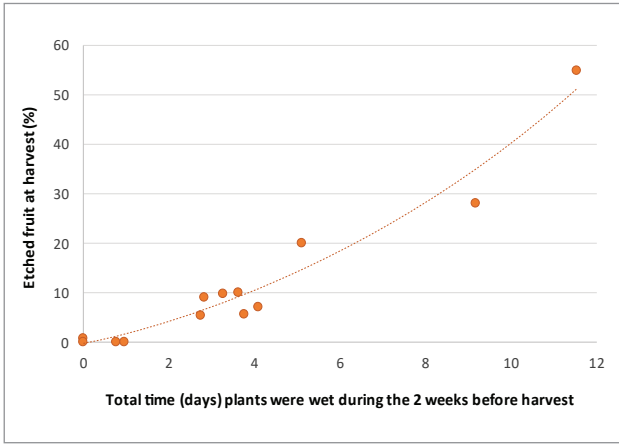


Figure 4. Relationship between time spent wet during fruit maturation and level of etch in the crop.

Even if the crop generally stays dry, an extended wet period during the month before harvest can also increase the risk of etch. Figure 5 shows that a single two day period of rain can result in more than 20% of pumpkins developing etch. If the wet weather continues for four days, half the crop may be affected.

Total time spent wet (Figure 4) is a good predictor when levels of etch are low, whereas the longest continual period spent wet (Figure 5) works best in rainy weather.

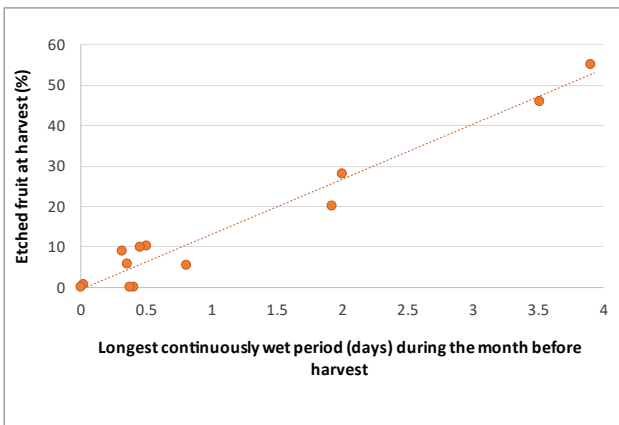


Figure 5. Effect of a single, extended wet period during the month before harvest on the level of etch in the crop.

Does etch develop after harvest?

If etch is found in the field, symptoms are likely to continue developing after harvest. Not only will affected areas expand, etch can appear overnight on previously unblemished fruit. While this is most likely during the first week of storage, new etch may continue to appear for up to two weeks.

For example, the data shown in Figure 6 was recorded for a crop where over 50% of harvested pumpkins had etch. The appearance of new etched areas peaked 3 and 5 days after harvest for initially etched and clean fruit respectively. In total, 28% of pumpkins clean at harvest developed etched areas after two weeks storage at 22°C.

Conversely, if there is no etch in the field, then etch rarely develops in harvested fruit.

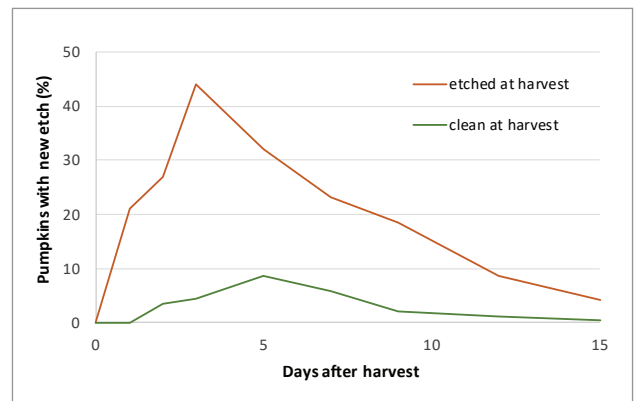


Figure 6. Development of new etch on pumpkins stored under ambient conditions with medium to high RH. While symptoms were most severe on pumpkins already etched at harvest (as in the picture shown at bottom), etch also developed on clean fruit.





What can I do about it?

Field trials have tested a wide range of treatments to control etch in the field. These included fungicide programs, products designed to improve plant defences and foliar nutritional supplements. **None of these products consistently reduced etch.**

In our trials we did not find any differences in susceptibility to etch between varieties, either in the field or postharvest. This includes the varieties Sunset QHI and Jacqueline.

We did find that cooling pumpkins and keeping the humidity low significantly reduced the incidence of etch.

- **Effects of cooling:** Cooling pumpkins to 5°C after harvest reduced etch development by 75% compared to holding fruit at ambient temperature.
- **Reducing humidity:** Keeping the storage environment dry, with 20% RH, significantly reduced etch development compared to storage in 70-95% RH.

Recommendations to reduce development of etch

In the field:

- Keep developing fruit as dry as possible. Strategies include increasing plant spacing to reduce humidity around the fruit and avoiding planting in damp areas.
- Irrigate crops with drip irrigation (preferably subsurface) instead of overhead irrigation.

In storage and transport:

- Cool pumpkins (12°C is optimum)
- Keep the humidity as low as possible, ideally under 20%

Note: If rates of etch in a crop are high and pumpkins are to be transported long distances, harvest the crop, store in harvest bins for at least a week, then repack for transport.

This will allow most of the underlying etch present in the fruit to appear. Discarding these pumpkins will avoid transporting low value fruit as well as the major costs associated with re-sorting at wholesale.

Can't we just tell consumers that etched fruit are still good to eat?

Yes, we can!

Most butternut pumpkins are sold cut in half and overwrapped. The undamaged flesh is clearly visible.

We conducted a small trial comparing sales of etched and non-etched pumpkins. Header cards were used to show customers the difference between the two. Most customers didn't look at the skin, and simply chose the cheapest option. As a result, a 50c/kg discount meant we sold 12% more etched than non-etched pumpkins. With a 20c/kg or zero discount, sales were generally similar regardless of skin blemish. While this may not be a solution right now, it suggests that consumers are willing to buy etched pumpkins if they can see that the fruit flesh is not diseased.

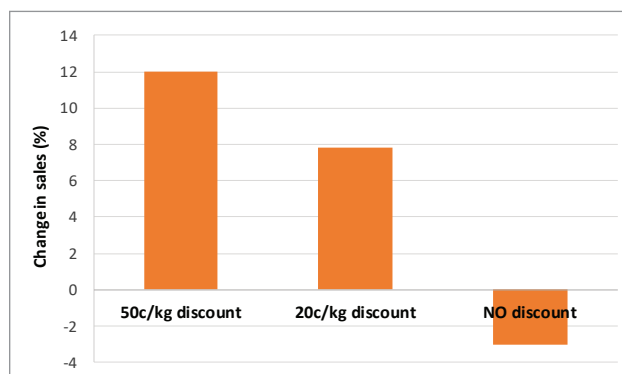


Figure 7. Sales of halved and overwrapped etched pumpkins compared to clean pumpkins when the etched fruit was sold with a 50c/kg discount, 20c/kg discount or no discount. Header cards displayed with the fruit are shown at bottom.