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Critical Issues for the Tomato Industry: Preventing a Rapid Postharvest Breakdown of the Fruit[1]

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What is rapid fruit breakdown? Rapidly growing lesions become visible within 12 to 18 hours after harvest and continue to develop among packed fruit in the ripening room. The lesions produce large amounts of fluid leading to wet patches appearing on the exterior of the cartons and the spread of decay within the box. Affected fruit are out-of-grade either prior to shipment or upon arrival at the receiver.

Brief History

Severe outbreaks of postharvest decay have occurred sporadically in the Florida and eastern U.S. tomato production areas for the past several years. During the summer of 2006, the problem was persistent in the production areas of Virginia and Maryland. In October, extensive losses occurred at the beginning of the harvest season in north Florida but disappeared within a few days. The decay losses feature a rapid breakdown of green fruit where lesions can appear within 18 hours of harvest. At the time ripening rooms are opened, packers observe lesions on fruit surfaces along with a release of fluids. Wet spots may appear on the lower part of cartons where the fluid has leaked.

Growers suggest that a condition called "tender fruit" leads to decay losses. The term "tender fruit" does not have a scientific definition, but to growers it means enhanced bruising during harvest. In 1964, R. S. Cox observed a field disorder, shoulder pox, on tomatoes produced in the lower east coast of Florida, which he attributed to the combination of tender fruit, cool moist weather and the application of certain pesticides. However, rapid fruit breakdown has usually occurred during or after warm, moist weather, which is also a likely promoter of fruit tenderness. A quick change in the weather from very warm, dry conditions to cooler temperatures featuring heavy fogs has also been associated with tender fruit. Conditions leading to tender fruit likely coincide with wet fields and moist plant canopies. This wetness promotes an increase in the populations of decay pathogens on the plants, and insect wounds and other types of injuries lead to infections. Moisture on fruit at the time of harvest readily

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disperses the pathogens to wounds. The common recommendation for avoiding decay issues associated with wet fields is “don't harvest if the plants have free moisture on them.” However, at times, this may not be a viable option for growers either due to price, crop maturity or labor issues.

The following guide is intended as a quick checklist of suggestions for minimizing rapid breakdown of tomato fruit. This breakdown is normally caused by two postharvest diseases, bacterial soft rot and sour rot. Key symptoms and causes about each type of disease follow.

Soft Rot Bacteria (Bacterial Soft Rot)

- Are found in all humid growing areas and exist in highest populations on plants and in surface water.
- May cause lesions at injuries on stems or petioles if the canopy remains wet for several days.
- Are dispersed to tomato fruit via rain splash, storms, insects, equipment, and the hands of field crews during harvest.
- Infect fruit equally well at any stage of maturity or ripeness.
- Cannot cause decay on healthy tissue - they enter via wounds or are forced into fruit by water.
- Rapidly disintegrate fruit tissues and usually produce cloudy fluids and an unpleasant aroma.
- Their infection first becomes visible as a water-soaking of wounds or portions of wounds including cuticle cracks, surface cracks, stem punctures, insect wounds, abrasions, etc.
- If internalized (forced into the fruit), cause lesions beside or beneath the stem scar, the attached stem (fruit still on plant) or beneath the blossom-end scar (Figs. 1-3).
- Become internalized when fruit are harvested wet (wet stem scars absorb bacteria), exposed to rainfall after harvest or submerged too long or deeply in dump tank water.
- A white yeast-like fungus may grow over the surface of the bacterial soft rot lesions (see sour rot section below).
- Decaying fruit collapse within a few days after disease onset, depending on the storage temperature.
- The contact of healthy fruit with the cloudy fluid from decaying fruit will spread the disease among packed fruit in cartons or among fruit still on the plant.
- Initial water soaking and disintegration of tissues can become visible within 12 h of inoculation, particularly among fruit stored at higher temperatures (>80°F).
- The disease is favored by moist conditions (dry wounds may remain free of disease for several days) and develops most rapidly at 77 to 97°F.
- Onset of the disease is delayed up to 3 days among fruit stored at 70°F as compared with those stored at 86°F.

Figure 1. Bacterial soft rot - internal lesion. Bacteria entered into fruit under the stem attachment Credits: S. R. Bartz

Figure 2. Bacterial soft rot - internal lesion. Bacteria entered through blossom-end scar of fruit. Credits: S. R. Bartz

Figure 3. Bacterial soft rot - internal lesions. Internal view of bacterial soft rot that began at blossom and stem ends of fruit Credits: S. R. Bartz

Sour Rot Pathogens (Sour Rot)

- Include certain *Geotrichum* species as well as bacteria that produce lactic acid.
- Have been isolated from the soil, plant debris, decaying tissues, garbage, and sewage as well as from the canopies of healthy plants (although the latter had only small populations).
- Are dispersed from sources to tomato fruit by splashing rainfall, field crews, equipment, and insects -- including fruit flies and those causing surface injuries.
- Cannot cause fruit decay unless they get into wounds or inside fruit (see soft rot bacteria for a description of internal lesions).
- Initial symptoms appear as a water-soaking of tissues in or around the edges of wounds including the stem scar, open blossom-end pore or scar, cuticle cracks, etc. (Figs. 4-6)
- Lesions do not enlarge as rapidly as those produced by soft rot bacteria.
- The minimum interval between inoculation of wounds and the beginning of water soaking is unclear but appears to take longer than soft rot.
- The liquid seeping out of sour rot lesions is generally clear and has a distinctive sour odor or no odor at all.
- Lesions usually become covered by a white yeast-like growth within 24 hours of exposure to air (Figs. 4 & 5).
- Warm moist conditions favor disease development (optimum = 86°F).
- Green tomatoes have been described as resistant to sour rot except if weakened by chilling injury. With exposure to air, sour rot lesions on tender green fruit (Fig. 7) often become arrested (Fig. 8). However, red tomatoes are susceptible. The susceptibility of green fruit being gassed with ethylene, bruised green fruit or tender green fruit is currently being investigated.
- Cracks in the fruit surface, including rain checks and cuticle cracks (Fig. 4, 5), may lead to infection, particularly under moist conditions.
- It is unclear if sour rot infects the petioles, stems or leaves of the fruit, but increased populations of lactic acid bacteria have been associated with humid weather in the field.

Figure 4. Rain check. Dark checked areas are a severe form of cuticle cracking that develops in wet weather. The cracks enable attack by postharvest pathogens. Credits: M. J. Mahovic

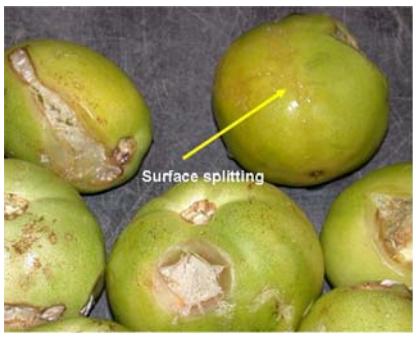

Figure 5. Sour rot - from natural outbreak. Dark, rough areas are rain checks. Fruit (upper right) has surface splitting due to decay spread in the carton. Credits: M. J. Mahovic

Figure 6. Sour rot - internal lesions from natural outbreak. Rough fruit became infected through blossom-end scars and wounds. Tissues appear to be pickled with only a little evidence of fungal development at the surface. Credits: P. R. Gilreath

Figure 7. Sour rot infection in green tomato involves high water content. An apparent bruise with infection occurring at tiny cracks in the fruit surface is evidence that this fruit is tender, which likely means high water content. Credits: M. J. Mahovic

Figure 8. Arrested sour rot lesions. Sour rot lesions in green fruit may become arrested when exposed to air. The decay will resume development as the fruit ripens. Credits: M. J. Mahovic

Preventing Losses to Postharvest Decay

- **Field practices.** Provisions should be made for insuring adequate drainage, particularly if unsettled weather might occur during the production season.
- Recommended disease and insect control practices should be used.
- If at all possible, fruit should not be harvested if the plants are wet, even if there are only a few droplets of free moisture on or at the edges of leaves. This will lead to the spread of decay pathogens among the fruit. Figs. 9 & 10 illustrate that wet stem scars rapidly internalize decay pathogens that contact the scar surface.
- Clean and disinfect all harvest containers prior to first harvest and periodically during the harvest season. Some packers clean and sanitize bins after each use.
- Immediately clean and disinfect any container that has been in contact with decayed fruit.
- Teach harvest crews to avoid handling or picking partially decayed fruit.
- Require harvest crews to wear gloves so that the glove surfaces can be washed in chlorinated water immediately after encounters with decaying fruit, as well as periodically during the day (lunch breaks, etc.).
- Avoid mechanically injuring fruit during harvest and avoid excessive load shifting during transport to the packing house.
- Bins or gondolas of harvested tomatoes should not be exposed to rainfall or suffer prolonged exposure to direct sunlight; loads hauled from fields to distant packing houses should be covered with a tarpaulin (Figs 9 & 10).
- **Postharvest practices.** The water in dump tanks and flumes should contain a minimum of 150 ppm free chlorine at pH 6.5 to 7.5 at the point where the fruit enter the water.
- Containers of chlorine products must be kept out of direct sunlight (heating causes a rapid loss of free chlorine) and should be stored in a cool, well-ventilated location.
- Flumes must be designed to avoid “dead” pockets, where fruit float in an eddy and do not progress promptly to the packing line elevator-conveyor.

- Fruit should not be allowed to remain in the water more than 2 minutes.
- The water can be warmed 5 to 10 degrees above the fruit temperature to improve fruit handling and drying.
- The spray rinse on the fruit exiting the flume should contain some free chlorine so that the fruit carry active disinfectant down the moist part of the packing line.
- At this time it is not recommended to replace the chlorine spray with an organic acid or other natural product-based material because the efficacy of these products for preventing biofilm development (sliminess on sponge beds or other equipment) is unknown. Additionally, the ability of these products to control lactic acid bacteria or the sour rot yeast (two of the decay agents isolated from decaying fruit) is unknown.
- All injured tomatoes must be culled prior to packing.
- The packed fruit should be promptly cooled to 70°F or less, particularly when the fruit appear to be tender and field conditions and temperatures favor decay development. Stacked pallets should be placed so as to ensure that all boxes are exposed to the circulating air in the gas room.
- **If a harvest must be scheduled while the plants are wet or the fruit are tender, the following will reduce the decay risk:**
- Picking containers of fruit must be gently emptied into field bins or gondolas as wet and/or tender fruit are prone to bruising and abrasions that lead to infection.
- Fruit must be gently hauled from field to packing house - speeding over rough roads can cause excessive fruit bouncing and vibration, which leads to bruising injury.
- Rapidly removing field heat will slow decay development. Tomatoes cooled to 68°F or lower by forced-air cooling are unlikely to develop lesions quickly. The moving air dries moisture from stem scars and fruit surfaces, which decreases the chances for infection.
- Holding bins of tender fruit overnight to facilitate the disappearance of minor bruises is likely to favor growth of decay pathogens if the pulp temperature remains high (>85°F). However, if the fruit are cool (< 70°F), the overnight holding period should decrease decay risks (dry wounds and stem scars aren't as susceptible as wet ones).
- People responsible for culling fruit on the packing line must “cull tight” and remove all injured fruit, even those with minor surface cracks.
- Chlorine concentrations in dump tanks and flumes must be monitored carefully, and should not be excessive. High chlorine concentrations will not control decay any better than recommended levels.
- Bins of fruit harvested from wet fields contain leaves and other debris and the fruit will appear “grimy.” Such loads have an unusually high chlorine demand and quickly depress active chlorine levels in the dump tank and flume.
- Maintaining adequate free chlorine concentration and pH in dump tank water during these periods requires vigilance. Frequent free-chlorine measurements are recommended, even if an automated oxidation-reduction measurement (ORP) system is in place. With the latter, false readings may occur due to fouled electrodes or other measurement problems.

Figure 9. Fruit picked during a shower and then dye added to wet stem scar. The dye was washed off after 2 minutes and the fruit was sliced. Note the green dye moving down vascular tissues from the stem scar (top). Credits: S. R. Bartz

Figure 10. Bacterial soft rot - internal lesion. Water - congested stem scar, such as was present in Figure 9, eliminated protection provided by a dry stem scar and enabled bacteria to enter fruit by capillary forces. Credits: S. R. Bartz

For More Information

The Growers IPM Guide for Florida Tomato and Pepper Production. http://ipm.ifas.ufl.edu/resources/success_stories/T&PGuide/index.shtml

Identifying and Controlling Postharvest Tomato Diseases in Florida. EDIS publication HS866. http://edis.ifas.ufl.edu/HS131

Physiological, Nutritional and Other Disorders of Tomato Fruit. EDIS Publication HS-954. http://edis.ifas.ufl.edu/HS200