BEST PRACTICE GUIDELINE

APPLE BRUISING MANAGEMENT

Based on a summary of a mini literature review, with a special focus on 'Cripps Pink'

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Purpose and key message

Bruising is caused by mechanical loading—impact, compression, rubbing and repeated vibration—that damages fruit tissue. The amount of damage depends on the interaction between the impact, fruit condition, packaging and handling system. For 'Cripps Pink', careful handling is essential at every stage. Fruit turgor, plant water status and fruit temperature may modify susceptibility, but the available literature does not establish a simple, cultivar-specific rule for these factors. Treat them as risk indicators to monitor, not as reasons to relax handling standards.

1. What producers need to know about turgor and water status

Fruit turgor: why it may matter

Turgor is the pressure of water inside living fruit cells against their cell walls. It affects the way apple tissue deforms under force. Mechanistic work on apple tissue indicates that higher turgor can increase cell-wall stretching and tissue stiffness, potentially leaving cells less able to accommodate additional deformation before damage occurs. However, this is a plausible mechanism—not proof that fruit with higher turgor will always show more visible bruising under commercial conditions.

Plant water status: the practical interpretation

The water status of the tree can influence fruit water status and turgor, but the relationship between irrigation, fruit turgor and bruising has not been directly established for 'Cripps Pink'. A study on 'Golden Delicious' reported greater bruisability in fruit picked early in the morning and observed that bruisability sometimes increased after irrigation. The authors proposed that higher turgidity could explain these patterns, but they did not directly measure turgor or fruit water potential. Results also differed between seasons.

Best practice

To manage bruising and internal browning, the following recommendations apply:

- **Irrigation management:** For orchards on heavy soils, stop irrigation 3–4 days before harvest, and for orchards on sandy soils, stop irrigation 2 days before harvest.
- **Large orchards:** Where an orchard takes more than 2 days to harvest, consider applying a short irrigation to wet only the top 30 cm of soil. This should definitely be considered before a weekend or when a heatwave is forecast.
- **Rainfall management:** If more than 10 mm of rain falls, wait 24 hours before harvesting. If 20 mm or more falls, wait 48 hours before harvesting.
- **Weather conditions after rainfall:** Weather conditions after rainfall play an important role in soil drying. Cold, cloudy weather results in low evaporation from the soil, meaning less water is lost to the atmosphere. Warm, windy weather promotes faster soil drying.

2. Pre-harvest orchard management

Correct thinning can reduce fruit pushing other apples off the tree. This is particularly relevant to short-stemmed cultivars such as 'Cripps Pink'. The problem with 10% fruit drop is that the remaining fruit on the tree develops large bruises. For this cultivar, this renders the fruit unsuitable for the export market. Good hand-thinning and proper fruit spacing are very important. Some plant-growth regulators may reduce push-offs by encouraging stem elongation; use only in accordance with registered and cultivar-specific recommendations.

Best practice

- **Excessive crop loads** make it difficult for fruit to develop good colour, resulting in the need for more selective picking. Each picking pass increases the risk of damage to the tree, as well as fruit being knocked off by ladders and falling to the ground.
- **Summer pruning, partial leaf removal before harvest, and the use of reflective materials** can improve fruit colour development, reduce the need for multiple picking passes, and minimise fruit damage.
- As fruit maturity advances, stem attachment may weaken and natural fruit drop can increase. **Pre-harvest AVG or 1-MCP has been reported to retard ripening and help prevent fruit drop;** follow approved product labels and market requirements.
- **Fruit on long, flexible branches may bruise or drop in strong winds.** Protective nets can mitigate wind effects where appropriate.
- **Do not overload the tips of soft branches with fruit.**
- **Repair and level orchard roads used by bin trailers and trucks before harvest.** Uneven roads increase jolting and the risk of bruising.

3. Fruit temperature: manage risk, do not rely on warming

The literature reports conflicting temperature effects. In one study on 'Gravenstein', warmer fruit showed less visible bruising after impact, especially at about 20°C. In contrast, a recent study using 'Golden Crown' apples found that simulated bruise volume increased as fruit temperature rose from 5°C to 35°C. A study on 'Braeburn' found no significant difference between fruit impacted at approximately 8°C and 26°C under low impact energies more representative of commercial handling. These differences show that temperature effects can depend on cultivar, impact severity, measurement method and the time allowed for bruise discolouration to develop.

Best practice

- **Start harvesting only when the trees are dry.** As 'Cripps Pink' is a late-season cultivar, cold mornings are often accompanied by wet conditions. Allow the trees to dry before harvesting and to support evapotranspiration from the fruit - usually by 09:30.
- **Use picking teams productively while waiting for the trees to dry.** Workers can collect fallen fruit from the previous day's harvest and clear fruit from the orchard floor. Picking teams can also work ahead in orchards scheduled for later harvesting or assist with partial leaf removal in 'Pink Lady' and 'Cripps Red' orchards.
- **Avoid unnecessary impacts** whether fruit is warm or cold. Impact prevention is more dependable than trying to control bruising through fruit temperature.
- **Keep harvested fruit shaded** and move it promptly through the intended cooling and handling process. Avoid prolonged exposure to direct sun or hot surfaces.
- **Do not deliberately warm 'Cripps Pink' to reduce visible bruising.** Warming may compromise storage potential and shelf life, and a less visible bruise does not necessarily mean that the underlying tissue injury has been prevented.

- **Record fruit/pulp temperature** at harvest and at key handling points during local bruise monitoring. Use these observations to identify patterns rather than assuming a universal temperature threshold.
- **Follow cultivar- and market-specific cooling and storage protocols.** Do not delay cooling or alter the cold chain solely to manage bruising.

4. Maturity and harvest timing

Bruise susceptibility can change with maturity, but the response is cultivar- and season-dependent. Studies on other apple cultivars often found greater bruising in later-harvested fruit. Harvesting too early is not automatically safer: fruit may detach less readily and require greater force, increasing the risk of picker damage.

- Harvest 'Cripps Pink' at the maturity stage specified by the applicable cultivar, market and packout protocol.
- Train pickers to lift and roll fruit off the spur rather than pull, squeeze, throw or drop it.
- Keep fingernails short; remove or cover sharp objects and jewellery that can puncture or mark fruit.
- Use clean, smooth picking bags with functioning padded bases. Empty bags gently and close to the receiving surface.

5. Prevent bruising through every handling stage

In the orchard and during picking

- Train team leaders annually so they can train and monitor picking teams. Closely supervise novice pickers, who may damage fruit when trying to keep up with experienced workers.
- Pick by twisting/lifting and rolling the apple off the spur rather than pulling. Pick one apple at a time, transfer it carefully between hands if needed, and place it gently in the bag; do not hold two apples pressed together in one hand.
- Use clean, smooth picking bags with padded bases. Do not bump or press bags against ladders or hard surfaces, place filled bags on the ground, or run while carrying them. If a bag must be set aside temporarily, hang it from a tree.
- Pick the bottom of the tree before moving a ladder into it. Move ladders carefully and do not pull branches to reach fruit, as rebounding branches can knock apples off.
- Empty bags gently into bins without bumping or pressing the bag against the bin sides. Do not overfill bins: after fruit has settled, it must not protrude above the bin rim, where the base of a stacked bin could press on it.
- Handle every apple as if it can bruise from a short drop or a hard contact.
- Do not overfill picking bags or bins. Avoid fruit falling onto fruit, bin walls or hard edges.
- Use bins in good condition. Loose slats can buckle during handling, and rough or damaged surfaces can injure fruit. The supplied industry guideline reports less bruising with plastic than wooden bins and a significant reduction when a commercially available bin liner is used.
- Keep bins clean, in good repair and free of splinters, protrusions and damaged surfaces.
- Approximately 31% of the fruit in a bin comes into contact with the sides and bottom of the bin, and this fruit experiences the highest incidence of bruising. Bin liners significantly reduce bruising and improve pack-out rates. Therefore, the use of bin liners, such as Fruitguard™, is strongly recommended.
- Ensure bin liners or cushioning, where used, are correctly positioned and not folded into hard ridges.
- Avoid rough driving and sudden stops with loaded bin trailers. Secure bins and reduce jolting.

Bin trailers and movement from the orchard

- Fit rubber inserts at trailer couplers to dampen movement. Keep trailers level and use tyres of the same size and good quality; check tyre pressure once or twice a week when bins are empty. The supplied

industry guideline recommends 2–3 bar and notes that excessive pressure can increase fruit impacts; follow the trailer/tyre manufacturer's specifications where they differ.
- Move loaded bin trailers at about 5–6 km/h or walking speed, and avoid speeding even on tarred farm roads. The bin farthest from the tractor experiences the greatest impacts and should be reserved for juice fruit where appropriate.
- Suspension and torsion bars reduce impacts. The least bruising occurs with bin-on-the-ground systems fitted with air suspension; systems with suspension generally perform better than those without.

Bin filling, storage and movement

- Fill bins in a controlled way to limit drop height and prevent fruit from striking exposed corners or hard surfaces.
- Avoid overfilling and excessive stacking pressure. Keep bins stable and aligned during movement.
- Forklifts are a major potential source of bruising because bins are handled repeatedly. Drive responsibly, accelerate and brake gradually, and lift/lower and set down bins gently. Avoid bumping bins and reduce the number of times each bin is handled. Vibration dampers on forklift masts may help reduce impacts.
- Insert forklift forks fully when lifting bins. Partially inserted forks can cause bins to buckle, increasing fruit movement and contact. Keep the farm loading slab level and smooth; bumps and ruts can bruise fruit.
    - This is important for bin trailers. If a trailer is poorly maintained and the bins are leaning when lifted by the forklift, the bins may twist during lifting, causing excessive fruit movement and placing additional pressure on the fruit.
- Use smooth routes and careful forklift operation; avoid sudden acceleration, braking, turning or impacts with doorways and other bins.
- Inspect bins and handling equipment routinely. Repair sharp edges, damaged rollers, gaps and height differences where fruit can drop or collide.
- Minimise unnecessary transfers between bins, trailers, conveyors and packhouse lines.

Packhouse and packaging

- Walk the line and identify every transfer point, drop, pinch point and hard contact surface. Measure or observe drop heights and correct avoidable impacts.
- Align conveyors and transfer plates; keep gaps small and use suitable food-safe cushioning where appropriate.
- Set brushes, rollers, belts and grading equipment to avoid excessive pressure, friction and fruit-to-fruit collisions.
- Keep fruit movement controlled through grading and packing. Packaging should cushion impacts and limit movement without creating pressure points.
- Do not assume individual trays always prevent bruising. Packaging performance depends on fit, stiffness, cushioning and whether fruit can move or repeatedly strike the package.
- Check packed cartons for overfilling, loose fruit, excessive compression and movement during handling.

Transport and logistics

- For transporting fruit from the orchard:
    - Transport trucks should have effective air suspension. Rubber cushioning on the truck bed may provide additional protection, especially on poor roads.
    - Suspension is designed for full loads, so avoid transporting partial loads where possible. If a partial load is unavoidable, seek appropriate advice on safe load compensation.

    - Set safe speeds for each route based on road condition and measured impacts; 80 km/h may be excessive on some tarred roads that are not in good condition. Drivers should accelerate and decelerate slowly. Consider logging impacts on poor or winding routes, include safe speeds in contractor agreements, and use GPS data to monitor compliance.
- Use suitable, well-maintained vehicles and secure loads to prevent shifting.
- Where feasible, favour smoother routes and vehicles with effective suspension; research in other cultivars found less vibration-related bruising with air-ride than leaf-spring suspension.
- Reduce unnecessary transport time and avoid rough handling during loading and unloading.
- Inspect cartons, pallets and fruit after transport to identify whether damage is concentrated in particular pallet positions or layers.

On-farm quality control

- Before picking starts, remove fallen fruit from the orchard. Team leaders should inspect fallen fruit regularly to identify fruit knocked or dropped during picking and take corrective action promptly.
- Randomly ask individual pickers to empty their bags into a separate box for damage assessment, in addition to quality-control sampling from bins. Use the results for coaching rather than assuming all damage found at the loading slab was caused by pickers.
- Assess samples from the orchard as well as the loading slab. Loading-slab samples reflect the combined effects of picking, bin trailers and forklifts. Sample different parts of the bin, including fruit near the sides and floor and at different heights; samples taken only from the centre can underestimate damage.
- Arrange rapid assessment of quality-control samples during harvest so handling problems can be corrected promptly, with sufficient staff available to collect and assess samples.

6. Monitor bruising and act on the cause

- Establish a simple, repeatable bruising check at harvest, after bin movement, after packing and after transport. Use the same sampling method and scoring criteria each time.
- Allow sufficient time for bruises to become visible before final assessment; a bruise may not be obvious immediately after impact.
- Record orchard/block, harvest date and time, recent irrigation and weather, fruit temperature, maturity, handling line, packaging type and transport conditions.
- Map where bruises occur: on fruit sides or shoulders, at contact points, near the stem/calyx, or in particular carton/pallet positions. Patterns can help locate the source.
- When bruising increases, investigate the handling system first: drops, impacts, vibration, pressure, fruit movement and equipment alignment. Change one factor at a time where practical and check whether bruising decreases.
- Use the results to give targeted feedback to pickers, forklift drivers, packhouse staff and transport operators.

7. Important cautions for ‘Cripps Pink’

- There is no evidence in the reviewed summaries to support a specific irrigation cut-off, time-of-day rule or fruit-temperature target for preventing bruising in ‘Cripps Pink’.
- Higher turgor may affect tissue mechanics, but the net effect on commercial bruising remains uncertain and may interact with impact severity, maturity, weather, fruit history and season.
- Temperature can influence both the mechanical injury and how strongly the bruise discolours. Less visible browning is not necessarily equivalent to less tissue damage.
- The most reliable immediate strategy is to reduce impact, compression, rubbing and repeated vibration throughout the value chain.

- Use a consultant, such as Henco Smit (Primadefensio), to audit your system. The consultant can use data loggers in crates and on pallets to identify opportunities for quick, significant improvements. In addition, when adjusting a process, such as vehicle driving speed, data loggers can help you quickly assess the impact of the change.

Literature basis and interpretation

This guideline is based on the supplied summary of a mini literature review. The evidence includes mechanistic work on turgor and apple tissue; studies of harvest time, maturity and bruise susceptibility in 'Golden Delicious', 'Braeburn', 'Granny Smith', 'Gravenstein' and 'Golden Crown'; and research on packaging and transport vibration in other apple cultivars. Findings from these cultivars are used to explain general risk factors, not to claim that the same response has been proven in 'Cripps Pink'.

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