MARCH 2012 FUTURE ORCHARDS WALK

Tools for Assessing Internal Quality

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Consumer acceptance, and retailer specifications, for fruit are punctuated by factors such as brix and dry matter content. Given fruit are very variable (depending on canopy structure), ideally every fruit would be assessed for such attributes. In this presentation a forward looking perspective is adopted, rather than a description of normal current industry practice. Examples are drawn from activity in the mango industry.

A Mango Story

Once upon a time there was a collection of mango growers. The crop was seasonal, and consumers associated mango with summer and Christmas, with the best prices achieved at the beginning of the season and the best volumes achieved around Christmas. Judging fruit maturity in order to decide when to harvest was sometimes a little subjective, but always harvest decisions were compromised to make the market windows. This is the story of a supply chain that took a different tack.

In mango, maturity indices are required for: (a) fruit harvested between full maturity and early climacteric, intended for immediate consumption (e.g. Fig. 1); and (b) fruit harvested physiologically mature before early climacteric, intended for transport to distant markets.

Figure 1. Tree ripening of fruit to maximise carbohydrate content (25% TSS recorded), with fruit caught within the net bag on drop. Photograph courtesy of Drs. Yonemori and Honsho.

Indices include:

Time (days from flowering, days from fruit set); Heat sum method; Physical appearance; Peel colour; Specific gravity; Flesh colour; Dry matter content; Starch content; °Brix ; Titratable acidity; Firmness of cheeks. Several indices can be used together to improve decision making, for example with respect to time of harvest.

Two handheld “near infrared spectroscopy” systems have been applied to the assessment of mango fruit quality attributes, the FT20 (Fantec; Japan) and the Nirvana (Integrated Spectronics, Sydney) (Fig. 2). Other manufacturers are also targeting the horticultural market (e.g. the Pigment Analyser, CP, Germany; DA meter, Italy). Such systems can be used to assess mango fruit DM and flesh colour at hard green (pre-harvest) stage, TSS at the fully ripe stage, and skin pigment levels at any stage. Coupled with a GPS device, the measurement of attributes related to fruit maturity becomes an application of precision agriculture.

A. Nirvana B. Fantec

Figure 2. Image of handheld NIRS units (A) Nirvana, Integrated Spectronics, and (B) NIRGun, Fantec.

This technology has been implemented into mango crop agronomy in the following ways:

(i) Variation within a tree

Fruit maturity will vary within a given tree canopy in relation to the age of the fruit (flowering event) and also in relation to canopy light conditions (outer canopy fruit on the northern side of a tree, for southern hemisphere plantings, having a high DM). Dry matter of fruit of a given flowering event on a given tree can be quite uniform for small canopy trees, and quite variable in trees with large, untrained canopies (Fig. 3). Assessment of this variation is useful to:

(a) provide information to picking crews,

(b) guide the design of sampling strategies (i.e. how should fruit be sampled on a tree to provide a meaningful estimate of fruit maturity?).

(c) inform the choice of crop architecture

(d) inform harvest strategy. For example, rather than require picking crews to selectively harvest ‘mature’ fruit from the whole tree, a decision can be based on knowledge of variation within the tree, e.g. to harvest only fruit from the outer parts of the northern side of the canopy, with later harvest of the other side and of inner canopy fruit.

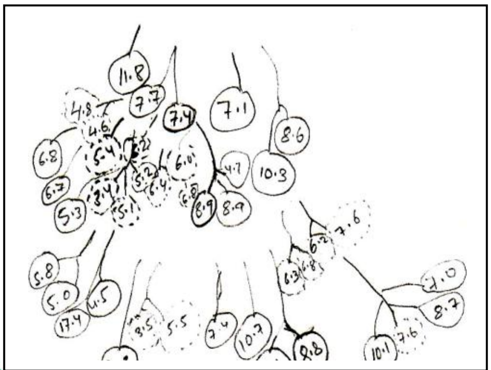
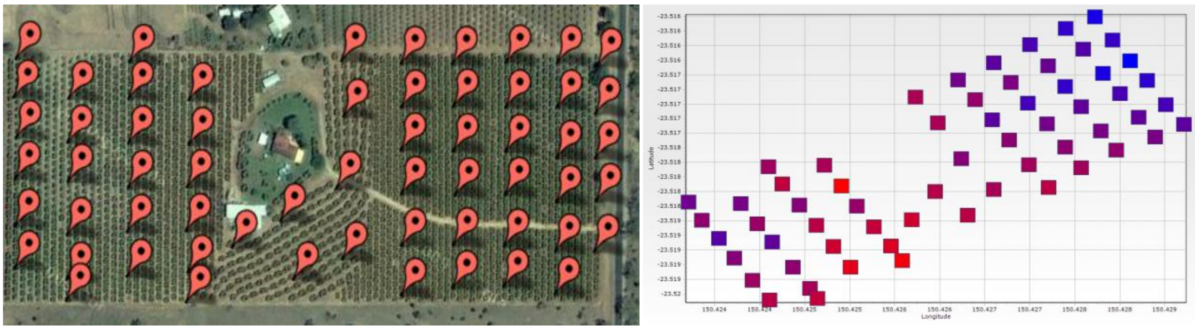


Figure 3. Representation of fruit with a single canopy, with DM values indicated. Fruit within the canopy have low DM.

(ii) Deciding when to harvest

In this application fruit from across an orchard or growing district is assessed using a systemic sampling method. A graphical display can then assist in the identification of areas of trees that have fruit of similar maturity (Fig. 4). Subsequent management can then be targeted at these maturity zones. Repeated measures over time can provide information on the rate of fruit maturation, and therefore guide a prediction of the time remaining to harvest. Such information is obviously critical to large operations reliant on employ of short term labour for harvest and packing, and in planning access to infrastructure such as picking aids, pack houses, cool stores, transport, and retail markets.



(A) (B)

Figure 4. Example output from the Integrated Spectronics Nirvana 'Geomap' feature, with (A) flags identifying sampled trees, and (B) colour coding on sample location representing fruit DM (blue, low; red, high).

Rather than repeated measure of random trees across the whole orchard, a number of 'sentinel' trees may be monitored, with the same fruit monitored at intervals. In the example provided (Fig. 5), DM continues to increase in fruit on tree past the commercial harvest, and DM varies between growing districts. A DM specification is required for each growing district and intended market.

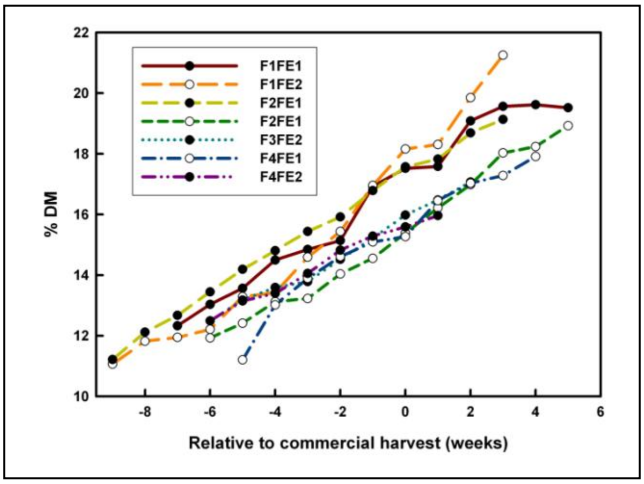
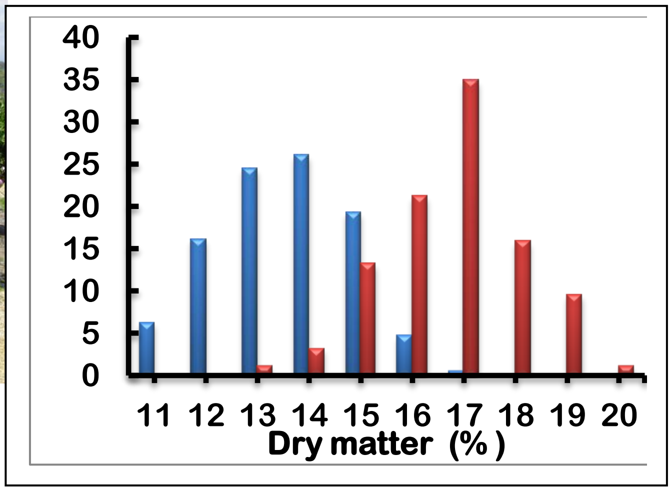


Figure 5. Dry matter assessed of fruit on tree, for different flowering events in each of four orchards located in different growing districts. Fifteen fruit per tree were flagged on each of three trees per orchard, with repetitive measurements made of these fruit over time (stone hardening to ripening stages).

(iii) Use in guiding and training picking crews

Training given to pickers on the recognition of mature fruit is often temporary in effect, with percentage falling within a single day from a morning training event. As an objective assessment system, handheld spectrometry can assist in reinforcing the training message. For example, random checks of DM distribution of harvested fruit and of fruit remaining on the tree (of a given flowering event) may be made (Fig. 6).



(A) (B)

Figure 6. (A) Picking crew and harvest aid moving through a field; (B) Dry matter distribution of fruit on the tress and in the harvest bin. In this example the picking crew has been successful in harvesting more mature fruit from the trees.

(iv) Use in the packhouse

The handheld unit described above is sometimes used in quality control programs within the packhouse (sampling a number of fruit per bin). However, similar technology can be installed on the pack-line. Commercial providers of pack line equipment such as MAF-Roda-Colour Vision Systems, Compac, Grefa and Aweta P/L offer such technology. In pack-line installations, the systems are not limited for power, as the hand-held units are, and therefore usually offer temperature stabilisation features for the detector and lamp. The pack-line installations also do not have the range of variation in light levels faced by in-field instrumentation, and so less frequent referencing occurs (as required for an application with throughput of several pieces of fruit per second).

The handheld systems described above use a system that transmits light through part of the fruit. Another approach transmits lights through the whole fruit – this requires intense light source and more sensitive detectors, so its application is limited to the packline, rather than in-field. Such systems can be used to assess internal browning in apple (Fig.7).

Information will be presented on the CVS-MAFRoda system.

Figure 7a. On line detection of internal browning in apple (IDD unit from CVS-MAFRoda.

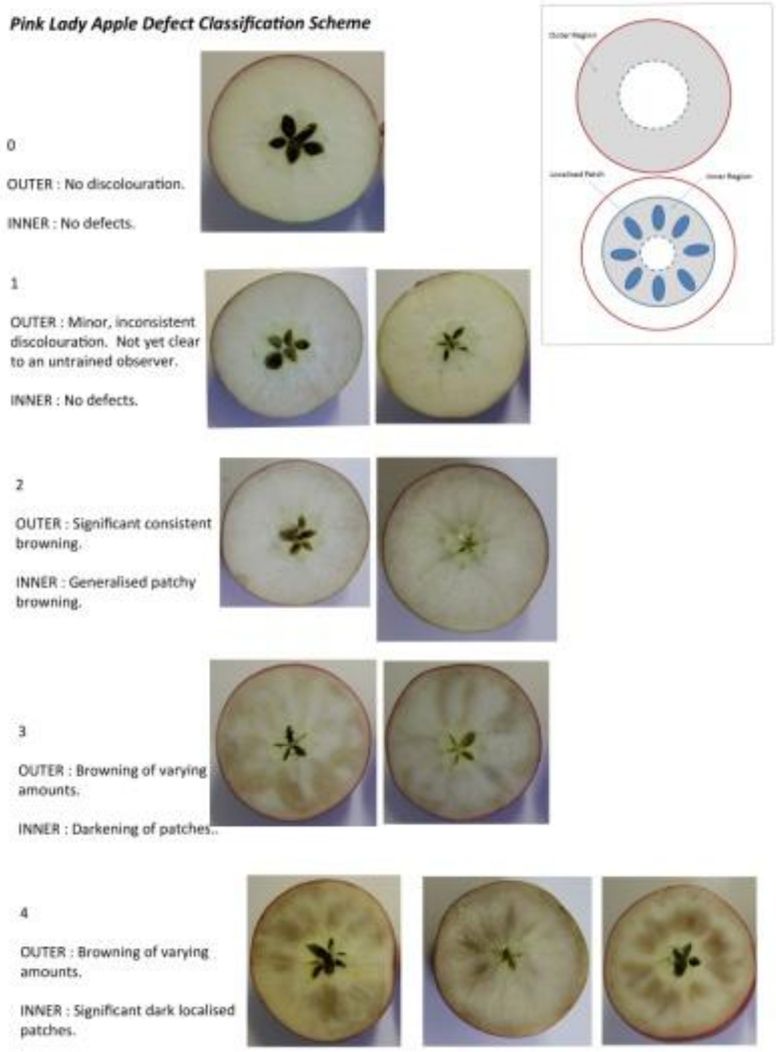


Figure 7b. Internal browning in apple (IDD unit from CVS-MAFRoda) reference scoring system.

Other technologies

Other sensor technologies will become available – (cheap) temperature, on tree fruit diameter and volatile detection (as an index of ripening) are examples. An enabling technology is that of wireless networks, which allow collection of data from fruit in the orchard or moving through the supply chain. Finally, all this technology is just a bunch of numbers without a smart 'Decision Support System' presenting the information in an easy to access and interpret way, to support the manager.

Acknowledgements

We thank Horticulture Australia Ltd., Hortical P/L, Colour Vision Systems P/L, Integrated Spectronics P/L and OneHarvest for support of related activity.