Can mealininess be nipped in the bud?

Where and how pears grow, and how they are harvested and stored, are all clues to the early detection, and even prevention, of a costly post-harvest disorder.

‘FORELLE’, A SMALLISH bi-colour pear with a distinctively sweet aroma and taste, is the second most produced pear in South Africa by volume. Popular as it is, the cultivar has one flaw. It is prone to mealininess, a condition that results in the fruit flesh becoming dry, soft and floury.

Previous research has revealed that mealininess is caused by the loss of cell-to-cell adhesion, and fruit that will become mealy has a higher porosity in the neck even before ripening. Researchers also agree that the condition has its roots in pre-harvest conditions, but they don’t exactly know which conditions and hence cannot predict susceptibility.

At present, the industry deals with the problem by subjecting ‘Forelle’ pears to a mandatory 12-week cold-storage period to prevent mealininess from appearing, or by keeping the pears firm with SmartFresh™ (Forelle Early Market Access protocol).

However, some markets do not like pears firm and sweet, but prefer them to be soft and juicy. It is, therefore, not difficult to understand how valuable it would be to have a way of predicting mealininess susceptibility in the packhouse, and to sort pears accordingly before they even start their journey to the consumer’s table.

Dr Elke Crouch, a lecturer and researcher at the Department of Horticultural Sciences at Stellenbosch University, has been investigating the mealininess phenomenon for a number of years.

In a previous project, jointly financed by the Post-Harvest Innovation Programme and Hortgro Science, her research team established that mealininess was a condition that existed prior to ripening in some ‘Forelle’ pears. Importantly, they also found that its development was associated with larger-celled fruit and those with large air spaces around their cells, and that in ‘Forelle’, specifically, mealininess development seemed to be linked to a high total soluble sugar (TSS) content.

These were important findings, given that researchers have been researching TSS concentrations – when they grow on the perimeter of the tree suggests a link between position and mealininess development.”

In addition to position, pollination, type of flower in a cluster, number of fruit in a cluster, ripening rate differences are factors that may affect fruit anatomy and physiology, and thus possibly mealininess susceptibility.

The link between TSS, a more intense blush and fruit position made colour an ideal focus for the new study that was designed to test predictors of mealininess. A successful outcome could lead to custom harvesting and storage protocols in order to reduce the risk of mealininess development, while also improving fruit quality after storage and ripening.

The project
With this objective in mind, Elke proposed a study that would investigate the link between mealininess and where in the canopy a pear grows and matures.

“We don’t know why some fruit on a tree is predisposed to mealininess and others not, and neither do we know if fruit position influences ripening rate or tissue density,” says Elke.

“However, the fact that ‘Forelle’ seems to have rosier cheeks – in most cases indicating higher TSS concentrations – when they grow on the perimeter of the tree suggests a link between position and mealininess development.”

In addition to position, pollination, type of flower in a cluster, number of fruit in a cluster, carbon assimilation due to sink strength, and ripening rate differences are factors that may affect fruit anatomy and physiology, and thus possibly mealininess susceptibility.

The project, once more financed by the Post-Harvest Innovation Programme and Hortgro Science, had four objectives that each required a specific methodology. However, some markets do not like pears firm and sweet, but prefer them to be soft and juicy. It is, therefore, not difficult to understand how valuable it would be to have a way of predicting mealininess susceptibility in the packhouse, and to sort pears accordingly before they even start their journey to the consumer’s table.

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VISUALISATION OF THE POROSITY IN THE NECK REGION OF A MEALY AND NON-MEALY ‘FORELLE’ PEAR.

OBJECTIVE 1: Map the fruit canopy positions in terms of fruit temperature, light interception, fruit tissue structure and porosity, fruit ripening potential and fruit mealiness development after ripening as well the relation to mealiness.

Trial 1: Fruit was tagged in five positions of 10 tree canopies with uniform height and shape in one row. Eight pears per tree position were marked and used to measure light irradiation with a quantum sensor attached to a light meter. Fruit surface temperature of the portion of the fruit facing the current position of the sun was measured by using high performance infrared thermometer.

Light irradiation and fruit surface temperature were measured three times a week, approximately four times a day, on cloudless days between 07:00 and 18:00, from mid-January until early March 2016.

Canopy temperature and relative humidity were measured continuously from mid-January until early March 2016 by means of tiny tags.

Findings:
- Outer canopy fruit was more prone to mealiness, and was associated with the highest temperature and irradiance levels.
- Mealy fruit had more porous neck tissue compared to non-mealy fruit.
- Euler values indicating connectivity of pore space, cell size per volume and cell size did not differ significantly for fruit from different canopy positions.
- However, the consistent differences in Euler values indicating differences in porosity did suggest that inside and outside fruit may indeed be different.

Trial 2: To determine whether mealiness differences within the canopy are related to storage potential and ripening rate differences for fruit from different canopy positions. Pears from the five positions were harvested at optimum and post-optimum maturity. They were evaluated for maturity and quality after storage (eight, 12 and 16 weeks at 0.5°C) and ripening (four, seven and 11 days at 20°C).

A total of 400 tagged pears – 80 fruit from each fruit position – were harvested at optimum harvest maturity on 2 March 2016. Maturity indexing was conducted at harvest and again after eight weeks of cold storage at 0.5°C, plus seven and 11 days of ripening at 20°C. Standard maturity parameters were measured, such as the fruit background colour, blush percentage, flesh firmness and TSS.

Micro-computed tomography was used to visualise fruit tissue density at harvest, after storage and after ripening. Nano-computed tomography was used to assess the quantitative porosity and cellular histology in the neck region of interest for fruit from different canopy positions.

Findings:
- The neck region (of both pollinated and non-pollinated fruit) had a higher porosity than pollinated fruit in both the neck and equator regions, which may result in a lower incidence of mealiness (see Fig. 1 on page 95).
- The neck region of both pollinated and non-pollinated fruit had a higher porosity than the equator, which indicates different levels of mealiness in different regions in the fruit (see below).

OBJECTIVE 2: Determine whether pollination/seed count affects mealiness potential.

Two treatments were applied on the western and eastern side of ten randomly selected trees during September 2015.

For treatment one, flowers of five trees were emasculated and hand cross-pollinated with ‘Early Bon Chretien’ pollen. Treatment two consisted of emasculating flowers of the remaining five trees without receiving pollen.

A total of 1 800 flowers per treatment were used, and approximately 1 700 fruit were harvested at optimum maturity.

Findings:
- Pollinated fruit had a lower level of mealiness compared to emasculated fruit.
- There is a difference in tissue density between full viable seeds and parthenocarpic seeds (two types – longer or small type), with the region next to full seeds being denser.
- Pollinated fruit had a lower porosity than non-pollinated fruit in both the neck and equator regions, which may result in a lower incidence of mealiness (see Fig. 1 on page 95).
- The neck region (of both pollinated and non-pollinated fruit) had a higher porosity than the equator, which indicates different levels of mealiness in different regions in the fruit (see below).

OBJECTIVE 3: Test the viability of commercial blush colour pre-sorters to determine mealiness susceptibility.

Findings:
- Canopy position seems to play a larger role in mealiness development than ripening potential of inside versus outside fruit.
- The outside fruit from the first harvest maturity did seem to exhibit differences in mealiness due to ripening and ethylene levels.
- Inside canopy fruit had higher levels of ethylene and not the highest level of mealiness.

X-ray micro-computed tomography (µCT) was used to visualise fruit tissue density. Nano-computed tomography was used for the quantitative porosity and cellular histology.

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‘Forelle’ pears were harvested from four different canopy positions in three orchards and sorted into four colour groups. The colour categories were related to mealiness development in ripened fruit in order to establish if colour can be used as a proxy for mealiness detection and, if so, how accurately a commercial colour pre-sorter can sort for mealiness before the condition develops.

Findings:
- Colour groups were related to mealiness development differences after ripening.
- The grading machine did not accurately detect the four colour groups. However, the machine’s ability can be improved through modifications to the ramp, rolling action or camera configurations on packlines specifically used for pears.

Conclusions:
- Direct irradiance and higher temperatures make outside fruit possibly more susceptible to mealiness.
- Mealiness may not be directly linked to ripening. Ethylene levels of inside fruit are in many cases higher, yet they are never as mealy as outside fruit.
- Outside west-facing fruit consistently had the highest Euler number, smallest cell size and highest amount of cells/mm³. This indicates that inside and outside fruit may indeed be different. However, a larger sample size may be required in order to statistically prove that fruit structure is different for different canopy positions.
- Pollinated fruit had a lower mealiness incidence, perhaps pointing to pollinated fruit having a better source of hormones during fruit set and development, which may influence porosity.
- CT scanning shows important histological differences between mealy and non-mealy fruit. The mealy fruit shows lower density regions in the neck, attributed to higher porosities.

These studies are to be repeated to confirm findings. The most important preliminary recommendation is that for fruit harvested on the outside canopy, or fruit that is well blushed, the protocols that reduce mealiness incidence should be followed carefully. These are:
- Harvest at optimum maturity – not over-mature.
- Store fruit for longer than 12 weeks at -0.5°C.
- Orchards that qualify for the ‘Forelle’ Early Market Access (FEMA) protocol should use this for recommended markets as fruit are eaten crisp and sweet.