Objectives & Rationale

- Storage potential of 'Fuji' is limited by the incidence of internal browning (IB).
- The objectives of this study were to:

i. Determine the effect of CO2 induced browning on the fruit microstructure:

ii. Determine the effects of different morphological and microstructural properties on the susceptibility of 'Fuji' to CO2 induced IB.

iii. Determine the effect of watercore on 'Fuji' susceptibility to IB.

iv. Determine which storage regime is most effective in reducing browning incidence.

v. To use high resolution X-ray computed tomography (CT) in establishing microstructural differences between different browning types.

vi. Comparison of the microstructure of 'Fuji' apples from different farms in different climatic regions (Koue Bokkeveld and EGVV).

Methods

- High-resolution and low-resolution X-ray CT scanning techniques were used to obtain images of fruit tissue. Specialised image processing such as Avizo, VGSTUDIOMax and CTAn were used to quantify microstructural properties of different IB types.
- For storage experiments, three storage regimes were used namely; regular atmosphere (RA), controlled atmosphere (CA) and delayed controlled atmosphere (delayed CA). Evaluations were done after 6 months at -0.5 °C, 4 weeks RA and 7 day shelf-life period.

Key Results

- Exposure of 'Fuji' apples to 50% CO2 for 3 days at 20 °C induced IB in the core region. Affected fruit tissue had low porosity and pore connectivity indicating membrane damage and cell death.
- Porosity mapping showed a high porosity distribution in the cortex region of 'Fuji' compared to the core region.
- Larger fruit (> 83 mm diameter) were more susceptible to CO2 induced IB.
- Watercore affected fruit tissue had significantly higher density, low porosity and low pore connectivity, conditions which promote IB incidence.
- RA storage for 6 months at -0.5 °C, promoted core-flush incidence while CA and delayed CA reduced core-flush whilst increasing radial browning.
- The benefits of delayed CA on 'Fuji' were not seen in this study.
- IB types evaluated in this study were core-flush, radial browning and CO2 induced IB with cavities. All IB types were characterized by collapse of cells.

Conclusion and Discussion / Recommendation

- High CO2 had a negative impact on 'Fuji' quality due to IB incidence in the core region of apples. The core is characterized by low porosity which may play a leading role in

predisposing fruit to localised development of CO2 induced IB as compared to overall fruit porosity.

- Larger sized fruit were significantly more susceptible and therefore it is recommended to avoid the harvesting and long-term storage of large over-matured fruit to reduce likeliness of IB incidence during storage. Carefully controlling pre-harvest factors such as crop load, nutrition and irrigation, which ultimately influence the final fruit size is recommended.
- Harvesting of over-matured fruit increases the probability of watercore development. The microstructure of watercore affected fruit may increase the risk of IB development during storage and long term storage of fruit with watercore should be avoided.
- The beneficial effect of delayed CA in 'Fuji' storage was not seen.
- X-ray CT was effective in this study to evaluate IB disorders in 'Fuji', and tissue density and structure. Gas diffusion modelling and biochemical studies may provide more insights on IB development.