Grower Summary

TF 199

Optimising the rate of establishment of Controlled Atmosphere storage of Bramley's Seedling apples

Final 2014

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Further information

If you would like a copy of this report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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GROWER SUMMARY

Headline

Progress is being made in identifying optimum establishment techniques for controlled atmosphere storage of Bramley.

Background and expected deliverables

Scrubbed low oxygen storage (5% CO_2 + 1% O_2 - 5/1 CA) has resulted in major improvements in storage quality of Bramley's Seedling apples particularly in the control of bitter pit and superficial scald. The use of 'SmartFresh™' (1-MCP) or ethylene scrubbing is widespread and provides further scald control. A disadvantage of 5/1 CA with either SmartFresh™ or ethylene scrubbing is the propensity for carbon dioxide injury to develop (Colgan et al. 1996). To avoid this, it is recommended that establishment of CA conditions for SmartFresh™-treated fruit is delayed for three weeks. Concerns regarding the ability of stores to achieve rapid establishment of 5/1 CA after this initial delay, has prompted many growers to adopt a procedure whereby stores are sealed immediately and carbon dioxide is scrubbed while oxygen concentrations are allowed to drop to 10% for 21 days before 5/1 conditions are established. An optimum strategy has not however been established.

This project therefore seeks to determine an optimum strategy to control CO_2-injury while maintaining background colour, firmness, bitter pit and scald control in long-term stored Bramley's in 5/1 CA. Bramley's stored long-term are also susceptible to high numbers of core rots (up to 8-10% losses). More rapid establishment of CA may lead to a reduction in the incidence of core rots.

Approximately 40% of the UK's Bramley's Seedling Crop is stored in traditional gas ventilated 9% CO_2, 12% Oxygen (9/12) stores. With the loss of the antioxidant diphenylamine (DPA) to control scald, growers are restricted to treating Bramley's with SmartFresh™ to reduce the development of superficial scald on long-term stored fruit.

Currently, a delay of three weeks in the establishment of CA conditions is recommended to avoid the development of CO_2-injury in 9/12 stores. Such a delay in CA conditions will often result in loss of quality during the storage season. The identification of a strategy to allow stores to be sealed earlier will help to improve the quality of fruit stored in the 9/12 regime.

Summary of the project and main conclusions

5/1 Stores

CA stores of Bramley's sealed immediately after fruit has cooled to store temperature (4-4.5°C) are best established through existing industry protocols; allowing oxygen to drop to 10% O_2 during the first three weeks of storage, and thereafter allowing store oxygen to drop to 1% O_2.

Early harvested fruit are particularly susceptible to external CO_2-injury. Bramley's are harvested in an immature state and the lack of reliable indicators of harvest maturity makes it difficult to predict fruits' susceptibility to damage. Moreover, large orchard to orchard variability compounds the problem of predicting fruits' susceptibility.

In Year 2 of the project, rapid establishment of CA within three weeks of sealing, in very early picked fruit (31/8/2012), led to 15-20% external CO_2 damage. By the following week's harvest (6/9/2012), the incidence ranged from 4-20%. In SmartFresh^{TM}-treated Bramley's, by delaying the rate of oxygen pull down and CO_2 establishment to four to six weeks, the incidence of external and internal browning damage was reduced without any apparent loss in fruit quality during long-term storage.

However, in Year 1, a five day delay in sealing cabinets, increased the incidence of internal carbon dioxide injury and core-flush during long-term storage. In cases where establishment took four or six weeks to achieve, the incidence of damage increased.

9/12 Stores

In the first year of the trial, delaying sealing of SmartFresh^{TM}-treated Bramleys in 9/12 CA for three weeks, resulted in an increased incidence of post-harvest rots (8.3%). Immediate sealing of stores and maintaining CO_2 at 1.5% for the first three weeks of storage reduced rotting to 2%. In the first year of this trial, immediate sealing of Bramley stores with a low build up (1.5%) of CO_2 did not result in significant external CO_2-injury.

In the second year of the trial, immediate sealing of cabinets and allowing a low concentration of CO_2 (1.5-3.0%) to build up during the first three weeks of storage didn't induce CO_2-injury. However there was no benefit in terms of rot control or improvement in fruit quality during storage.

Main conclusions

- The impact that the establishment of CA conditions has on Bramley quality is dependent on fruit maturity at the point of cabinet sealing.
- In the first year of the trial, the incidence of external injury was low and the impact of rapid CA establishment was difficult to determine. However there was a greater incidence of internal damage and a slight trend for increasing internal browning with slower rates of establishment.
- In the second year of the trial, the potential for external and internal CO_2 injury was greater. Early harvested fruit was more susceptible to external CO_2 damage when a rapid pull down to 1% oxygen was achieved within three weeks of sealing. Extending the pull down rate to four to six weeks before establishing CO_2, reduced the incidence of damage.
- A more rapid pull down of oxygen may be possible on later picked fruit where the propensity to develop external CO_2 injury is less.
- The incidence of internal browning was made worse by rapid establishment over a three week period in early harvested fruit. Slowing CA establishment over six weeks helped to reduce internal injury. Internal browning was worse on later picked fruit.
- A more rapid pull down of oxygen may help to reduce internal injuries on later picked fruit where delay in establishment can lead to higher fruit respiration rates.
- In these small scale trials, the rate of CA establishment did not improve retention of firmness or background green colour of fruit.
- Delaying sealing of stores after fruit has reached store temperature increased the risk of internal browning.
- The existing industry strategy of allowing store oxygen to drop to 10% O_2 during the initial three week period after store sealing (<1% CO_2) should be continued by growers at present. While some benefits on the internal quality of Bramley's have been found more an earlier pull down of oxygen the susceptibility of fruit to external CO_2-injury in early harvested fruit makes this a risky strategy.

- In the first year of the trial SmartFresh^{TM}-treated Bramley's kept in traditional ventilated 9% CO_2, 12% oxygen (9/12) storage benefited from sealing stores immediately after cooling fruit to store temperature and maintaining CA at 1.5% CO_2 for the first 3 weeks of storage through venting with air. This regime in the first year of the trial reduced the incidence of storage rots and internal flesh browning (core-flush and senescent browning), but was not observed in the second year. While in the second year no benefit in rot control was achieved, immediate sealing of stores and maintaining CO2 at 1.5-3.0% did not lead to external or internal CO2 injury.

Financial benefits

Reduced wastage through lowering the incidence of internal browning disorders of Bramley's and lowering the incidence of rotting will have a financial benefit to growers.

Action points for growers

From the results of this project over two storage seasons, growers may consider the following conclusions when managing controlled atmosphere Bramley stores:

- Early harvested Bramley's are more susceptible to CO_2 injury
- Susceptibility to external CO_2 injury declines with increasing fruit maturity
- For lowering the incidence of external CO_2 injury, immediate sealing of stores and allowing oxygen to deplete to 1% over a period of six weeks was as effective as current industry practice of maintaining store oxygen at 10% during the first three weeks of storage.
- A more rapid establishment may be possible on later picked fruit.
- A slower decline of oxygen over a six week period reduced the incidence of internal browning.
- The optimum strategy for CA establishment of Bramleys is subject to the relative state of fruit maturity at harvest.
- Delaying store sealing after fruit has cooled to store temperature can increase the risk of internal browning.
- In 9/12 gas ventilated stores, after cooling, immediate sealing of SmartFresh^{TM}-treated Bramley's stored and maintaining CO_2 at 1.5% for the first three weeks of storage through venting with air, did not induce external or internal CO_2 damage. In the first year of the project, this strategy significantly reduced the incidence of post-harvest rots, but this was not observed in the second year of the trial.