Canadian Agri-Science Cluster for Horticulture 2

Development of External CO_2 Injury in 'Empire' Apples during Storage Room Loading

by Jennifer DeEll, PhD

Jennifer DeEll, Fresh Market Quality Program Lead (Hort Crops) for the Ontario Ministry of Agriculture, Food and Rural Affairs, undertook research on External CO2 Injury in 'Empire' Apples during Storage Room Loading as part of CHC's Canadian Agri-Science Cluster for Horticulture 2.

External CO_2 injury in 'Empire' apple

Our research project for CHC's Canadian Agri-Science Cluster for Horticulture 2 program is aimed at optimizing storage regimes and utilizing the available multiple storage technologies to improve efficiency, reduce energy consumption, and extend the availability of Canada apples for domestic and export markets.

As part of our project, we investigated the development of external CO_2 injury in 'Empire' apples during storage room loading, as well as the effects of cooling rate and SmartFresh technology.

Within one hour of harvest last year, 'Empire' apples from a commercial orchard near Simcoe, Ontario were transported to the Apple Research Storage Lab in Simcoe. Fruit maturity upon arrival at the lab was assessed as 4.7 ppm internal ethylene concentration, 15.2 lb firmness, 10.6% soluble solids concentration, 764 mg malic acid per 100 g of juice, and 5.5 starch index. This would be considered slightly past optimum maturity for long-term storage, making the fruit less susceptible to external CO_2 injury.

Half of the 'Empire' apples were rapidly cooled to 3^{o}C, while the others were slowly cooled from ~22^{o}C down to 14-16^{o}C overnight. Half of the apples at each temperature were also treated with SmartFresh (1 ppm, 1-MCP) overnight. After 24 hours, all apples were held in ~17% O_2 + 4% CO_2 at 3^{o}C for 1, 2 or 4 weeks. These scenarios were intended to mimic the build-up of CO_2 during commercial room loading before the establishment of controlled atmosphere. Upon removal from storage, fruit were allowed to warm to room temperature and then evaluated for quality that day.

'Empire' fruit started to exhibit external CO_2 injury after only one week of storage (Table 1),

with significant increases after two and four weeks. Slow cooling increased the incidence of CO_2 injury and the disorder appeared sooner compared to fruit cooled rapidly. As expected, SmartFresh also increased incidence of CO_2 injury.

These research results indicate that storage operators should be cognizant of CO_2 accumulation when loading storage rooms with 'Empire' apples. This cultivar is extremely sensitive to CO_2. The use of diphenylamine (DPA) will reduce the development of external CO_2 injury.

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Table 1: Quality of 'Empire' treated with or without SmartFresh, cooled rapidly or slowly, and held for 1, 2, or 4 weeks in air at 3°C with ~4% CO_2.

	Internal ethylene (ppm)	Firmness (lb-force)	External CO_2 injury (%)
1 Week			
No SmartFresh			
Rapid	11	15.2	0
Slow	2	15.8	0.5
+ SmartFresh			
Rapid	2	15.2	0
Slow	1	15.6	1.0
2 Weeks			
No SmartFresh			
Rapid	8	14.9	3.5
Slow	11	15.2	9.5
+ SmartFresh			
Rapid	1	14.8	14.0
Slow	2	15.1	30.5
4 Weeks			
No SmartFresh			
Rapid	17	14.4	7.0
Slow	7	14.8	26.0
+ SmartFresh			
Rapid	1	14.8	22.5
Slow	20	14.4	59.0