

REGION-BY-REGION STORAGE RECOMMENDATIONS FOR HONEYCRISP: Responses from apple storage researchers.

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Summary Table for Storage Recommendations for Honeycrisp

State or Province	Primary Harvest Indices	Preconditioning	Pre-storage treatments	Air Storage	CA storage
Michigan	Starch, background color, red coloration	5 days at 50 °F	SmartFresh	38 °F	Not recommended
Minnesota	Background color	5-7 days at 55 °F	None	34-36 °F w/ Preconditioning	Not recommended
New York	Background color and red coloration	7 days at 50 °F	None	38 °F	Not recommended
Nova Scotia	Starch and background color	6 days at 68 °F	None	37-41 °F	37-41 °F w/prec. 2% O ₂ , 1% CO ₂
Ontario	Color, starch, soluble solids	5 days at 50 °F	SmartFresh	37-41°F	Not recommended
Washington	Background color,	7 days at 50 °F	SmartFresh	35-36 °F	35 °F w/ prec.,

Michigan – Dr. Randy Beaudry, Michigan State University, East Lansing, MI

HARVEST

Most important harvest maturity indices include: *Starch index (4-6), red coloration, change in background color from green to yellow*

Range in number of harvests/pickings for a single block: *3 to 4*

PRECONDITIONING

Typical preconditioning temperatures and durations for air storage: *50 °F for 5-7 days*

Typical preconditioning temperatures and durations for air storage + MCP, if different from above: *No difference*

Typical preconditioning temperatures and durations for CA storage: *No recommendation yet; evaluating 50 °F for 5-7 days, followed by 38 °F CA storage*

Typical preconditioning temperatures and durations for CA storage + MCP, if different from above: *No difference*

Other (e.g., humidity control, moisture loss): *No recommendation*

PRESTORAGE TREATMENTS

1-MCP application: *Yes, especially for long-term (5-7 mo.) air storage.*

DPA application: *Not advised as a dip to avoid spread of fungal spores. DPA provides only a marginal benefit in the prevention of soft scald. Impact on internal CO₂ injury is being evaluated.*

Fungicides: *Not advised as a dip to avoid spread of fungal spores. Thermofogging needs to be investigated.*

Calcium dip: *Not advised for same reason as for DPA, unless growers have not been spraying calcium in orchard preharvest*

STORAGE TREATMENTS

Air storage

Temperature or temperature range: *38 °F*

Maximum duration: *3 to 4 months*

Control of CO₂ during room loading: *Advised; CO₂ levels should remain below 1% during loading.*

CA storage – *Not currently advised, although some success has been achieved experimentally and at some storage facilities in Michigan. Marked differences in susceptibility to CA injury were detected between growers and growing regions.*

Temperature or temperature range: *No recommendation, although temperatures will likely have to be greater than 36 °F, due to sensitivity to chilling injury.*

Maximum duration: *No recommendation*

Oxygen levels: *No recommendation, although 3% yielded less CA injury than 1.5%.*

Carbon dioxide levels: *No recommendation; early research results suggest maintaining CO₂ levels below 1% for at least the first 30 days of storage.*

Control of CO₂ during room loading: *Advised – keep CO₂ levels below 1%.*

OTHER COMMENTS or RECOMMENDATIONS -

Minnesota – Dr. Cindy Tong, Univ. of Minnesota, Minneapolis, Minn.

HARVEST

Most important harvest maturity indices include: *change in background color from green to yellow*

Range in number of harvests/pickings for a single block: *2 or 3*

PRECONDITIONING

Typical preconditioning temperatures and durations for air storage: *55 °F for 5-7 days*

Typical preconditioning temperatures and durations for air storage + MCP, if different from above: *MCP not used*

Typical preconditioning temperatures and durations for CA storage: *55 °F for 5-7 days, followed by 34-36 °F CA storage*

Typical preconditioning temperatures and durations for CA storage + MCP: *no recommendation*

Other (e.g., humidity control, moisture loss): *N.R. (no response)*

PRESTORAGE TREATMENTS

1-MCP application: *no*

DPA application: *no*

Fungicides: *no, but some commercial use occurs*

Calcium dip: *no, unless growers have not been spraying calcium in orchard preharvest*

STORAGE TREATMENTS

Air storage

Temperature or temperature range: *34-36 °F*

Maximum duration: *usually done by end of January*

Control of CO₂ during room loading: *N.R.*

CA storage – *Not recommended, but some success has been achieved at some commercial storage facilities. The following represent commercial practices.*

Temperature or temperature range: *34-36 °F*

Maximum duration: *done by end of January or February*

Oxygen levels: *1%*

Carbon dioxide levels: *1%*

Control of CO₂ during room loading: *N.R.*

OTHER COMMENTS or RECOMMENDATIONS - *A web site on Honeycrisp Apple research results has been developed by Dr. Cindy Tong of Minnesota. The address is:*

<http://smfarm.cfans.umn.edu/Honeycrisp.htm>.

New York State – Dr. Chrisopher Watkins, Cornell Univ., Ithaca, NY

HARVEST

Most important harvest maturity indices include: *Color, flavor*
Range in number of harvests/pickings for a single block: *3-6*

PRECONDITIONING

Typical preconditioning temperatures and durations for air storage: *50 °F for 7 days*
Typical preconditioning temperatures and durations for air storage + MCP, if different from above: *Not much SmartFresh use, if any*
Typical preconditioning temperatures and durations for CA storage: *None - not recommended, though several folk have had mixed success*
Typical preconditioning temperatures and durations for CA storage + MCP, if different from above: *N.R. (no response)*
Other (e.g., humidity control, moisture loss): *N.R.*

PRESTORAGE TREATMENTS

1-MCP application: *Not recommended, but may change because of potential titratable acidity benefit*
DPA application: *I discourage postharvest drenches of any sort because of decay risk - easily damaged apple and even with fungicides not worth the risk*
Fungicides: *N.R.*
Calcium dip: *N.R.*

STORAGE TREATMENTS

Air storage
Temperature or temperature range: *38 °F*
Maximum duration: *not sure there is limit yet; most fruit is marketed pretty promptly*
Control of CO₂ during room loading: *None*

CA storage
Temperature or temperature range: *N.R.*
Maximum duration: *N.R.*
Oxygen levels: *N.R.*
Carbon dioxide levels: *N.R.*
Control of CO₂ during room loading: *N.R.*

OTHER COMMENTS or RECOMMENDATIONS - N.R.

Nova Scotia – Dr. Robert Prange, Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, Kentville, NS

HARVEST – *Clip fruit stems to control decay*

Most important harvest maturity indices include: *When considering harvest, the change of fruit starch to sugar is a reliable initial indicator of ‘Honeycrisp’ readiness. The change in background colour from green to cream is a good visual indicator of when to begin harvest.*

Range in number of harvests/pickings for a single block: *Repeat spot-pick for size and colour*

PRECONDITIONING – *Delay cooling is essential to control disorders*

Typical preconditioning temperatures and durations for air storage: *50-68 °F (10-20 °C) for 4-7 days,*

Typical preconditioning temperatures and durations for air storage + MCP: *N.R. (no response)*

Typical preconditioning temperatures and durations for CA storage: *(68 °F) 20 °C for 6 days prior to CA conditions*

Typical preconditioning temperatures and durations for CA storage + MCP: *N.R.*

Other (e.g., humidity control, moisture loss): *Initially, it was believed that the benefit of 6 days at 20 °C was due to a slight loss (1%) of moisture from the fruit. However, similar or better benefits are achievable with 1-2 days at 25 °C or 1 day at 30 °C with minimal moisture loss (DeLong et al., 2009) so the control of these disorders is not solely linked to moisture loss after harvest. During delay-cooling treatment, O₂ and CO₂ should be monitored to avoid the occurrence of unsafe levels for both human activity and the fruit.*

PRESTORAGE TREATMENTS

1-MCP application: *Not recommended, may cause CO₂-like disorders even in air storage*

DPA application: *Do not drench*

Fungicides: *Do not drench*

Calcium dip: *Do not drench*

STORAGE TREATMENTS

Air storage

Temperature or temperature range: *37-41 °F (3-5 °C).*

Maximum duration: *< 6 mo.*

Control of CO₂ during room loading: *N.R.*

CA storage – *Retention of constant firmness throughout the refrigerated air (RA) storage period may cause one to question the necessity for CA for ‘Honeycrisp’ apples. Controlled-atmosphere storage reduces the incidences of fruit decay and greasiness, and maintains juiciness and flavor when compared with cold stored apples.*

Temperature or temperature range: *Storage operators must ensure that the desired storage temperature of the fruit is obtained prior to applying CA conditions to the sealed storage room*

Maximum duration: *6-12 mo.*

Oxygen levels: *0.5%-0.8%, up to 2%*

Carbon dioxide levels: *We have observed experimental evidence of CO₂-related injury. Therefore, (CO₂ should initially be scrubbed to less than 1% for 3 to 4 weeks prior to allowing it to accumulate up to, but not exceeding 1%, long-term)*

Control of CO₂ during room loading: *See comments above under PRECONDITIONING*

OTHER COMMENTS or RECOMMENDATIONS - *Our research has demonstrated that 'Honeycrisp' fruit harvested during the optimum harvest window and delayed cool-treated for 6 days at 68 °F results in superior fruit quality after storage. 'Honeycrisp' fruit do not have ultra low oxygen (ULO) sensitivity and fruit have been stored experimentally in Dynamic Controlled Atmosphere (DCA) at 0.7% O₂ without injury for 9 months. Waxing should be done with caution as excessively thick wax can cause total deterioration of the fruit within 2-4 days*

Ontario – Dr. Jennifer DeEll, Ontario Ministry of Agr. Food and Rural Affairs, Simcoe, ON

HARVEST

Most important harvest maturity indices include: color, starch, SSC

Range in number of harvests/pickings for a single block: 2 to 4

PRECONDITIONING

Typical preconditioning temperatures and durations for air storage: *5 days at 10 °C (50 °F)*

Typical preconditioning temperatures and durations for air storage + MCP: *5 days at 10 °C (50 °F)*

Typical preconditioning temperatures and durations for CA storage: *5 days at 10 °C (50 °F)*

Typical preconditioning temperatures and durations for CA storage + MCP: *5 days at 10 °C (50 °F)*

Other (e.g., humidity control, moisture loss): N.R. (no response)

PRESTORAGE TREATMENTS

1-MCP application: *can reduce greasiness but little effect on firmness or disorders*

DPA application: *never saw an effect on soft scald when tested*

Fungicides: *avoid drenching*

Calcium dip: *avoid drenching: use calcium sprays in the orchard, lots!*

STORAGE TREATMENTS

Air storage

Temperature or temperature range: *3 to 5 °C*

Maximum duration: *4 to 6 mo.*

Control of CO₂ during room loading: *maybe monitored, but not much more*

CA storage - *no solid recommendation and not used commercially*

Temperature or temperature range: N.R.

Maximum duration: N.R.

Oxygen levels: N.R.

Carbon dioxide level: N.R.

Control of CO₂ during room loading: N.R.

OTHER COMMENTS or RECOMMENDATIONS – N.R.

Washington State - Dr. Gene Kupferman, WSU (Kupfer@wsu.edu) and Dr. Jim Mattheis
USDA – ARS

Honeycrisp is likely the most challenging apple variety grown commercially in Washington State. Consumer demand has been exceptional, leading to high returns and a rapid increase in plantings. As volume increases, the necessity to increase the length of the storage season also increases. Limited research experience on Honeycrisp grown in the Pacific Northwest has been undertaken in recent years by scientists at the Tree Fruit Research Laboratory (USDA-ARS) in Wenatchee. This research confirms the challenges facing the industry in judging maturity and storage.

This [response] combines the results of this research with that of scientists in other locations where Honeycrisp has been grown and studied over a longer period of time. Due to the limited timeframe of this research, caution is advised in putting this information to play in a commercial situation. The authors recommend that storage operators set up their own trials on maturity, drenching, pre-storage conditioning and storage to gain first hand experience with this variety under different conditions. A cautionary note: It is critical to be aware that this is a very chilling sensitive apple. The disorders that can develop from rapid cooling or excessively cold storage temperatures include Soft Scald and Soggy Breakdown. The potential for this to happen is very real and often can have serious economic repercussions.

HARVEST - *Judging maturity on Honeycrisp is not simple. Fruit firmness does not change during the maturation stage and in most locations when starch is only moderately cleared the fruit are not commercially acceptable.*

*Most important harvest maturity indices include: Most commercial experience has been to use the change in **ground color** from green to white to time the harvest, providing commercial red color has been reached. Typically, when maturity is judged using background color little **starch** remains in the fruit, thus the life of the fruit in long-term storage is shortened. Research from scientists in the eastern United States has shown that the risk of Soft Scald increases in early-harvested fruit even when caution is taken to avoid chilling after harvest.*

Range in number of harvests/pickings for a single block: N.R. (no response)

PRECONDITIONING - *It is critical to re-iterate that Honeycrisp is a very chilling sensitive apple. The disorders that can develop from rapid cooling or excessively cold storage temperatures include Soft Scald and Soggy Breakdown. The potential for this to happen is very real and often can have serious economic repercussions. These disorders have appeared in as little as 7 to 14 days in fruit that were placed rapidly in storage and held in low temperature (32 °F).*

Typical preconditioning temperatures and durations for air storage - Research in Washington and New York has shown success when Honeycrisp is held at or about 50 °F for 7 days prior to being placed in cold storage. However, when Bitterpit susceptible fruit are held at these warm temperatures this disorder can become a big problem. Therefore, minimization of Bitterpit risk in the orchard is an important component in growing this fruit. There has been little success in increasing calcium in apples (to reduce the potential for Bitterpit) through the use of postharvest calcium drenches.

Typical preconditioning temperatures and durations for air storage + MCP, if different from above: N.R.

Typical preconditioning temperatures and durations for CA storage: N.R.

Typical preconditioning temperatures and durations for CA storage + MCP, if different from above: N.R.

Other (e.g., humidity control, moisture loss): N.R.

PRESTORAGE TREATMENTS - *Honeycrisp has a high potential for decay. Therefore, the postharvest application of a fungicide drench or preharvest fungicide spray should be considered.*

1-MCP application: *In research trials, the application of SmartFresh has shown to reduce acidity loss, greasiness and internal radial browning. SmartFresh has not been identified as affecting the risk of Soft Scald or Soggy Breakdown.*

DPA application: *Researchers in the eastern United States have not found a benefit from the application of diphenylamine (DPA) and there has been no experience with it in Washington.*

Fungicides: N.R.

Calcium dip: N.R.

STORAGE TREATMENTS - *The delay in temperature reduction has shown to be effective in reducing storage disorders whether fruit are to be placed in controlled atmosphere or air storage.*

Air storage

Temperature or temperature range: *Research with Washington grown Honeycrisp has shown that when the fruit have been stored in the upper 30's (°F), over time they become greasy, the skin color changes and acidity is lost. Limited storage trials at 35 to 36 °F have given a better balance of quality and reduction of storage disorders. Temperatures in the lower 30's (°F) have resulted in an increase of storage disorders.*

Maximum duration: N.R.

Control of CO₂ during room loading: N.R.

CA storage - *Very limited trials in CA. This apple has not easily lost firmness after harvest; but there has been little work on the effect of storage on the retention of the special characteristics of aroma, flavor and texture.*

Temperature or temperature range - *CA storage at 35 °F has given good results.*

Maximum duration – N.R.

Oxygen levels: 2%

Carbon dioxide levels: 1%

Control of CO₂ during room loading: N.R.

OTHER COMMENTS or RECOMMENDATIONS - *A Note on Packing - Researchers in the eastern United States report that the use of wax on Honeycrisp could have led to the development of severe internal breakdown in as little as 5 to 10 days in storage.*