

Project Title: Phase 3 Evaluation of Apple Breeding Selections

Report Type: Final Project Report

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Cooperators: Growers: Stemilt Inc., Allan Brothers and Douglas Fruit. Apple Breeding Program Advisory Committee: Aylin Moreno (Taggares Fruit), Oscar Garcia (Taggares Fruit), Garrett Henry (Douglas Fruit), Mark Stennes (Agrimacs), Jonathan Cox (Double Diamond), Paul Cathcart (Columbia Reach), Dale Goldy (Gold Crown), Dave Gleason (Superfresh), Jeff Cleveringa (Columbia Fruit), Anne Morrell (Columbia Fruit), Jeff LaPorte (Chelan Fruit), Lauren Gonzalez (GS Long), Sarah Franco (Allan Bros.), Suzanne Bishop (Allan Bros.), Rob Blakey (Stemilt), Bernardo Reyes (Stemilt), Craig Anderson (Gilbert Orchards), Dena Ybarra (Perleberg orchards), Matt Miles (WTFRC commissioner). Technical consultants: Stefano Musacchi, Carolina Torres, Bernardita Sallato, Dave Rudell. Industry partners: AgroFresh and Storage Control Systems.

Project Duration: 3 Years

Total Project Request for Year 1 Funding: \$53,478

Total Project Request for Year 2 Funding: \$56,127

Total Project Request for Year 3 Funding: \$59,791

Other related/associated funding sources: Stemilt and Allan Brothers provide farm crew assistance for pruning, thinning, and field maintenance, Agrofresh donates Smartfresh, and Stemilt assists with SmartFresh and postharvest fungicide application. Columbia Fruit and Columbia Reach assisted with packing line assessment. Washington Fruit donated apple boxes and trays.

Agency: WSU apple breeding program royalties**Amount awarded:** ~\$500,000 per year (2023-2026)**Notes:** Funding supports all other aspects of the apple breeding program (Phase 0 to Phase 2), including all program staff, a full-time farmworker position at WSU Columbia View orchard, and graduate student assistantships. Funds to supplement Phase 3 evaluations are provided as necessary for consumer tastings, equipment, and consumables.**Funding Duration:** 2021-2024**Agency Name:** WSDA Specialty Crop Block Grant Program**Amount awarded:** \$220,045**Notes:** Establishing rootstock and production system recommendations for new Washington apple selection (WSU 'L') Evans, Musacchi, Sallato. This project will collect complementary information for an elite P3 selection that will be released.**Funding Duration:** 2021-2024**Agency Name:** Washington Research Foundation**Amount awarded:** \$99,932**Notes:** Rootstock and systems trial for WA 64 apple. Evans, Musacchi, Sallato. This project continues the development of production recommendations for WA 64.**Funding Duration:** 2024-2025**Primary PI: Manoella Mendoza****Organization Name:** WA Tree Fruit Research Commission**Contract Administrator:** Paige Beuhler**Telephone:** (509) 665-8271**Contract administrator email address:** paigeb@treefruitresearch.com**Station Manager/Supervisor:** Ines Hanrahan**Station manager/supervisor email address:** hanrahan@treefruitresearch.com

Item	2023	2024	2025
Salaries			
Benefits			
Wages	\$28,523.00	\$30,079.00	\$32,259.00
Benefits	\$11,409.00	\$12,120.00	\$13,204.00
RCA Room Rental	\$12,746.00	\$13,128.00	\$13,528.00
Shipping			
Supplies	\$500.00	\$500.00	\$500.00
Travel	\$300.00	\$300.00	\$300.00
Plot Fees			
Miscellaneous			
Total	\$53,478.00	\$56,127.00	\$59,791.00

Footnotes: Wages/Benefits: calculated based on expected staff wage adjustments. RCA room rentals: 2 rooms, including room operation costs and warehouse fees, adjusted yearly. Supplies: consumables for fruit quality analysis (KOH, distilled water, iodine, etc.). Travel: in-state travel

Justification

New and improved apple varieties are essential for a successful Washington apple industry. The WSU apple breeding program (WABP) aims to produce a portfolio of new, improved, unique varieties specially selected for the environment of central Washington and available to Washington's growers. Developing improved apple varieties leads to *sustainable production and enhanced postharvest efficiency*, thereby promoting *sustainability and long-term economic viability by increasing apple packouts*.

P3 selections were planted in three grower-collaborator sites. The advantage of this arrangement is the ability to observe the growth habits and characteristics of advanced selections in a commercial production setting. Having the WTFRC manage P3 provides an independent, industry-oriented evaluation that, with input from industry representatives on the apple breeding program advisory committee (BPAC), ensures that the data collected and information provided align with stakeholders' interests. The project results, including single pick potential, harvest window, storability, and resistance to biotic and abiotic stress, are presented to the BPAC annually. Field visit opportunities are included throughout each season.

Objectives

1. Evaluate and determine the commercial potential of advanced selections of the WABP

Significant Findings

1. Although selection P has good shelf-life potential, it was *discontinued* due to its consistent bi-annual bearing and small fruit size.
2. Although selection R had a lower incidence of storage disorders, it was *discontinued* due to its inconsistent flavor and lower firmness retention.
3. Q and S grew to reach the top wire within the first year on both sites.
4. Selection Q has good firmness retention, losing only about 2 lb. after long-term storage, but bruises relatively easily.
5. Selection S, a yellow-colored apple, has good storage potential, maintaining flavor and texture long term.
6. Selection S presents low storage disorder overall, but internal browning incidence can be high due to advanced maturity at harvest.
7. The clusters of WA 64, also known as selection L, are mostly singles and doubles, but there are differences between sites.
8. WA 64 performed well in packing line assessments, achieving high packouts (71% to 92%).
9. WA 64 is not sensitive to high CO₂ concentration (0.5% O₂/ 5.0% CO₂) and performs well under low oxygen storage (0.6% O₂ and 0.5% CO₂).

Methods

Bud and Bloom observation: Field observations began as the trees started to bloom, occurring at least twice a week, considering the weather patterns and their influence on blooming. The full bloom date is determined for each Phase 3 (P3) selection and the standard varieties near the P3 plots. Starting at this stage, every field visit includes general observations on disease incidence, tree growth habits, and health. Standard management practices (rodent activity monitoring, powdery mildew sprays, row mowing, etc.) are conducted and discussed with field managers. Pest and disease incidence and monitoring are documented during the entire season.

Fruitlet development and pre-harvest: Field activities for this stage start after June drop. Orchard visits occur at least every other week until a month before the predicted harvest. Observations on fruit sets and self-thinning were documented. The orchard crew performed hand-thinning and summer pruning when appropriate, as if the selections were being produced commercially. A specific pruning recommendation plan was put forward following consultation with the grower, BPAC members, and other specialists (e.g., Stefano Musacchi and Bernardita Sallato).

Harvest: Starch degradation, color, background color, and flavor development were assessed during pre-harvest visits. Once the harvest date was established, the harvest was conducted in one to three picks, depending on selection and crop load. The selections were strip-picked. Apples were harvested using picking bags and placed in blue crates (30 lb.). The apples with cracks, insect damage, chemical damage, splits, severe sunburn damage, bitter pit, and bird peck were classified as culls in the field. These apples were collected during harvest and weighed separately; the reason for cullage was assessed on individual fruit, and the data were used to calculate the percentage of fruit loss in the field.

The storage samples were weighed in the field and separated into two storage conditions: Refrigerated air (RA, 33°F) and controlled atmosphere (CA, 34°F 1% CO₂, 2% O₂), with and without 1-MCP treatment. This fruit was drenched with postharvest fungicide at a Stemilt drencher location and stored at the Research CA rooms at Stemilt. Stemilt administered the 1-MCP treatment within one week of harvest.

Quality at harvest was assessed within 48 hours. Evaluations included starch degradation (Cornell 1-8), firmness (lb.), soluble solids (% Brix), titratable acidity (% m.a.), color (% of red coverage), background color, size (in.), weight (gr.), DA index, and presence/absence of internal and external defects/disorders.

Post-harvest: Quality assessment was conducted at 3 and 6 months of storage for apples in RA and at 6 and 9 months for apples in CA. Apples with and without 1-MCP treatment were evaluated at the same time points. Quality analysis was conducted after 7 days at room temperature to determine the potential quality for consumers after shipping, handling, and purchase. Per BPAC recommendation, apple quality was also evaluated after 2 weeks at room temperature for fruit stored at 6 months in RA and 9 months in CA, starting with fruit harvested in 2024. This analysis will assess the potential quality for consumers in a scenario where the time from fruit handling to consumption exceeds one week. Box size distribution data was generated from individual fruit weights. Fruit was distributed at meetings and events as available.

Advanced Phase 3

When a selection is considered a good contender for commercialization (typically after at least four years in P3), it will receive the following additional evaluations:

- commercial packing line handling: glossiness, bruising, stem puncture, cullage, size and packout data is collected. Fruit is evaluated in the laboratory after the packing line run on the same day, after 7 days in RA storage, and 7 days in RA + 7 days at room temperature.
- formal consumer taste panels: coordinated with Kate Evans (co-PI and WSU apple breeder) and performed in locations or events with diverse consumer demographics (i.e., Spokane mall, Apple Blossom Festival). The protocol utilized was generated by Carolyn Ross (Professor and Director of the Sensory Evaluation Facility, WSU Pullman).

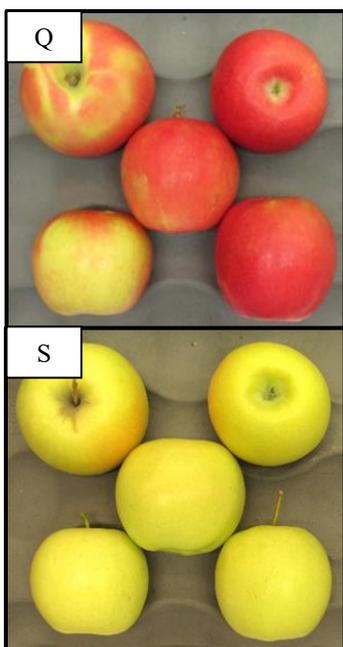
WA 64 (selection L)

In addition to packing line handling and a formal taste panel, this selection was tested for CO₂ sensitivity and Low oxygen storage. The CO₂ sensitivity test was performed using the USDA CA chambers (0.5% O₂/ 5.0% CO₂, 37°F), and low oxygen storage experiment was performed in two SafePods (control: 2.0% O₂ and 1.0 % CO₂, treatment: 0.6% O₂ and 0.5% CO₂), both set at 37°F.

Results and Discussion

During this reporting period, we evaluated five selections: L, P, Q, R, and S. Selection L (WA 64) has been released, while selections P and R have been discontinued (refer to previous reports for details). Selections Q (Cripps Pink × Honeycrisp) and S (Honeycrisp × WA 2) remain active within the program. This report will provide detailed information on selections Q, S, and WA 64.

Selections Q and S:



These two selections were topworked in Quincy in 2020 and in Sagemoor in 2021. Most of the trees reached the top wire within one year. Tree growth is similar on both sites, with some blind wood in the middle section and heavily cropped treetops. Both locations were defruited in the first year and hand-thinned in the following years.

At the Quincy site in 2023 and 2024, the farm crew performed hedging and summer pruning in accordance with Stefano Musacchi's recommendations. In Sagemoor, winter pruning was performed following selection-specific recommendations by Bernadita Sallato.

Fruit was harvested in 2022 from Quincy and from both sites in the following years. In 2022, all ABP selections and apple varieties harvested by the WTFRC crew generally had less color and higher bruising incidence. Also, we observed a period of stagnation in starch degradation for a few weeks, followed by rapid depletion, which might have led to fruit being picked at an advanced maturity stage. In 2023, the harvest timing was adjusted, and the fruit had better color and lower bruise incidence. The information in the following sections summarizes all the data collected until 2024. Quality analysis for 2025 is ongoing.

Selection Q

A bicolor apple with medium to large fruit, with box size peaking at 72 (range 72-88). Fruit typically has a short stem and is considered easy to pick. This selection was strip-picked in two picks, except in the first year of production in Quincy, when it was harvested in three picks. Starch degradation at harvest ranged from 2.4 to 5.6 (Cornell, 1-8). It has a good texture and flavor, but the percentage of bland and off-flavor increased with storage duration and days at room temperature (7 to 14 days).

Selection Q retains firmness well. At harvest, it ranged between 15.3 and 17.0 lb. in Quincy and 16 to 20 lb. in Sagemoor, with a maximum loss averaging 2 lb. during storage. SSC increases by about 2.0 (% Brix) from harvest to 9 months CA. Titratable acidity varied, with an average of 0.55, but in some instances, it decreased to 0.25.

There was a low incidence of preharvest and storage disorders. The incidence of bitter pit, soft scald, superficial scald, and split was below 1% per pick. Internal browning was most often observed in fruit stored in CA for 9 months, with a few instances in fruit stored in RA for 6 months. Incidence for each time point was higher in Quincy (up to 20%) than in Sagemoor (up to 7%). This selection bruises relatively easily compared with apples that are more resistant to bruising, like WA 64 or WA 38.

Action plan: In addition to the standard evaluations, this selection will be analyzed on the AWETA research packing line at TFREC to collect data on standard packout grading (color and size) and bruise sensitivity.

Selection S



This is the only single-colored apple selection in P3 currently in production. At harvest, the color at both sites ranged from pale yellow to golden, with a darker color and a blush on the sun-exposed side of the apple. At Sagemoor, the trees are planted on a spindle system on G.969 rootstock at 4 x 12 ft spacing. In Quincy, the trees were planted in a biaxis system on M9 Nic.29 and G.41 at 3 x 12 ft spacing. Two additional plots were planted near Pasco, at Douglas Fruit orchards in 2025, one with and one without netting.

Biannual bearing was observed on both sites, but more prominently in Quincy, where 2023 was a low-production year. 2024 was heavily cropped and not thinned properly, resulting in small, under-colored apples and no crop in 2025. Fruit in P3 is typically hand-thinned to observe inherent tree bearing characteristics. Due to the highly variable crop load scenario, selection S will be chemically thinned in 2026.

In Quincy a wide variation in starch degradation at harvest (Cornell 2 to 7) was observed on the first pick in 2022 and 2024 (heavy crop years). The second and third picks had advanced starch degradation at harvest (7.3 ± 0.6). In 2023 (low crop), the fruit in Quincy was harvested in a single pick, about 2 weeks earlier than in 2022, and starch degradation was 2.4 ± 1.1 . In Sagemoor, starch degradation was less advanced at harvest in 2023 (1.8 ± 0.7) than in 2024 (4.8 ± 0.4).

No bitter pit or pre-harvest drop was observed. However, overall limb rub incidence was considerable, ranging from 11.2% to 16.5% across all years and locations. Sunburn development is more prominent in Sagemoor than in Quincy, resulting in 13% cullage due to sunburn (Figure 1). In Sagemoor, Parka is used to mitigate sunburn, while overhead cooling is used in Quincy. The latter has no fruit loss due to sunburn cullage. Blush was also more prominent in Sagemoor (56%) than in Quincy (13%) (data not shown).

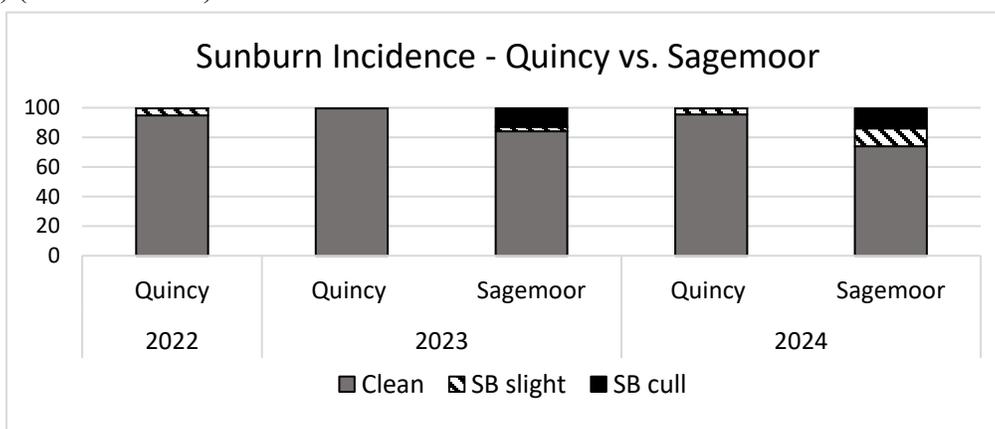


Figure 1. Total annual incidence of sunburn for selection S by location and sunburn type: no sunburn (clean), slight, and severe (cull)

Overall, greasiness was low, with a higher incidence in fruit stored for 6 months in RA. Stem puncture and soft scald were below 2%, and superficial scald was below 1%. Split incidence is typically higher in Quincy (2.8%) than in Sagemoor (1.9%). Average per pick can range from 0.8% to 6%, with a higher incidence on the last pick. The highest incidence of bruising was observed in the first year, when fruit was harvested at advanced maturity. Flavor and texture are consistently highly rated.

Senescent internal browning was observed in all years and locations, ranging from 0% to 80% (Table 1). In 2022, fruit from Quincy developed internal browning in most of the timepoint/treatment combinations, starting at 3 months in RA and increasing by pick and time in storage. In 2023 and 2024, internal browning at a much lower rate and was first observed after 6 months in storage. In Sagemoor, the incidence of internal browning was very low in 2023 and increased in 2024, when apples were harvested at a more advanced stage of starch degradation. These results indicate that the high incidence of this disorder is due to advanced maturity at harvest and might also be influenced by crop load.

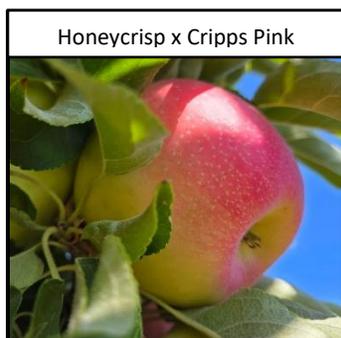
Table 1. Internal (senescent) browning incidence for selection S harvested from Quincy and Sagemoor, by year and storage timing evaluation. Years of heavy bearing are indicated with an asterisk (*).

Year	Quincy						Sagemoor	
		2022*		2023	2024*		2023*	2024
Har. Date	9.28	10.6	10.12	9.11	9.12	9.18	9.5	9.1
Starch (1-8)	5.8	7.3	7.4	2.4	4.6	-	1.8	4.8
	Internal Browning incidence (%)							
Harvest	0	0	0	0	0	0	0	0
3 mo RA	0	40	43	0	0	0	0	3
3 mo RA+MCP	18	38	40	-	0	0	-	-
6 mo RA	8	33	33	18	0	33	10	8
6 mo RA+MCP	0	80	35	-	0	3	-	-
6 mo CA	25	58	65	25	15	48	10	53
6 mo CA+MCP	38	58	40	-	-	13	-	-
9 mo CA	10	55	70	23	13	30	0	0
9 mo CA+MCP	23	80	75	-	13	38	-	-

Action plan:

- To mitigate internal browning, some batches of selection S were conditioned at 50°F for a week and stored in RA (33°F) or CA (0.5% O₂/ 5.0% CO₂, 37°F) in 2025, following Rudell's recommendation.
- To address annual bearing, the selection will be chemically treated on all sites in 2026, including the new plantings at Douglas fruit.
- For sunburn mitigation, adjustments to spray applications are needed at Sagemoor, and the addition of netting at Douglas fruit will provide insight into the efficacy of different sunburn mitigation techniques, including the overhead cooler in Quincy.

WA 64 (Selection L) – Sunflare™



WA 64 is the new release from the WSU apple breeding program and has received the commercial name of Sunflare™. Commercial planting availability and the first commercial harvest are predicted for 2026 and 2029, respectively.

This selection was grafted in 2015 on both Prosser and Quincy locations, on M9.337 and G.41 rootstocks, respectively. Tree structure (type III) is comparable to cv. Braeburn, and harvest timing is similar to cv. Golden Delicious, with bloom time similar to cv. Gala in Quincy.

WA 64 is a bicolored symmetrical apple that colors well when exposed to sunlight, typically achieving 50% to 70% red/pink blush with a yellow background. It is slow to brown, easy to pick, and pre-harvest drops have not been observed. Its unique trait is high firmness retention during storage, which, combined with the low incidence of disorders and diseases in the field and during storage, grants this selection a long shelf-life potential.

Self-thinning was observed and recorded as qualitative data in the P3 sites for a few years of production. In 2023, sections of 30 trees in each location were marked with ribbons during bloom, and the number of clusters was recorded. The number of fruitlet clusters and cluster classification (singles, doubles, triples, and quadruples or higher) were recorded after the June drop but before hand-thinning. The tree sections were selected that had 50 to 60 bloom clusters.

In Quincy, fruitlet distribution was similar across years, with more than 60% of clusters set as singles, and triples and quadruples combined equaling 8 to 10% (Figure 2). In Prosser, the crop load was more evenly distributed between categories, with an increase in quadruples from 2023 (12%) to 2024 (21%). A higher percentage of single fruitlets and a lower percentage of quadruples were observed in Prosser in 2025 in comparison with previous years. The clusters in Prosser were hand-thinned to singles and doubles, and production levels were similar to previous years (data not shown).

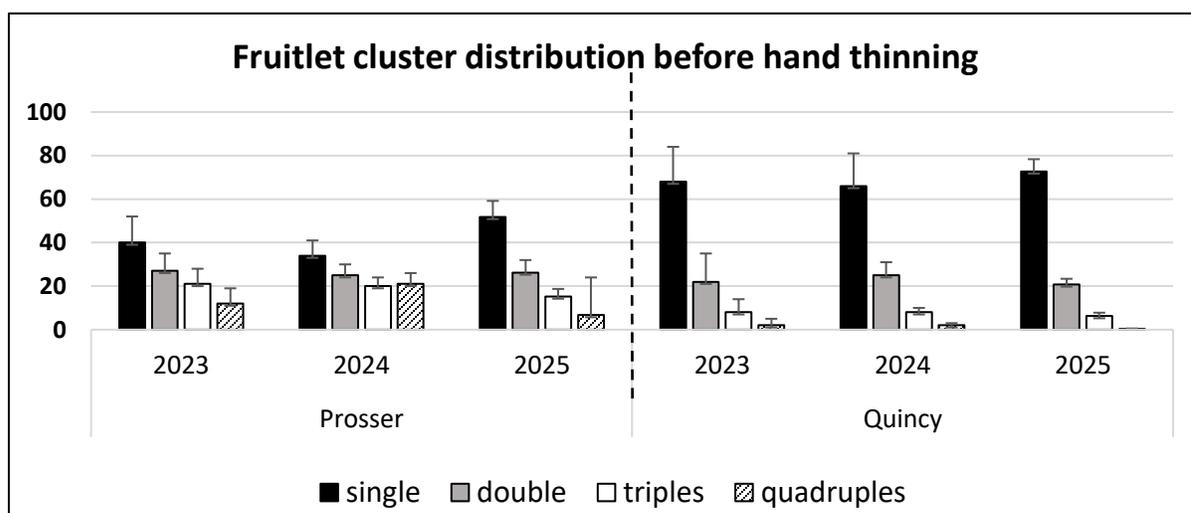


Figure 2. Distribution (%) and standard deviation of WA 64 fruitlet cluster by category (singles, doubles, triples, and quadruples or higher) in 2023, 2024, and 2025 for Prosser and Quincy.

Fruit flavor after harvest

This data was collected to determine whether WA 64 apples can be eaten immediately after harvest, meaning no delays in packing and shipping. WA 64 harvested from Prosser and not treated with 1-MCP was stored in RA for one week. The apples were tasted at room temperature during four events, 10 to 18 days after harvest. A total of 97 participants evaluated the appearance, flavor, and texture of WA 64 apples on a scale from 1 (poor) to 5 (outstanding). The combined scores for categories 4 and 5 were 93% for appearance, 94% for flavor, and 96% for texture. No starchy or poor flavor was detected. These results indicate that WA 64 can be immediately packed after harvest.

Packing line assessments

Packing line handling evaluations, including glossiness, bruising, stem puncture, decay, storage disorders, and fruit flavor, were conducted in 2022, 2023, and 2024. In 2022, two bins of WA 64 were harvested from Quincy, and the evaluations occurred in March and August of 2023 using fruit stored in RA and CA, respectively (Figure 3A). In 2023, 2 bins of apples were harvested from each site, and one bin per site was stem clipped. One set (stem clip vs. non-stem clipped) was stored in RA and evaluated in May; the other in CA was evaluated in August 2024 (Figure 3B and C). In 2024, 4 bins of apples from Quincy were evaluated in August 2025. The Cripps Pink grading program was used for all packing line assessments.

Packed fruit ($\geq 25\%$ red color + small or no defect) was above 70% for all packing line assessments, achieving as high as 92% for fruit from Prosser. Quincy is a challenging site for color development, and the variability is reflected in the increase of the “25 to 49% + no defect” category in 2023. In 2024 fruit was classified in only three packout grades, and total packable fruit was 91% (Figure 3D). WA 64 from Prosser typically has better color and size than Quincy, thus delivering higher packouts. Stem clipping provided slightly higher packouts in fruit from Quincy (Figure 3B), with less fruit allocated for processing and lower cullage. Fruit from Prosser that was not stem clipped had higher packouts but slightly higher cullage.

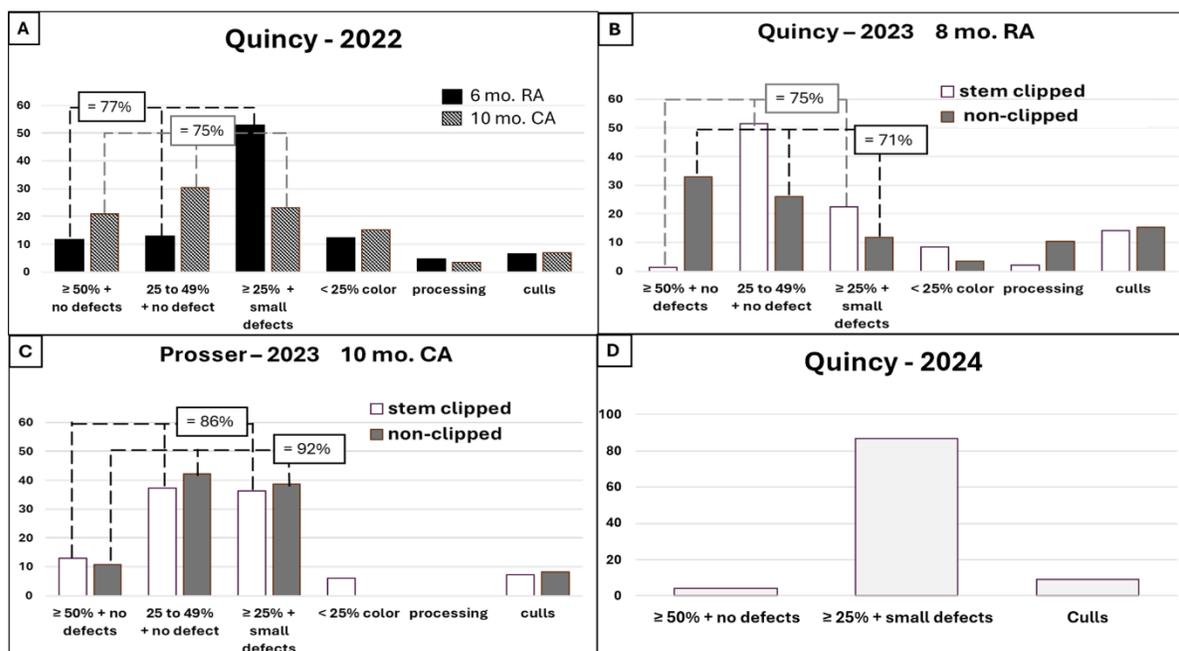


Figure 3. Packout results for the WA 64 packing line assessment conducted with fruit from Quincy (A, B and D) or Prosser 2023 (C). In 2022 and 2024, the fruit was not stem clipped. The sample size for 2022 and 2023 is one bin per treatment. In 2024, sample size is four bins.

Storage trials

CO₂ sensitivity: WA 64 apples were stored for 6 months in CA chambers at the USDA with high CO₂ concentration. Evaluations occurred monthly for external symptoms, and fruit was kept at room temperature for two weeks after the end of the experiment. No internal or external CO₂ injury was found. This evaluating as scheduled to be repeated in 2025, but it was not executed due to the government shutdown.

Dynamic controlled atmosphere: Fruit from Quincy and Prosser were transported to Union Gap and stored for 6 months at the Storage Control Systems cold room (37°F) in two SafePods (control: 2.0% O₂ and 1.0 % CO₂, treatment: 0.6% O₂ and 0.5% CO₂). In summary, fruit quality parameters were equivalent between treatments and similar over time. Better ratings for flavor were observed on fruit with lower oxygen levels after 6 months in storage and a week at room temperature.

WSDA experiment samples: WA 64 samples were collected from Sunrise in 2024 and 2025, and Roza in 2025 and stored in RA and CA, without 1-MCP. Apples were separated by rootstock and tree training system to evaluate the impact of these variables on fruit quality.

Outreach

- The article WA 64 – Tree Characteristics and Horticulture (authors: Bernardita Sallato, Sara Serra, Manoella Mendoza, Kate Evans, and Stefano Musacchi) is available at the WSU Tree Fruit website
- Legacy Grower Meeting in 2024
- WA 64 Session in the WA State Tree Fruit Association 2024 Annual Meeting
- Total of 6 WA 64 field days from 2023 to 2025. Both P3 plantings will continue to host the WA 64 field days in conjunction with the WSDA sites (Sunrise and Roza)
- WA 64 News and Tasting events held in Yakima and Wenatchee in 2025
- Two Fruit Matters articles about fruit quality and storability will be written in 2026, based on the data collected by WTFRC in P3

Project Title: Phase 3 Evaluation of Apple Breeding Selections

Keywords: apple breeding, cultivar performance, postharvest storage, field evaluation

Executive summary

The Washington State University Apple Breeding Program (WABP) seeks to deliver new apple varieties that enhance the long-term sustainability, profitability, and competitiveness of the Washington apple industry. Phase 3 (P3) evaluations play a critical role in this effort by assessing advanced breeding selections under commercial orchard and postharvest conditions. The Phase 3 (P3), managed by the Washington Tree Fruit Research Commission (WTFRC), provides an independent, industry-focused evaluation framework informed by direct collaboration with growers and the Apple Breeding Program Advisory Committee (BPAC).

Advanced apple selections were planted and evaluated at multiple grower-collaborator sites to capture performance across commercial production environments. This approach enabled detailed assessment of tree growth habits, cropping behavior, harvest timing, fruit quality, storability, and susceptibility to biotic and abiotic stress. Results were shared annually with BPAC members and the industry through data summaries and field visits, ensuring alignment with industry priorities.

During the reporting period, five selections (L, P, Q, R, and S) were evaluated. Based on cumulative field and postharvest performance, selections P and R were discontinued due to unfavorable horticultural and quality traits, including biennial bearing, small fruit size, inconsistent flavor, and reduced firmness retention. Selections Q and S remain active and continue to be evaluated. Selection Q demonstrated strong tree vigor, good firmness retention, and low disorder incidence, but exhibited higher bruise susceptibility and increased bland or off-flavor development with extended storage. Selection S showed excellent long-term storability and consumer-relevant texture and flavor, but performance was influenced by crop load variability, sunburn incidence at certain sites, and a risk of senescent internal browning associated with advanced maturity at harvest.

WA 64 (selection L), now commercially released as Sunflare™, consistently demonstrated high packout potential, strong firmness retention, low disorder incidence, and favorable consumer acceptance. The selection performed well in commercial packing line assessments, with packouts ranging from 71% to 92%, and showed tolerance to elevated CO₂ and low-oxygen storage conditions. Consumer taste panel results indicated excellent appearance, flavor, and texture shortly after harvest, supporting immediate packing and marketing opportunities.

Overall, this Phase 3 evaluation program successfully supported data-driven advancement, discontinuation, or commercialization decisions for elite apple selections. The outcomes strengthen the WABP pipeline, reduce industry risk associated with new cultivar adoption, and contribute directly to sustainable production systems and improved postharvest efficiency for Washington growers.