

Tree Characteristics and Management Recommendations for WA 64



Introduction

WA 64 is a bicolored apple, the result from a cross between Honeycrisp and Cripps Pink. It was developed by Washington State University's apple breeding program led by Kate Evans and Bruce Barritt. Patented by WSU in 2023, the trees will become available for Washington growers in 2026. WA 64 is characterized by a small- to medium-sized apple, is closer in taste and appearance to its Cripps Pink parent, and has outstanding storability (Evans et al. 2023). It is estimated to ripen around the end of September in eastern Washington conditions, close to Golden Delicious timing, and two weeks before WA 38 (Evans et al. 2023).

In 2022, two pilot orchards were planted to better understand the influence that rootstocks and training systems have on WA 64 tree growth. The rootstocks included Bud9 (very dwarfing), G.969 and G.41 (dwarfing), and G.890 (semi-dwarfing). This publication provides preliminary findings and general recommendations based on the observations from these two sites for the first three growing seasons.

Environmental conditions including soil type, elevation, temperatures, water quality, and management can significantly influence tree growth, fruit quality, and overall productivity. Thus, when interpreting cultivar-rootstock differences, it is important to consider the sites' environmental conditions.

WSU Sunrise Research Orchard (SRO), Wenatchee

The WSU Sunrise Research Orchard is located close to Rock Island, Washington (47°18'38.6"N, 120°03'52.4"W). The elevation is approximately 900 ft (around 274 m), with annual mean temperatures ranging between 23°F and 83°F. Soil has a neutral pH (7.3–7.4) and sandy-loam texture, and the northern end of the trial plot has a higher percentage of sand. The mineral composition in the northern end has less organic matter (OM 0.9%), is very high in potassium (K), magnesium (Mg), high in Zinc (Zn), moderate in calcium (Ca), low in phosphorous (P), and extremely low in boron (B) and sulfur (S). The southern end is loamier and has higher OM (1.1%), is very high in K, Mg, and P, elevated in Ca, and low in Zn, B, and S. To stabilize this soil variability, peat moss (5 m³ = 6.5 yd³ per row) was supplemented via a 3.2-foot-wide strip of mulch close to the trees in all the rows in trial for the entire length of the row.

Randomized blocks were designated within the research plot due to the soil variability. The trial was planted on May 24, 2022, with four randomized blocks each including two training systems (spindle and bi-axis) and four rootstocks (Bud9, G.969, G.41, and G.890). Planting distance was the same for both training systems (11 ft × 3 ft), corresponding to a planting density of 1,320 trees/acre. Snowdrift, Evereste, and Indian Summer pollinizer trees were interplanted every ten WA 64 trees along the rows.



WSU Roza Research Farm, Prosser

WSU Roza Research Farm is located in the Yakima Valley near Prosser (46°17'31.3"N, -119°43'54.6"W). The elevation is approximately 1,164 ft (around 355 m), with annual mean temperatures ranging between 22°F and 77°F. The soil is a Warden silt loam, with an effective depth ranging from 32 to 48 inches and characterized by a layer of calcium carbonate (caliche) at variable depth. Soil pH is neutral to alkaline with a slow water infiltration rate of 0.5 in/hr. Soil OM is low (0.8%), and nutrient levels are high, except for P, B, and S, which are generally below adequate ranges in the Yakima Valley (Sallato et al. 2019).

The demonstration plot has one 400 ft row established as a V-angled system at 12 ft between rows, and three vertical rows at 10 ft. Within the V-trellis system, trees were planted by rootstock (not randomized), starting with 25 double-budded trees planted at 1.5 ft apart (forming a Y-trellis), followed by the single-budded trees (forming a V-trellis system). A modification of the system was established for a few trees on G.969 and G.41 rootstock, and the laterals were trained to the vertical wire in a Tatura-style system (Van den Ende et al. 1987). Two of the remaining vertical rows were planted with 3 ft between trees, the first grown as bi-axis and the second as spindle. In the last vertical row, a set of five trees per rootstock were planted at 6 ft, 5 ft, and 4 ft apart, trained to an upright fruiting offshoot (UFO) training system.

Growth and Productive Habit

Tree Habit

WA 64 tree growth habit is similar to Braeburn, considered a type III bearer (classification from Lespinasse [1977]) with low-medium vigor, depending on the rootstock. A severe lack of vigor can result in excess spur formation, compromising fruit size. It tends to produce abundant, lateral shoots with a wide crotch angle (from 60° to 90°) (Figure 1). WA 64 tends to produce on spurs and terminal mixed buds of one-year-old shoots.

The apical bud of the leader, when in vertical position, consistently developed two to three uprights equivalent in size, suggesting it does not have strong apical dominance. It is important to remove the competition during active growth (i.e., spring) to promote growth of the leader during orchard establishment (Figure 2).

WA 64 produces plenty of mixed buds; it is recommended to remove them in the first year to promote growth. Shortening the shoots requires attention in high-vigor

conditions, because the internodes can be long, and die-back can occur (Figure 3).

Bearing Wood

WA 64 bears fruit on the terminal buds of the shoots (*brindilla*) or on spurs (Figures 4 and 5).

Bloom

Like its parent Cripps Pink, WA 64 blooms early, around the same timing as Gala. At the Sunrise Research Orchard during the 2024 season, the king flower opened on April 3 (Figure 6, left photo) and was the earliest cultivar to bloom on site. In Prosser, the bloom was two to three days after Honeycrisp, around April 18 in the 2024 season (Figure 6, right photo). Bloom density was higher than both Honeycrisp and WA 38. More years of data are needed to better define bloom time and intensity.



Figure 1. Crotch angle on WA 64. Photo credit: S. Musacchi.



Figure 2. WA 64 terminal growth with three uprights during spring active shoot growth (left) and after pruning (right). Photo credit: B. Sallato.



Figure 4. Fruit produced from spurs on the main axis (left photo) and close-up of a spur (right photo). Photo credit: S. Musacchi.



Figure 3. Stub cut with normal bud break and shoot formation (top photo). Long internodes result in blind wood, and only collar latent bud responds to the cut (bottom photo). Photo credit: S. Musacchi.



Figure 5. Mixed terminal bud led to three fruitlets and one bourse shoot (left photo) or two bourse shoots (right photo). Photo credits: B. Sallato (left) and S. Musacchi (right).



Figure 6. Detail of a WA 64 flower cluster (left photo) and bloom intensity (right photo) during spring 2024. Photo credits: S. Serra (left) and B. Sallato (right).

Pollinizers

The study of the S-alleles for WA 64 is ongoing; however, given that the parents of WA 64 are Cripps Pink S_2/S_{23} and Honeycrisp S_2/S_{24} , most crab apples will work well as pollinizers. Snowdrift (S_{25}/S_{45b}), Indian Summer (S_{26}/S_{50b}), and Evereste (S_{20}/S_{26}) (Sheick et al. 2018) were planted as pollinizers at the Wenatchee and Prosser sites (Figure 7). At the WSU Roza site in 2024, first bloom was observed on April 12 and full bloom on April 15, coinciding with Evereste and Snowdrift bloom.

Thinning and Crop Load Management

WA 64 can be highly productive, and preliminary work suggests the need for crop load management strategies. Trees left unthinned lead to doubles, triples, quadruplets, and sometimes five apples, which will compromise fruit size and color (Figure 8). However, in previous work on phase 3 trees, approximately 60%–80% of the clusters naturally thinned to singles and doubles.



Figure 7. First bloom on WA 64 (left photo) in 2024 (April 12) at Prosser, similar to first bloom with the pollinizers Evereste (center photo) and Snowdrift (right photo). Photo credits: B. Sallato.



Figure 8. Unthinned WA 64 clusters, with two fruitlets (left photo) and five fruitlets (right photo). Photo credit: B. Sallato.

A thorough trial will be necessary to establish the thinning procedure for WA 64. No information is available on biennial bearing due to the age of the orchards. In Wenatchee, 50% of the trees in the trial were defruited entirely in the third year. Cropping trees in its third leaf dramatically reduces vegetative growth (Figure 9 shows G.969 and Figure 10 shows G.890).

Harvest

Under Washington growing conditions, the WA 64 apple requires 150–165 days after full bloom to ripen, equivalent to Golden Delicious timing. In Prosser, harvest has occurred approximately two weeks before WA 38.

Like other bicolored apples, good light distribution through the canopy is essential for color development. Managing light at least two weeks before harvest with hedging, leaf removal, or reflective material could benefit color development.



Figure 9. WA 64 on G.969 trained as bi-axis in its third leaf with fruit (left photo) and completely defruited (right photo). Photo credit: S. Musacchi.



Figure 10. WA 64 on G.890 trained as bi-axis in its third leaf with fruit (left photo) and completely defruited (right photo). Photo credit: S. Musacchi.

Fruit Quality

WA 64 is a bicolor apple, characterized by a small to medium size, and is closer in taste and appearance to its Cripps Pink parent. One of the most prominent characteristics of this apple variety is firmness retention.

Previous research shows that firmness decreases 2 lb on average after long-term storage.

WA 64 is described as a firm, crisp, and juicy apple with a balanced sweet-tart flavor. Taste and texture were preferred by consumers when directly compared to Cripps Pink or Honeycrisp in pairwise tests in April and May 2022. There has been no incidence of internal browning or cavities, and water core was found only sporadically at harvest. No bitter pit or superficial scald incidence has been recorded in the breeding program phase 3 evaluations, while only a few apples with bitter pit were found in the WSU Roza orchard.

If left unprotected, the fruit is susceptible to sunburn (Figure 11), similar to other bicolor apples, and heat-mitigating practices will likely be needed in Washington.



Figure 11. WA 64 sunburned fruitlets (necrosis and oxidative stress). Photo credit: B. Sallato (left) and S. Musacchi (right).

Fruit quality assessment on the apples harvested in the two test sites will continue as trees mature.

Rootstocks

Four rootstocks have been evaluated: Bud9, considered very dwarf, G.969 and G.41, considered semi-dwarfing, and G.890, considered vigorous. These rootstocks represent a wide range of vigor and provided general information relative to vigor influence and its relation to each other.

Some differences regarding vigor level have been noticed between the two locations. This can be related to the different soil conditions between Wenatchee and Roza sites and management practices. For this reason, each site is reported separately.

WSU Sunrise Research Orchard

One month after planting in the spindle combinations, the G.969 trunk cross-sectional area was smaller, similar to Bud9, while G.41 was intermediate, and G.890 was larger (Figure 12).

The bi-axis trees at planting show a different situation. G.969 consistently had the smaller trunk cross-sectional

area, while no differences were noticed between G.41 and Bud9 trees (Figure 13). G.890 showed the larger trunk cross-sectional area. In general, the bi-axis trees showed reduced vigor compared to the single-axis trees by approximately 25% (Figures 12 and 13).

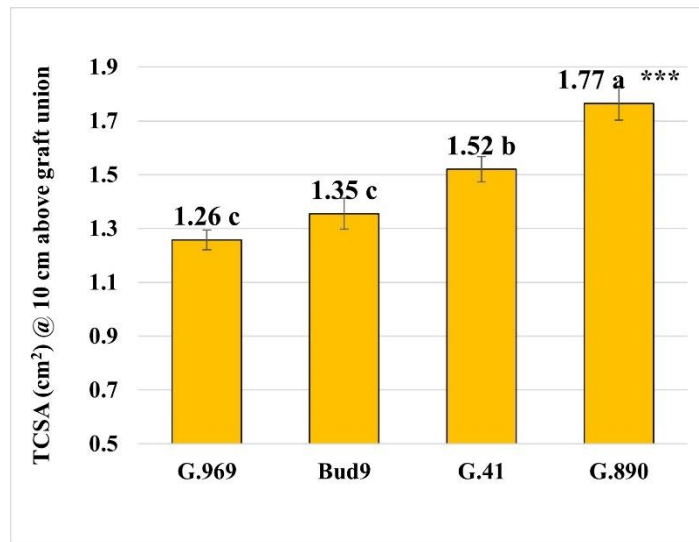


Figure 12. Trunk cross-sectional area (TCSA) of spindle trees ($N = 48 - 50$) at planting (one-year-old) in the WSU Sunrise Research Orchard. Column bars represent the means, and the error bars the standard error. Different letters associated with the means indicate statistically significant differences ($*** = p < 0.001$).

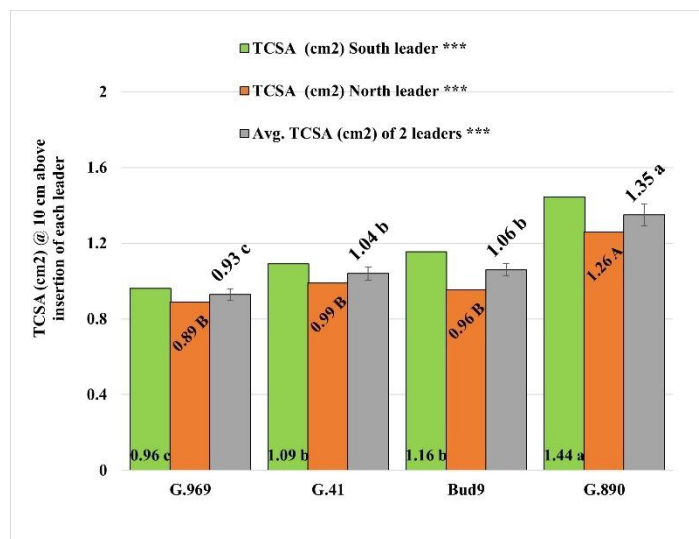


Figure 13. Trunk cross-sectional area (TCSA) of bi-axis trained trees ($N = 47 - 49$) at planting (one-year-old) in the WSU Sunrise Research Orchard site. The average trunk cross-sectional area has been calculated as the mean of the two leaders and represented with the grey bars, while the single leader values are reported in green for the south leader and in orange for the north leader. Error bars represent the standard error. Different letters associated with the means indicate a statistically significant difference ($*** = p < 0.001$).

After two growing seasons, there were differences in vigor among rootstocks. Trees grafted on Bud9 were significantly smaller than the other rootstocks in both training systems. G.969 and G.41 showed an intermediate vigor, and G.890 was the most vigorous (Figure 14). The

TCSA for spindle-trained trees were 51% higher than bi-axis trees (Figure 14).

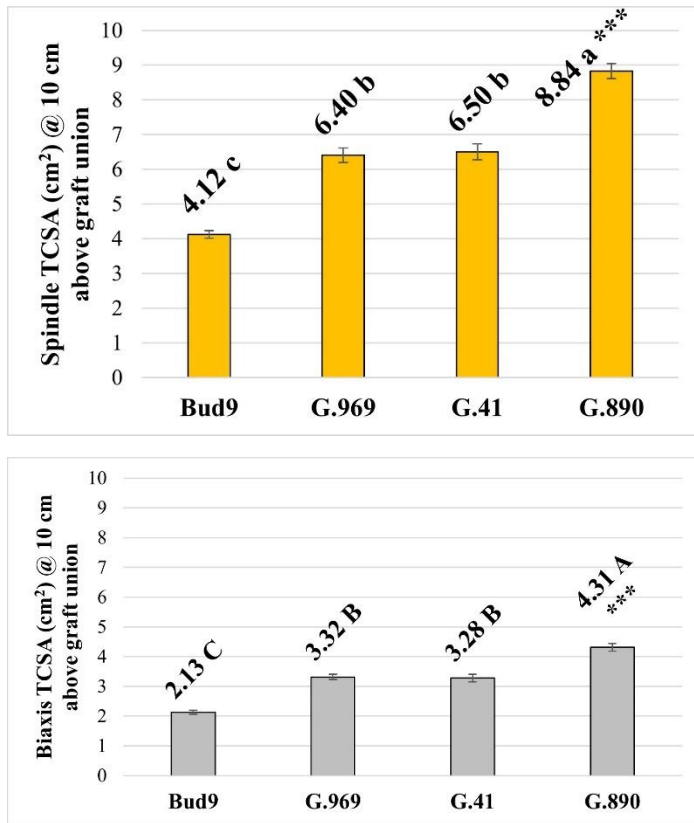


Figure 14. Trunk cross-sectional area (TCSA) of spindle trees (left graph) and bi-axis trees (right graph) after two vegetative seasons (October 2023) at the WSU Sunrise Research Orchard site. Bi-axis TCSA has been calculated as an average of the two leaders' TCSA. Different letters associated with the means ($N = 47 - 50$) indicate a statistically significant difference ($*** = p < 0.001$). Error bars represent the standard error.

WSU Roza Research Farm

Trees on Bud9 are smaller and very fruitful. Given the reduced vigor imposed on the cultivar, Bud9 would not be a suitable rootstock for sandy, coarse soils, soils with reduced nutrient and water retention, or stress conditions. If choosing Bud9, single leader systems might be better than the bi-axis or multi-leader systems. To promote vigor, intensive winter pruning will be necessary for Bud9 or other very-dwarfing rootstocks. Avoid cropping the trees until the leader reaches 70% of the desired height. Crop load management will be necessary to maintain adequate shoot-to-fruit balance and fruit size.

At the WSU Roza Research Farm, almost all terminal buds were reproductive (Figure 15). Thus, heading the laterals to promote structure during orchard establishment is recommended for vegetative growth.

The first year after planting, G.41 at Roza grew like G.890 and G.969. However, after the third year, tree growth of G.41 was reduced (Figure 16).



Figure 15. WA 64 on Bud9 terminal reproductive buds at the WSU Roza Research Farm on April 23, 2023. Photo credit: B. Sallato.

The G.890 and G.969 had equivalent height and shoot growth. Due to the higher vigor imposed by these rootstocks when planted in fertile soils coupled with high water retention, it is recommended to consider management practices to control excessive vigor. For example, minimize winter pruning, reduce nitrogen and water, and conduct summer pruning or de-leaving prior to harvest. Given the susceptibility of WA 64 to sunburn damage, if high temperatures and light intensity conditions are expected before summer pruning or de-leaving, growers will need to implement heat mitigation practices as well (e.g., protective sprays, shade).

When utilizing vigorous rootstocks in vigorous conditions, training systems that provide vigor control might be more suitable—for example, bi- or multi-axis, angled systems (V- or Y-trellis, or Tatura-style) at high density to restrict root growth.



Figure 16. Three-year-old WA 64 trees grown as spindle, at 3 ft x 10 ft on Bud9, G.41, G.969, and G.890 rootstock (left to right). Photo credit: B. Sallato.

At the WSU Roza Research Farm, tree height was lowest in Bud9, when compared to all Geneva rootstocks, regardless of the training system (Figure 17). The angled bi-axis system provided greater vigor control compared to all other training systems.

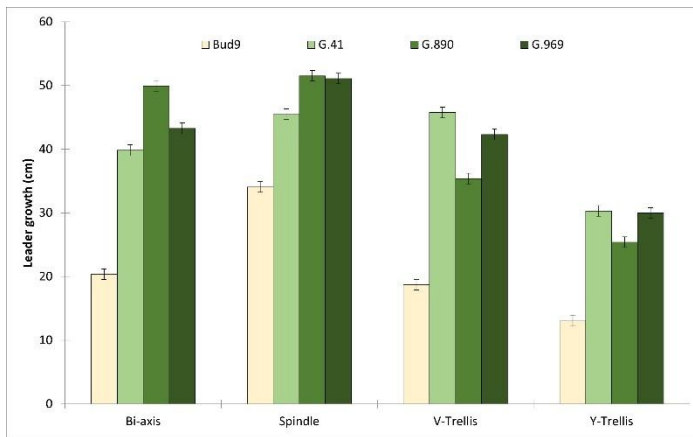


Figure 17. Differences in the main leader growth after the second year (17 months) among rootstocks and training systems at WSU Roza demonstration site (not replicated, N = 25 trees per rootstock and training system).

Training System

One of the most important decisions growers make when establishing a new orchard is the training system. In most cases, the chosen training system will remain unchanged throughout the orchard's life and will determine the block's cost and productivity. Matching the cultivar-rootstock combination with the site, planting density, and grower preferences can be challenging. In Washington State, most apple orchards are planted on a high-density trellis system. Thus, the comparisons were made among most commonly used systems. High-density systems are intended to manipulate the tree's natural growth habit to promote precocity and productivity.

WA 64 was established as spindle and bi-axis at the WSU Sunrise Research Orchard, while at the WSU Roza

Research Farm, a plethora of training systems have been set up for demonstration, including spindle, bi-axis, angle systems (V-trellis, Y-trellis, and Tatura style), and upright fruiting offshoot (UFO).

Spindle

Spindle trees have a single central leader as a permanent structure and many lateral branches of different lengths, with larger laterals at the bottom and smaller at the top (Figure 18). The distance between trees can range between two and three feet. This system architecture allows for good light interception and distribution. In general, it is not recommended to head-back the leader. At the same time, vigorous limbs, with a diameter equal to or higher than 50% of the stem where they are inserted, needs to be removed. Dormant pruning in consecutive years consists of removing vigorous, upright-growing shoots, thinning excessive or crowded areas, and stub-cutting all laterals. If trees become too vigorous, spring pruning (June) could promote fruiting wood and prevent excessive shading.

The spindle system is suitable for most rootstocks and conditions. Relative to the other systems described here, it promotes more vigor for the individual trees. When selecting dwarfing rootstocks such as Bud9, the distance between trees must be reduced (1.5 to 2.0 ft) to fill the allocated space adequately.



Figure 18. Third leaf WA 64 trees grafted on G.969 grown as a spindle at the WSU Sunrise Research Orchard. Photo credit: S. Musacchi.

Bi-Axis

This system is a nursery innovation that utilizes double budded trees from the nursery (Bibaum) or headed back in the field after planting. Trees can be planted vertically (longitudinal Y) or at an angle (Y-angled trellis).

In the longitudinal Y-trellis system, trees are planted with the double axis oriented toward the row to form a flattened shape and a two-dimensional canopy (Figure 19). Dividing the vigor between two leaders helps control vegetative growth and might reduce the number of trees per acre. The distance between trees will depend on the vigor of the cultivar–rootstock combination but commonly ranges between three and four feet apart with each leader 1.5 to 2 feet apart from the next.



Figure 19. Third leaf, double budded WA 64 trees on G.890 rootstock grown in a bi-axis system at WSU Roza Research Farm. Photo credit: B. Sallato.

Once the two main leaders are selected, they should not be headed. The pruning strategy consists of removing vigorous, upright-growing shoots, thinning excessive or crowded areas, and heading (stub) cutting laterals.

This system is preferred for vigorous growing conditions; loamy soils or sites with high nutrients and water retention, and provides greater vigor control relative to the spindle. It is suitable for most rootstocks but should be avoided for dwarfing and weak growing conditions (Figure 20).



Figure 20. Third leaf WA 64 trees grafted on G.969 rootstock grown in a bi-axis system at the WSU Sunrise Research Orchard. Photo credit: S. Musacchi.

Angle Systems

In angled systems, trees are bent to form a V or Y shape, generally at a 75°–80° angle from the horizontal (equivalent to 30°–10° opening). Angled systems are generally more productive as they can provide approximately 70% more growing area. However, they are not as well suited for potential mechanical pruning and harvest technologies. The lower third of the trees can become shaded if not managed appropriately.

- V-trellis: Trees are grown as a single leader from single-budded trees. After planting, trees are bent to opposite sides of the trellis (Figure 21). This system can be more vigor-controlling, relative to the spindle, if the distance between leaders remains equal. The planting distance between trees varies between 1.5 and 2 ft apart. This system seems suitable for all rootstock combinations at the WSU Roza orchard.
- Y-trellis: The Y trellis can be achieved by utilizing bi-axis trees (described above). Trees are planted in the middle of the row, and each leader is bent to opposite sides of the trellis (Figure 22). This system is more vigor-controlling, relative to the previously described systems. The distance between trees will determine the distance between leaders. This system is recommended for semi-dwarfing to vigorous rootstocks, such as G.41, G.890, and G.969, with planting distances varying between 1.5 and 3 ft. The Y system is not recommended for very dwarfing rootstocks, such as Bud9.



Figure 21. Third leaf WA 64 trees on G.969 rootstock grown in a V-trellis system at WSU Roza Research Farm. Photo credit: B. Sallato.

Multi Leader or Upright Fruiting Offshoot

The upright fruiting offshoot (UFO) is a highly productive system intended to create a wall of fruit, easy to manage and prune once fully established. This system can be established with double-budded trees, headed trees, or within top-grafted orchards. At WSU Rosa Research Farm, leaders in the double-budded trees were crossed to reduce strain at the bud union and then were tied in an upright position, forming a U shape (Figure 23). Bending the leaders, close to the horizontal angle, induces new uprights, filling the center of the U. This system provides flexibility regarding number (and distance) between fruiting uprights, as it can be adjusted as the trees fill the space.

This system is suitable for medium- to high-vigor conditions and rootstocks. The distance between trees will depend on the vigor of the rootstocks. At WSU Roza Research Farm, G.969 and G.890 have filled the space adequately when planted at 5 ft to 6 ft tree spacings, while G.41 can be planted closer (4 ft to 5 ft). This system is not suitable for very dwarfing rootstocks (Bud9).



Figure 22. Third leaf WA 64 trees on G.890 rootstock grown in a Y-trellis system at WSU Roza Research Farm. Photo credit: B. Sallato.



Figure 23. Third leaf WA 64 on G.969 grown as an upright fruiting offshoot (UFO) at WSU Roza Research Farm. Photo credit: B. Sallato.

Tatura

The Tatura system can be either vertical or angled (Figure 24). Only laterals near the wires are encouraged to grow at planting, while all the laterals between the wires (or windows) are thinned. Laterals are tied to the horizontal wire at the end of the growing season, creating a permanent structure for future fruiting wood. The distance between horizontal wires is commonly 18 to 22 inches. This system requires intensive training during establishment; however, once established, it is easy to prune and harvest. The Tatura system provides great light distribution, which is important for color coverage in WA 64.

This system is more suitable for medium- to high-vigor conditions and rootstocks. The distance between trees will depend on the rootstocks' vigor and angle. At the WSU Roza Research Farm, a few trees on G.969 and G.41 were trained in a Tatura-style system on a V trellis, with single-budded trees planted 1.5 ft apart (3 ft between leaders). This system is not recommended for very dwarfing rootstocks, such as Bud9.



Figure 24. WA 64 on M.9-337 rootstock in a Tatura-style system during eighth leaf at the breeding program phase 3 site in Prosser (left photo), and WA 64 on G.969 rootstock at WSU Roza Research Farm. Photo credit: B. Sallato.

Pruning Techniques

WA 64 has shown good response to heading or stub cuts, leading to regrowth of one or two laterals right below the cut. Renewal cuts should be made each year to promote vigor, renew old or weak wood, and create laterals to fill trellis space.

Even very short stubs (less than one inch) led to regrowth of one or more laterals in vigorous conditions. Thus, when considering thinning cuts (not intended for renewal) to remove excessive or crowded branches, vigorous uprights, or competition, it is recommended to make the cut close to the origin.

At the WSU Roza Research Farm, Bud9 trees were pruned more intensively in the winter to remove excessive competition and promote vegetative growth. Laterals were thinned out or headed to two or five inches (Figure 25).

The same strategy was used for all Geneva rootstocks; however, depending on the vigor of the trees, basal laterals in the bottom third of the trees were pruned to five to eight inches, leaving a few terminal fruiting buds. All shoots in the upper third of the tree (except for the leader), were headed to remove floral buds, and excessive branches were thinned (Figure 26).

In the WSU Roza Research Farm, unpruned trees on Bud9 exhibited high crop load and precocity, stunting the tree growth when compared to pruned trees. Similarly, but to a lesser degree, G.41 had an intermediate crop load. While unpruned G.969 and G.890 combinations were relatively less productive, they had excessively long branches and blind wood in shaded areas.

Summer pruning (July to August) on WA 64 can induce fall blooms (Figure 27). However, this response is dependent on timing and environmental conditions; for example, in 2023, summer pruning led mostly to vegetative regrowth. Secondary bloom seems common in WA 64, especially in low-vigor conditions.

Overall, WA 64 trees have adequate branching and do not have a strong apical dominance, which provides flexibility in determining the optimal training system. The tree responded well to short stub cuts for wood renewal in both test sites. As a scion, it has intermediate vigor, thus will perform well with various rootstocks. However, growers should be cautious utilizing very dwarfing rootstocks (Bud9) in weak growing conditions. More information on WA 64 will become available as the trees mature and new orchards become available.



Figure 25. Before winter pruning (left photo) and after winter pruning (right photo) during third leaf in WA 64 grown on Bud9 rootstock. Photo credit: B. Sallato.



Figure 26. Before winter pruning (left photo) and after winter pruning (right photo) in WA 64 on G.969 rootstock. Photo credit: B. Sallato.



Figure 27. Blossoms observed September at WSU Roza Research Farm, following early August pruning. Photo credit: B. Sallato.

Further Reading

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