Center for Crop Diversification
Martin-Gatton College of Agriculture, Food and Environment

Center for Crop Diversification Fact Sheet
CCD-SP-21
ccd.uky.edu

High-wire Tomato Production in the Greenhouse

Arundathi Sharma, Kim Leonberger, Nicole Gauthier and Qinglu Ying

Tomato is one of the most popular crops for greenhouse production. Soilless high-wire tomato production is a highly efficient greenhouse production method that allows growers to achieve consistent yields and superior fruit quality through precise environmental and nutrient management. Unlike traditional soil-based cultivation, plants are grown in soilless substrates, enabling optimal control over root-zone conditions and fertigation. The high-wire training system supports vertical plant growth, improving light interception, air circulation, and ease of crop management tasks such as pruning, deleafing, and harvesting. This method is increasingly adopted by greenhouse vegetable growers seeking to maximize productivity, extend the growing season, and reduce soilborne disease risks.

System Overview and Materials

High-wire tomato production imposes substantial and continuous vertical and lateral loads on greenhouse structures. Under full fruit load, a single mature plant may weigh 15 to 45 lb (7 to 20 kg). At typical commercial densities of 2 to 3 plants/m_2, support structures of the production system must safely carry the combined weight of the crop, retained irrigation water, and routine worker activities over a production cycle that can last 8–11 months.

A properly designed hanging infrastructure is essential for safe and successful high-wire tomato production. Support systems should use high-tensile galvanized steel wires that are securely anchored to load-bearing structural components, such as greenhouse trusses, reinforced purlins, or dedicated vertical posts instead of bows or ridge poles. All attachment points, including eye bolts, cable clamps, and hangers, should be rated for sustained crop loads and installed to distribute weight evenly across the structure. If high tunnels or lighter greenhouse structures have to be used, growers should consider independent or freestanding trellis systems that transfer crop load directly to the ground instead of the frame.

Once the support structure and hanging infrastructure are in place, additional materials are required to trellis and maintain indeterminate tomato crops, including string, wire, or twine (e.g., nylon), plant clips, hooks (e.g., roller hooks or Tomahooks). Regardless of structure type, hanging wires, anchors, and connections should be inspected regularly, particularly during peak fruit load, to reduce the risk of structural damage and ensure worker safety

In soilless high-wire tomato production systems (Fig. 1), each plant typically requires 3.5 to 5 ft² (0.33 to 0.46 m²) of growing area, equivalent to about 0.25 plant per ft² (2.2 to 3 plants per m²). Rows are generally spaced 3 to 5 ft (1 to 1.5 m) apart to allow adequate light penetration and access for crop management. Plants are commonly trained to a single main stem (also known as single head); however, during periods of high light intensity, such as in summer, an additional head may be allowed to develop from a side shoot to increase overall productivity. Tomatoes are typically grown in 3 to 5 gallon containers filled with soilless substrates or in rockwool slabs, depending on the production system used. Drip irrigation should be used to deliver water and nutrients, as it enables precise, uniform, and efficient delivery to each plant.

Figure 1. High-wire tomato demonstration in the research greenhouse at UK Horticulture Research Farm (left), and in a high-tech greenhouse facility (right). Key components include the sturdy overhead support, hooks, greenhouse twine, and clips.

Market and Economic Consideration

Between 2017 and 2022, greenhouse tomato production in the U.S. showed notable growth in both the number of operations and overall market value, emphasizing the increasing role of controlled environment systems in specialty crop production. According to the U.S. Department of Agriculture (USDA) Census of Agriculture, the number of U.S. farms producing tomatoes grown under glass or other protection increased from 7,974 in 2017 to 11,465 in 2022, a 44% increase, while total production area grew modestly from 63.9 million ft_2 to 68.4 million ft_2 (United States Department of Agriculture,2024). Despite the slight expansion in production area, sales value rose by

31%, from $748 million to $982 million, indicating higher value per unit area and improved production efficiency. Most greenhouse tomato operations remain small-scale, with 3,904 farms under 1,000 ft_2, 1,343 farms between 1,000 to1,999 ft_2, and 1,042 farms between 2,000 to 3,000 ft_2, showing that small growers make up the majority of the sector. In Kentucky, the number of greenhouse tomato farms grew from 328 in 2017 to 361 in 2022 , while production area expanded from 1.13 million $ft_2$to 5.59 million ft_2 (United States Department of Agriculture,2024). This remarkable 394% increase in greenhouse tomato production area does not capture some of the major commercial expansions that occurred between 2017 and 2022. These gains reflect strong momentum among small and mid-sized Kentucky growers entering the greenhouse tomato market.

A Note on Cultivars

Tomato cultivars (cultivated varieties) can broadly be characterized as determinate or indeterminate in terms of growth habit (Fig. 2). Tomatoes grown in the greenhouse are usually indeterminate, as these enable an extended harvest period.

Determinate cultivars	Indeterminate cultivars
- Grow to a maximum height of 4-5 ft - Restricted branching - Shorter harvest period	- Grow to indefinite height - Tall, vining growth habit - Extended harvest period

Figure 2. Photo examples and comparison of determinate and indeterminate tomato cultivars

Greenhouse tomatoes sold in wholesale markets (e. g., grocery stores) are often labeled with descriptors like “beefsteak,” “tomato on the vine” (TOV), or “cherry,” and accordingly packaged and marketed differently. Fruit is differentiated by morphological characteristics and crop management. Seed packets do not necessarily indicate which management strategy should be taken for a given cultivar. Therefore, growers (especially those selling direct-to-consumer) should consider customer preferences for taste, appearance, and packaging, as well as labor capacity and greenhouse climate management, when selecting varieties.

Tomato Growth Stages and Steering

A typical greenhouse tomato crop cycle lasts approximately 10 to 12 months. Throughout this extended production period, it is essential to identify plant growth stages and shift the crop toward desired developmental states to maintain yield and quality.

Like other plants, tomato plant growth has two main phases, including vegetative growth (focused on the development of leaves and stems) and generative growth (focused on the development of flowers and fruit). Successful production depends on maintaining a plant growth balance between vegetative and generative growth (Table 1). Vegetative growth sustains the plant's structure and productivity, while generative growth determines fruit yield and quality. Through proper crop management and environmental control, growers can influence plants to shift toward one state or the other (i.e., steering). Understanding the plants' current growth state enables growers to make informed decisions about irrigation, temperature, pruning, and other cultural practices (Table 1).

Growers are encouraged to select management strategies based on the controls and technologies already available in their production system. If existing methods are not sufficient, additional tools or technologies may be introduced to fine-tune the crop balance and improve yield and fruit quality. For example, if irrigation-based adjustments do not achieve the desired results, other technologies, such as improved active climate control, may be considered.

Table 1. Examples and indicators of vegetative and generative growth of high wire tomatoes, and strategies of crop steering.

	Vegetative Growth	Generative Growth
Examples		
Indicators	• Rapid growth • Large leaves • Soft lush growth • Thick brittle stems • Thick growing heads	• Thin growing point/head • Small leaves • Poor flower development • Short internodes

	• Large, deep yellow flowers • Long internodes • Short fruit • Leaf growth from fruit branches	• Small flowers and small, underdeveloped fruit • Very dark green color • Weak laterals
Strategies	To steer toward generative growth <u>Climate-based approach:</u> • Increase daily average temperature • Increase nighttime temperature • Increase difference and/or quickly change between day and night temperatures • Reduce relative humidity • Increase ventilation and air circulation around crop <u>Crop-based approach:</u> • Leave fruit on plant • More leaf pruning <u>Fertigation-based approach:</u> • Reduce volume of run-off • Increase water stress • Larger, less frequent irrigations • Start irrigation later and finish earlier in the day • High EC in the root zone to increase water stress • Very low EC in root zone creating nutrient stress • Reduce root pressure <u>Other approaches:</u> • Increase carbon dioxide • Wet the leaves (includes application of pesticides and foliar fertilizers)	To steer toward vegetative growth <u>Climate-based approach:</u> • Decrease daily average temperature • Reduce nighttime temperatures • Decrease difference and/or slowly change between day and night temperatures • Increase relative humidity • Reduce ventilation and air circulation around crop <u>Crop-based approach:</u> • Removal of fruit • Less leaf pruning <u>Fertigation-based approach:</u> • Increased volume of run-off • Increase nitrogen level • No water stress – frequent but small irrigations • Start irrigation earlier and finish later in the day • Low to moderate EC in the root zone • Increase root pressure <u>Other approaches:</u> • Reduce carbon dioxide

High-Wire Crop Management Tasks

High-wire, indeterminate tomato production requires consistent, timely management to maximize yield, improve fruit quality, and maintain predictable harvest schedules. Effective crop management tasks also contribute to plant steering (Table 1), helping growers guide their crops toward desired growth to achieve specific production goals.

Key routine tasks include:

- clipping and twisting
- fruit cluster pruning and deleafing (removing lower leaves)
- lowering (lower the main stem and lean along the row)
- harvesting

Clipping and Twisting

Clips and twists reduce the strain of the plant's own physical weight, transferring it to the string, and onto the overhead support. To install the system, hang the tomato hooks with the strings from the overhead support wire or support beam (Fig. 3) and attach clips to firmly hold the string in place (Fig. 4).

Figure 3. Two types of trellising hooks used for greenhouse tomato production to support vines and facilitate plant lowering. Photo: Hook suppliers

Figure 4. Properly secured clips along the string transfer the plants weight to maintain upright growth. An example of an improperly fixed clip is shown on the right.

Begin clipping the plant's main stem to the hanging string when a plant has 6 to 8 leaves, which is approximately 8 inches (20 cm) in height. As plants grow, twist the hanging string around the stems every 1 to 2 ft (30 to 60 cm) of growth. Add a new clip

every 2 to 4 ft (60 to 120 cm) of growth. Clips need to be fixed along the string (Fig. 5) and should not be placed directly above or below flower and fruit clusters to avoid impeding fruit development.

The tension of the string and tightness of twisting can be adjusted according to growing conditions (Fig. 5). For instance, under high humidity or low vapor pressure deficit, new growth tends to be softer and more delicate, so twisting should be slightly loose to avoid stem damage. Proper installation and adjustment of strings and clips help maintain vertical growth, improve light penetration, and reduce labor required for vine management.

Figure 5. Loose twisting (left) provides moderate support while allowing proper airflow and reducing the time and effort required for training. Tight twisting (center) secures the vine firmly to the support; however, it may cause damage to the stems as they grow if done too tight (right).

Pruning and Deleafing

Once fruit is set, prune each cluster to the desired number of tomatoes by cutting the truss just after the last desired fruit (Fig. 6). The optimal number of fruit per cluster varies by cultivar, plant vigor, and growing environments, but general recommendations are:

- 2 to 4 fruit per cluster for beefsteak tomatoes
- 4 to 6 fruit per cluster for tomato on the vine (TOV)
- 8 to 12 fruit per cluster for cherry tomatoes.

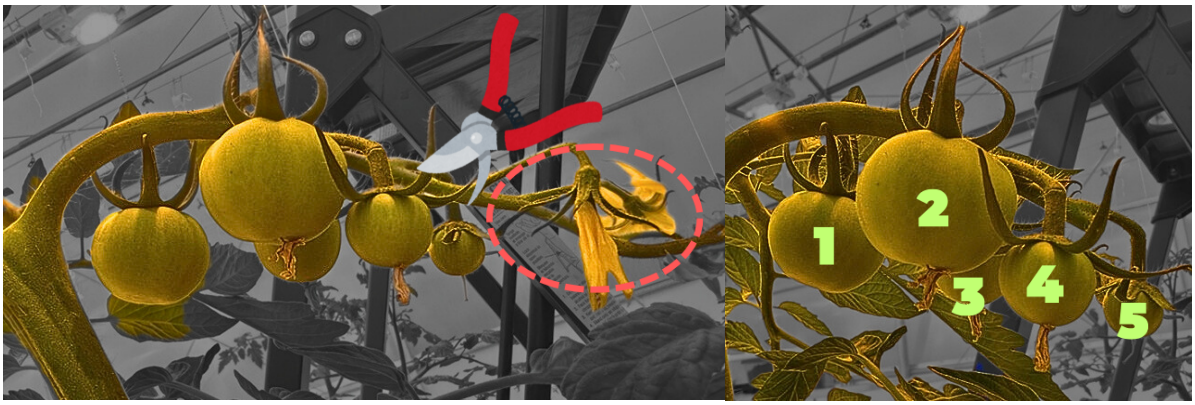

Figure 6. Tomato on the vine (TOV) fruit cluster before (left) and after (right) pruning of excess flowers. The flowers highlighted in the red circle were removed, leaving five developing fruit on the cluster.

Pruning immediately after the final desired fruit has set helps ensure proper fruit load and directs the plant's energy toward the development of desired fruit (Fig. 7). Flower pruning improves the uniformity of fruit sizes and ripening by concentrating resources toward set fruit and preventing allocation of energy to flowers that may not become viable fruit.

Figure 7. A single cherry tomato cluster can contain more than 20 flowers at different developmental stages (left). Excessive fruit set causes imbalance in energy allocation within the plant, leading to uneven ripening and irregular fruit sizes (center). Pruning is necessary to ensure uniform fruit set and ripening within the cluster (right). This enables regular harvest of entire trusses and avoids labor-intensive plucking of individual fruits.

Similar to flower pruning, deleafing is also an essential practice in high-wire tomato production to maintain plant growth balance, improve light interception, and enhance airflow throughout the canopy. Deleafing should begin once the first cluster of fruit has set and be performed on a weekly basis. Leaves from the lower portion of the plant should be removed either by gently pulling them downward or by cutting them flush with the stem using sanitized pruning shears. Each plant should retain 12 to 15 fully developed leaves (Fig. 8), which typically results in the removal of 3 to 4 leaves per week. All detached leaves should be promptly collected and removed from the greenhouse to minimize the risk of pest and disease development.

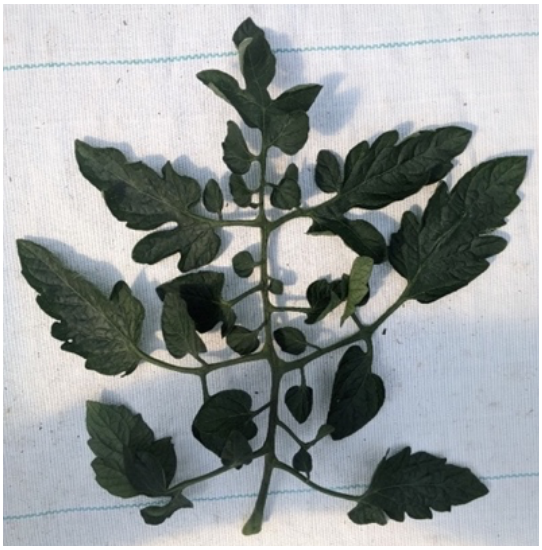

Figure 8. An example of a single, fully developed leaf that was removed from the main stem at the bottom of the plant – note that one single tomato leaf is composed of many leaflets.

Each node will produce a sucker, which will develop into a shoot (a new growing head). Suckers should be removed at each node by breaking or cutting it at the main stem, without leaving any stumps. This should be done at the early stage of sucker development, ideally on a weekly basis (Fig. 9). Allowing suckers to grow diverts energy to unwanted growth and results in larger wounds, increasing the risk of diseases.

At an early stage of plant development, growers may choose to allow one of these suckers to develop into a full additional growing head, allowing harvest from two heads at once on a single plant. Sufficient light, heat, and fertilizer are needed to maintain the growth of both heads.

Figure 9. A sucker at early stage (left) compared to late stage (right) for removal.

At the end of the growing season, growers may also consider topping off plants as another form of pruning. It involves removing the terminal portion of the main stem (growing head), which stops further vegetative growth at the top of the plants. By doing so, plant energy and resources are redirected away from producing new shoots, flowers, and leaves and instead are concentrated on developing and ripening existing fruit.

Lowering

Once a plant reaches the height of the support wire, it should be lowered to provide additional vertical growing space (Fig. 10). This is achieved by moving the supporting hook along the overhead wire so that it hangs above the next plant. Repeat this process down the row so that all plants lean uniformly to one side. When a plant reaches the end of the greenhouse row, it can be trained around the end trough or growing container to continue growing back along the row on the other side.

Figure 10. Plants that reach the top of the support wire must be lowered to provide additional space for continued vertical growth. Image courtesy of Alabama Cooperative Extension

Harvest

Tomato fruit can be harvested at various ripening stages ranging from light to fully red, depending on market requirements, storage, and transport logistics. Fruit may be picked individually or as whole clusters, and cluster harvesting is typically used for TOV types to enhance visual appeal and shelf life. When harvesting individual fruit, retaining the calyx is recommended, as it helps preserve freshness and reduces water loss. The ideal time for harvesting is during the early morning hours, when fruit temperature is lower and turgor pressure is higher, minimizing the risk of physical damage and postharvest deterioration. Once all fruit on a truss are harvested, the remaining cluster stem should be pruned from the main vine to maintain plant hygiene and reduce disease risk (Fig. 11). In high-yielding greenhouse systems, tomato plants may require harvesting two to three times per week to ensure optimal fruit quality and uniformity. Harvested fruit can be stored at 50 to 55 °F for 2 to 3 weeks and should not be stored with crops that are sensitive to ethylene (e.g., leafy greens, cucumber, broccoli).

Figure 11. Cluster stem should be pruned from the main stem after all fruit is harvested.

Irrigation and Nutrient Management

A drip irrigation system is the recommended method for high-wire tomato production in greenhouses. Drip irrigation allows precise control of water and nutrient delivery to the root zone. Continuous monitoring of irrigation volume, nutrient concentration and drainage is essential to ensure optimal growth and to intentionally steer crops toward the desired vegetative or generative growth balance. A complete, balanced fertilizer solution is necessary to support both plant growth and fruit development and should be adjusted according to crop growth stages.

In general, the nutrient solutions should start at relatively low concentrations during early plant establishment (e.g., ~100 ppm nitrogen with an electrical conductivity of 1.0 mS/cm) and gradually increase through transplanting, flowering, fruiting and peak fruit

load stages, an example is provided in Table 2. Fertigation strategies can be further adjusted to encourage vegetative growth (e.g., stronger shoot growth and leaf expansion) or generative growth (e.g., increased flowering and fruit set) by modifying EC, irrigation frequency, and dry-back targets (Table 1). Adequate water supply is critical for healthy plant development; a mature tomato plant can use 0.5 to 0.8 gal (1.9 to 3.0 L) of water per day under hot summer conditions.

Table 2. General fertigation recommended for high-wire tomato production at different growth stages

	Target N (ppm)	**Target EC (mS/cm)**	**Production strategy**
Seedling and transplant production	80-150	0.8 - 2.0	Short, frequent irrigation to develop uniform and strong plants
Vegetative growth post transplanting	150-200	1.5 - 2.0	Gradually increase irrigation frequency and nutrient strength to promote leaf expansion and root penetration to the entire substrates
Flowering and early harvest	180-200	2.0 - 3.0	Further increase irrigation and nutrient strength to retain constant growth and right balance
Heavy fruit load	200-220	3.0 - 3.5	Adjust irrigation based on the needs of the crop to maximize fruiting potential, steer plants vegetatively or generatively depending on the crop conditions

Disease Management

Tomatoes are susceptible to several diseases that can result in reduced yield. The most common diseases are included in Table 3 below, but growers may encounter additional diseases not included in this publication. Contact a county Extension agent for assistance with disease confirmation.

Table 3. Common diseases in hydroponic tomato production.

Diseases	Management
Gray mold (*Botrytis cinerea*) is characterized by a distinctive gray to light-brown, fuzzy, moldy growth that appears on diseased leaves, stems, and blossoms. Occasionally, infections to green fruit may result in "ghost spots" that make fruit unmarketable. Cool temperatures and high humidity favor disease.	• Remove dead, dying, and diseased leaves as soon as they appear. • Maintain humidity below 85% by exchanging indoor air. • Preventative fungicides are effective when conditions are conducive for disease.
Pythium root rot (*Pythium* spp., *Phytopythium* spp., *Globosporangium* spp.) causes brown, rotting roots. Stem constrictions may occur at the soil line, sometimes with a lesion extending upward. Like other root rot diseases, plants may be stunted, exhibit nutrition deficiency symptoms, and suffer reduced yields. Pythium species are water mold pathogens with very wide host ranges.	• Avoid introducing diseased plugs into production systems. • Remove dead, dying, and diseased plants as soon as they appear. • Fallow and sanitize greenhouses and hydroponic systems between crops. • Fungicides can help suppress disease or prevent new infections.
Leaf mold *(Passalora fulva [formerly Fulvia fulva or Cladosporium fulvum])* develops mainly on leaves in the form of light green or yellow spots on upper leaf surfaces. As lesions mature, a green, velvet-like layer of sporulation can be visible on lower leaf surfaces. Affected leaves eventually die and drop from the plant. Wet conditions and high humidity (greater than 85% relative humidity) favor disease.	• Select resistant cultivars. • Maintain humidity below 85% by exchanging indoor air. • Remove dead, dying, and diseased plants as soon as they appear. • Preventative fungicides applied at fruit set are effective when conditions are conducive for disease.

For additional information on tomato diseases and their management see the publications available on the University of Kentucky, Department of Plant Pathology Extension publications page (https://plantpathology.mgcafe.uky.edu/extension/publications).

References/Resources:

Blanchard C., Pickens J., da Silva A. and Wells D. Greenhouse Tomato Production. 2023. Alabama Cooperative Extension.

Buonassisi, A. J. , Sabaratnam, S. , Woodske, D. , and Bitterlich, I. 2013. Biosecurity Guidelines for Post- harvest Greenhouse Tomatoes: Prevention of Post-harvest and Storage Rot.

Gagne, C., Mattson, N., & Kovach, D. (2020, December 30). *Your guide to high-wire tomato growing*. Greenhouse Grower. https://www.greenhousegrower.com/production/your-guide-to-high-wire-tomato-growing/

Gauthier, N., Kight, J., Owen, W.G., and Anderson S. 2020. Cleaning & Sanitizing Commercial Greenhouse Surfaces. University of Kentucky Cooperative Extension.

Hochmuth, G.J. Production of Greenhouse Tomatoes—Florida Greenhouse Vegetable Production Handbook, Vol 3. 2012.

Snyder, R. G. Greenhouse tomato handbook. 2016. Mississippi State University.

United States Department of Agriculture, National Agricultural Statistics Service. (2024). *Table 34. Floriculture and Bedding Crops, Nursery Crops, Propagative Materials Sold, Sod, Food Crops Grown Under Glass or Other Protection, and Mushroom Crops: 2022 and 2017*. 2022 Census of Agriculture, Volume 1, Chapter 2: U.S. State Level Data.

Suggested Citation:

Sharma, A., Leonberger, K., Gauthier, N., Ying, Q. (2026). *High-wire Soilless Tomato Production in the Greenhouse.* CCD-SP-21. Lexington, KY: Center for Crop Diversification, University of Kentucky, Martin-Gatton College of Agriculture, Food and Environment. Available: https://ccd.uky.edu/resources/systems

Reviewed by: Rachel Rudolph, Extension Professor, University of Kentucky & Chad Conway, Agriculture Agent, University of Kentucky.

Photo Courtesies: Unless otherwise noted, all photos taken by Qinglu Ying and Arundathi Sharma.

Figure 1. (right), Gagne, C., Mattson, N., Kovach, D. *Your guide to High-Wire Tomato Growing.* Greenhouse Grower.

Figure 2. Cornell University, *Tomatoes for the High Tunnel.*

Cooperative Extension Service

Agriculture and Natural Resources
Family and Consumer Sciences
4-H Youth Development
Community and Economic Development

MARTIN-GATTON COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT