University of Kentucky
College of Agriculture,
Food and Environment
Cooperative Extension Service

Center for Crop Diversification Fact Sheet
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Rotating Cut Flowers Within a Tomato High Tunnel Production System

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High tunnels provide opportunities for season extension by granting early and late-season protection from cold temperatures. High tunnels are most cost-effective when utilized to produce specialty crops that bring potentially higher profits in otherwise out-of-season periods. Although many high tunnel growers in Kentucky utilize their tunnels nearly 12 months of the year, high tunnels are most often used during spring and summer. Tomato production is the most common and highest-valued vegetable crop grown in high tunnels. Early spring high tunnel tomatoes go to market several weeks earlier than open field-planted tomatoes. However, growers often do not rotate because high tunnel tomatoes offer the most potential profit compared to other vegetables. This can lead to production complications with excess nutrients, disease, and pest pressure.

Photos by Nicole Gauthier, University of Kentucky

Figure 1. Fall cut flowers can introduce a new marketable commodity for producers using high tunnels.

Incorporating another crop that can follow tomatoes in the same year can help preserve the profit potential of tomatoes while introducing a new marketable commodity (Figure 1). An inter-season rotation can also help take up some of the excess nutrients that build up to toxic levels in high tunnel soils. This inter-season crop should also create a physical and temporal break from common pests and diseases in tomatoes. Cut flowers have been shown to serve as a potential new crop to serve these purposes while utilizing the same infrastructure and demanding fewer inputs than tomatoes. A fall cut flower rotation can help growers maintain the integrity of their high tunnel soils and ecosystems while maintaining tomato revenue.

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Spring Tomatoes: The Basis for Fall Cut Flower Production System

Production

The spring tomato crop usually establishes the production system and infrastructure of a fall flower crop. High tunnel tomatoes are typically transplanted in late March to early April in Kentucky.

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In this system, harvest begins in June and peaks in July. Crops are terminated in mid- to late August.

During March and April, nighttime temperatures are cool and can drop below freezing. Heavy row cover (1.5 oz/square yard, such as Agribon-50; Figure 2) is recommended to protect against frost and freeze damage when temperatures drop below 40°F inside the tunnel. Row cover should to be removed during the day when in-tunnel temperatures rise above 50°F.

Photo by Rachel Rudolph, University of Kentucky

Figure 2. Early planted tomatoes (mid-March) require row cover for additional protection during cold nights (positioned along rows to be ready as needed); woven weed mat is used for weed management.

Nutrition

The current fertility recommendations for tomato are 125 to 150 lb of actual nitrogen (N) per acre. This N is typically applied as 50 lb of N preplant, with the remainder divided into weekly applications through the drip irrigation system (fertigation). For organic growers with limited options of water-soluble fertilizer, most or all the fertilizer should be incorporated into soils prior to transplanting. Additional phosphorus (P) applications are rarely needed for Kentucky soils, but should be applied prior to planting if the soil test indicates a need. Potassium (K) depletion has been documented in high tunnel soils in Kentucky, so yearly soil tests are necessary to monitor K levels. Other nutrients, such as magnesium (Mg), can build up in high tunnel soils. The lack of rain in high tunnels prevents nutrients from leaching through the soil profile as they would in open field production. Nutrients not taken up by plants often build up in soils and can lead to ripening disorders and other nutrient-related complications.

Irrigation and Ground Cover

High tunnel tomatoes are typically grown with plastic mulch or woven fabric ground covers with drip irrigation laid underneath. Recommended irrigation systems are drip tape with emitters spaced 8 inches apart.

Pests and Diseases

Arthropod pests are common in tomato and can be introduced through infested transplants, when weeds near the structure act as a natural bridge for entry, or simply fly/walk in when the sidewalls are open during warm weather. Tomato pests, such as aphids, whiteflies, thrips, and cutworms can gain entry through these means. Other tomato pests that may reoccur annually, such as hornworms (as pupae in the soil) or spider mites (which hide in structural crevices), can overwinter in tunnels. While high tunnels seem like effective barriers for preventing pests from entering, they can likewise offer winter cover and protection from enemies once pests are inside. Thus, in some cases, the pests can be even more successful in tunnels than in fields.

Diseases are also common in high tunnel tomatoes. Most tomato diseases are specific to tomato and/or their Solanaceous relatives. These include bacterial spot, early blight, leaf mold, and Septoria leaf spot. Other pathogens, such as causal agents of soilborne diseases like southern blight, Fusarium wilt, and root-knot nematodes, can become established in high tunnels if they are not managed carefully. With a lack of rotation, pathogens can build up in soils, increasing in numbers each year. Once these pathogens become established, they can be challenging to manage and often impossible to eradicate.

Fall Cut Flowers: Inter-Cropping with Tomato

Using cut flowers as a fall crop (rotated with spring/summer tomatoes) takes advantage of the fall flower market, including farm market sales, seasonal events such as weddings, and holidays such as Thanksgiving. Cultivars with traditional fall colors such as yellow, orange, red, and bronze are particularly popular. Flowers with long stems are also highly desired by consumers and florists. Bouquets averaging $15 have been shown to be favored by Community Supported Agriculture (CSA), farm stand, and farmers market customers. Flowering annuals with short seasons and fewer days to maturity are ideal for high tunnel rotations, including flowers in the Asteraceae and Amaranthaceae families. Cool-season flowers with lower light and temperature requirements can also increase expected yield.

Marketing is an important factor when establishing a cut-flower planting. Growers with on-farm or market stands can incorporate bouquets into their regular sales. Those targeting direct sales should consult with florists early in the season to determine flower types, colors, and quantities. Consider current trends, particularly wedding trends, when deciding on colors and cultivars. Planning for sales is a vital part of cut flower production.

The economics of fall cut flower production in Kentucky are still under investigation. Based on preliminary studies on fall-grown flowers, gross returns per square foot of high tunnel space are approximately half that of spring/summer tomato. In general, direct input costs are low. Labor is the most limiting factor regarding profitability and is dependent upon growers' ability to integrate tasks such as pesticide applications into those of other crops. See appendix, budget template (Pages 10-11).

A primary benefit of a cut flower rotation is the disruption of pest and disease cycles so that high-value spring tomatoes can be planted annually. Further, cut flowers uptake excess nutrients that build up during the tomato cropping season. No economic data is available regarding this pest disruption or mitigation of nutrient-related issues. However, inter-cropping with cut flowers can allow for more successful, continuous spring tomato production. Budget models reflecting these indirect relationships are still several years away.

Potential revenue for fall-grown cut flowers
Example fall sales for mixed fall flowers installed in mid-August and harvested mid-September through mid-November. Scenario based off of a 15 ft x 45 ft high tunnel (675 sq ft) with three 3 ft x 40 ft beds (360 sq ft). Bouquet size is 10 like-stems per bunch.

Revenue: $1,571

- Sunflower – 25 bunches
- Amaranth – 25 bunches
- Zinnia – 25 bunches
- Cosmos – 25 bunches
- Strawflower – 10 bunches

Photo by Rachel Rudolph, University of Kentucky

Figure 3. Seeding in July is recommended so that flower transplants can be ready as soon as the tomato crop is terminated in August.

Photos by Rachel Rudolph, University of Kentucky

Figure 4. Cut flower possibilities include (from left to right) zinnia, amaranth, and sunflower.

Production
Flowers should be started by sowing seed in the greenhouse in July so that seedlings can be transplanted as soon as tomatoes are terminated (Figure 3). Transplants require 4 to 6 weeks to reach proper transplant size. In general, the longer the growing season, the better, so transplanting seedlings in mid-August is recommended (earlier in the northernmost regions). Consider cultivars that have no more than 90 days to maturity to assure harvest during peak markets or schedule seed sown to account for proper crop timing. Some popular flowers include amaranth, cosmos, strawflower, sunflower, and zinnia. Cool-season options that may further extend the fall season include lisianthus, snapdragons, and stock. Most flowers can be planted with a between-row and in-row spacing of 9 inches (Figure 4). Weed mat is recommended. Sunflowers can be direct-seeded with a between-row and in-row spacing of 4 to 6 inches for single stem or 12 to

Photo by Rachel Rudolph, University of Kentucky

Figure 5. Sunflowers may be direct-seeded without the use of weed mat. Other flowers, such as cosmos or amaranth, will need to be transplanted and weed mat is recommended.

24 inches for branching cultivars (Figure 5). Weed mat is not needed for sunflowers because they grow rapidly, and canopies close quickly to shade out weeds. Other annuals can benefit from black plastic mulch, which can also help reduce soil heat loss and maintain warmer temperatures later into the season.

Nutrition

Annual cut flowers are typically less nutrient demanding than most vegetables. In UK research trials, only supplemental N was needed to produce quality flower crops successfully; additional P and K were not needed. In fact, cut flowers grown in the absence of added P and K can take up excess nutrients left from tomato production and help mitigate excess nutrients in soils. This can help prevent nutrient toxicities that are commonplace in multi-year systems in which fertilizers are continuously added each season. Typical fertilization recommendations are 1 to 2 lb of actual N per 1,000 sq ft per flower crop, divided through the season by fertigating (Figure 6). At transplanting/seeding: apply 20% of total N for the season. When plants are 10 inches tall, apply 30% of total N. One month before harvest, apply the remaining 50% of N. For example, using calcium nitrate ($CaNO_3$; 15-0-0) would equal approximately 12.9 lb granular fertilizer per 1,000 sq ft.

Potential fertilization plan for fall-grown cut flowers

Example fertilization plan for annual flowers following tomatoes using calcium nitrate ($CaNO_3$; 15-0-0) fertigation using an injector system: 15 ft x 45 ft high tunnel (675 sq ft) with three 3 ft x 40 ft beds (360 sq ft planted to flowers):

High input option: total 2 lb N/1,000 sq ft:
4.82 lbs of $CaNO_3$ needed for the entire season
- 20% at planting = 1 lb of $CaNO_3$
- 30% when plants are 10 inches tall = 1.45 lb of $CaNO_3$
- Remaining 50% at 4 weeks before final harvest = 2.41 lb of $CaNO_3$

Moderate input option: total 1.5 lb N/1,000 sq ft:
2.41 lbs of $CaNO_3$ for the entire season
- 20% at planting = 0.5 lb of $CaNO_3$
- 30% when plants are 10 inches tall = 0.73 lb of $CaNO_3$
- Remaining 50% at 4 weeks before final harvest = 1.2 lb of $CaNO_3$

Ground cover

The use of weed mat can help reduce the amount of time and labor devoted to weed management throughout the season. If plastic mulch or woven weed mat is used for tomatoes, it may be left in place and reused for flowers. Additional holes can be cut or burned, typically at 9 x 9 inch spacing, to maximize the use of space.

Irrigation

Utilization of the same irrigation system used for tomato can save time and money. Drip irrigation systems are also used for fertigation, and some insecticides and fungicides are also applied through this type of system. For a 3 ft-wide bed of annual flowers,

Photo by Rachel Rudolph, University of Kentucky

Figure 6. Fertilizer injection (fertigation) used for tomato production is also appropriate for cut flower production.

two to three lines of drip tape is recommended. Avoid overhead irrigation, if possible, to help reduce humidity and leaf/petal wetness and thereby risk for disease and damage to blooms.

Labor

Annual flowers require less labor than tomatoes, although the distribution of that labor is different. Pesticide application and harvest comprise the majority of the labor required for cut flower production. Other labor includes trellising tall flowers (Figure 7) soon after planting. When temperatures drop below 40°F, row covers need to be put into place to protect flowers that are still in production (Figure 8); flowers may need to be covered and uncovered daily, depending on temperatures. Research trials suggested that most cultivars proved to be fairly cold tolerant through November, with only minor cold injury observed in the corners of high tunnels where cold air leaked through. Once harvest begins, a regular schedule must be followed, usually at least twice per week.

Potential inputs for fall cut flower production

Example inputs for fall flowers installed in a 15 ft x 45 ft high tunnel (675 sq ft) with three 3 ft x 40 ft beds (360 sq ft).

Inputs:

- Transplant and seed costs = $245.60
- Supplies (irrigation, woven mat, soil testing) = $162.13
- Insecticides and fungicides = $23.63
- Labor, 12 to 14 hours/week, total 45 hours
  - preplant and plant = 11 hrs
  - in-season labor and pesticide application = 18 hrs
  - harvest = 10 hrs
  - post-season labor = 6 hrs

Photos by Rachel Rudolph, University of Kentucky

Figure 7. Plastic trellis netting provides support and keeps flowers growing upright and maintaining marketable straight stems.

Figure 8. Large sheets of row cover can be used to cover multiple rows at once in order to reduce labor.

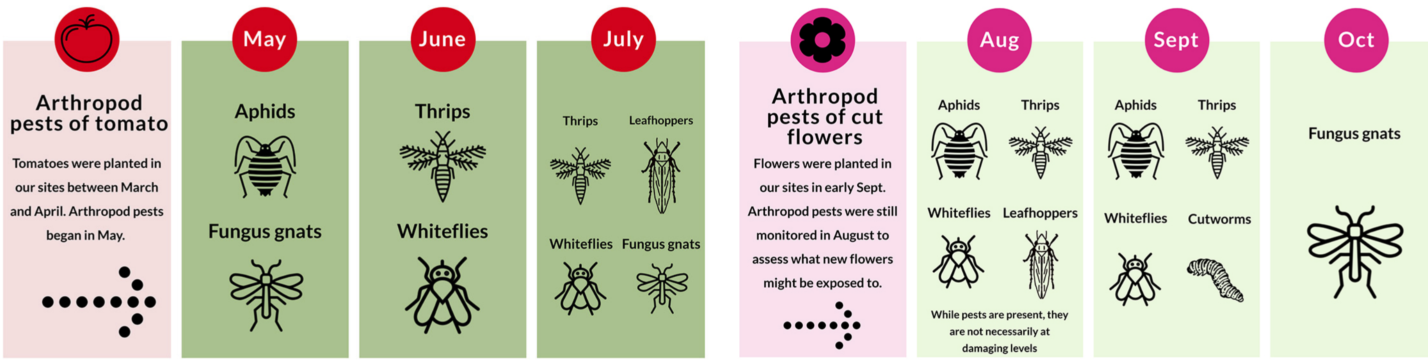
Photo by Rachel Rudolph, University of Kentucky

Pests and Diseases

Arthropod pests that are frequently found in high tunnel tomato production can also affect cut flowers. Typical tomato pests such as aphids, thrips, and whiteflies can become risks for fall flowers, although there is typically less pressure than spring or summer production (Figure 9). Aphids can be the most problematic

Figure 9. The insects of the high tunnel tomato and cut flower rotation. Starting from the left in the top row, aphids, whiteflies, and thrips. Starting on the left of the bottom row, leafhopper, fungus gnat, and cutworm larvae.

Potos by Jim Kalisch, University of Nebraska-Lincoln



Graphic by Jonathan Larson, University of Kentucky

Figure 10. Insects affecting tomato and annual cut flowers with peak timing.

insect for fall flowers. In contrast, the later planting for fall flowers results in a shorter season for some of the most common flower pests, particularly thrips and spider mites. Fungus gnats, on the other hand, can be found throughout the growing season; fungus gnats are soilborne and thereby can remain problematic for long periods (Figure 10).

Diseases common to high tunnel tomato are typically different from those that affect cut flowers. The most common diseases of tomato (Figure 11) are specific to tomato and/or Solanaceous crops. These diseases do not carry over to cut flowers. Likewise, diseases known to affect fall cut flowers are specific to select plant families and will not carry over to tomato. Two common diseases of both crops, powdery mildew and Septoria leaf spot, are both caused by fungi specific to the host crop, and thereby cannot carry over between tomato and cut flower crops (Figure 12). For example, Septoria leaf spot on tomato is caused by a different species than the one that affects sunflower. Conversely, several soilborne diseases (Figure 11) can affect a wide range of crops and can build up in soils over time. They can become severe if introduced into cropping systems and left unmanaged. It is important to confirm disease at the onset of symptom development and destroy affected plant material immediately.

Cut Flower Pest, Disease and Weed Management

Integrated Approach

Effective pest and disease management requires an integrated approach. Integrated pest management (IPM) includes a combination of cultural controls and, if necessary, targeted pesticide applications. Cultural controls should be incorporated into every pest and disease management schedule, whether the produc-

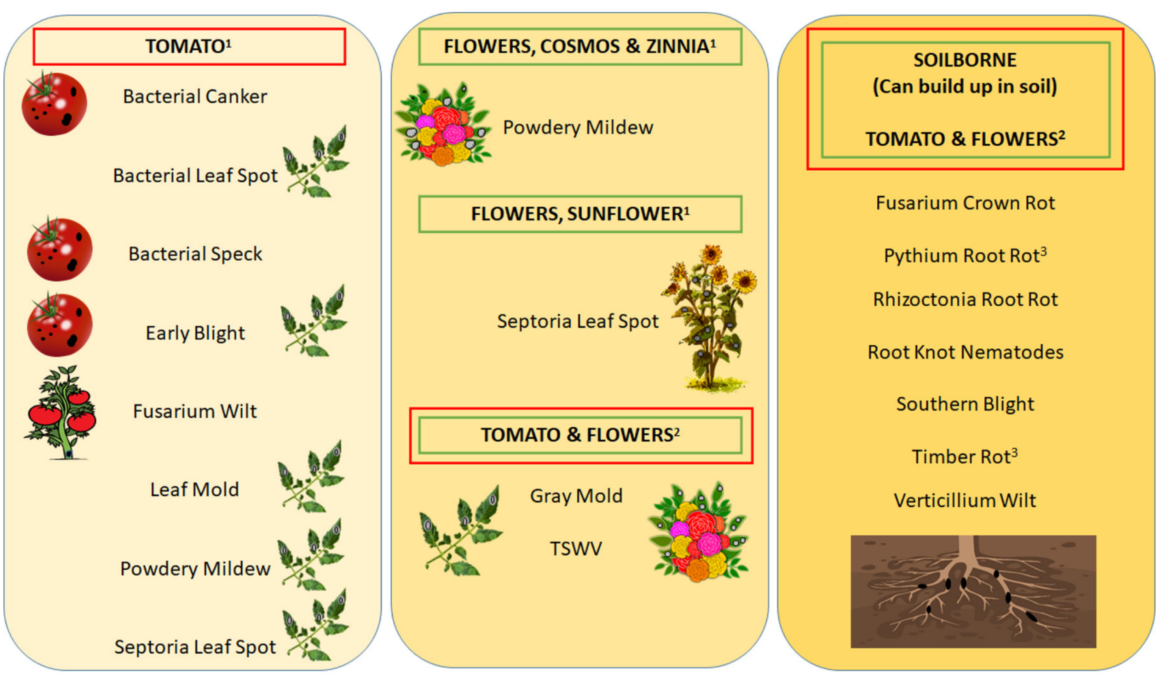


Figure 11. Diseases of tomato and annual flowers with potential for crossover infection.

Graphic by Kim Leonberger, University of Kentucky

[1]Host specific diseases target single host and/or close relatives; no cross infection
[2]Wide host range, many hosts affected
[3]Cool-season disease, usually spring only

Figure 12. Common diseases of cut flowers (from left) include Septoria on sunflower, southern blight, botrytis, and powdery mildew on zinnia.

Photos by Bruce Watt, University of Maine, Bugwood.org (sunflower, far left), and Nicole Gauthier, University of Kentucky

tion system is no-spray, organic, or conventional. Fall cut flowers are conducive to cultural management and require fewer insecticides or fungicides.

Cultural Practices

Cultural practices begin with pest and disease prevention. Avoidance techniques can prevent introduction of pests and diseases into high tunnels. However, proper identification (scouting and/or diagnostic lab confirmation) is critical if problems occur. Crop rotation and changing the timing of planting are both essential for the disruption of pest life cycles. By inter-cropping fall flowers with tomato and by planting flowers in fall instead of spring, cultural methods are already being deployed to help minimize pests and diseases on flowers. Other cultural practices are listed below. These practices can help prevent problems or manage pests and diseases, so they do not reach damaging levels:

- Disease-resistant cultivars
- Rotation with nonhost species
- Clean or certified seed
- Clean transplants; pest- and disease-free transplants
- Solarization of high tunnels between crops
- Weed-free perimeter in and around the high tunnel structure
- Drip irrigation to reduce leaf wetness
- Spacing to increase air circulation, reduce leaf wetness, and lower relative humidity
- Avoidance of wounding, especially when trellising and pruning
- Removal of debris, clippings, and other plant material
- Removal of diseased and infested plants and/or plant parts to prevent population flareups
- Post-season tillage to expose overwintering pests to the elements and to encourage degradation of diseased plant debris

Chemical Management

If insecticides or fungicides are needed, products must be approved for greenhouse use. In Kentucky, pesticide regulations consider high tunnels to be greenhouse structures.

Insect and Mite Pests

To manage pest populations, monitor with sticky cards and scout weekly (for cut flowers) or bi-weekly (for tomatoes). Scouting helps determine when pest populations are at their weakest and thereby easiest to manage, exactly what pests to target, and in what areas of the high tunnel those efforts should be focused. Keeping a detailed record of scouting results also provides valuable year-to-year data that can help anticipate issues so that growers can be prepared with management strategies. Traps used for monitoring do not provide pest control.

A multifaceted approach using cultural control methods and insecticides will be needed to curtail problems.

- Delay insecticide applications until certain thresholds are reached; insect thresholds are lower for cut flowers (damage is less acceptable) than vegetable crops.
- Biological control agents are good options in high tunnels when sidewalls are closed in spring and fall. Closed sidewalls somewhat restrict the escape of beneficial insects/mites relative to open air production where there is an instantaneous loss of purchased bio-control organisms. Biological control agents are often paired to specific pests, so proper pest identification is necessary. Refer to *Biological Control of Arthropod Pests in High Tunnels and Greenhouses* (ENT-327) to learn more about biological control options.

- Organic and biorational insecticide options are also available, including *Bacillus thuringiensis* (Bt) (for caterpillars), neem (for whiteflies and aphids), insecticidal soap (for whiteflies and aphids), and Spinosad (for thrips). These products can reduce certain pests with lesser effects on non-target organisms.
- Conventional insecticide options include pyrethroids (such as bifenthrin) or other synthetic products (such as malathion) or systemic options like those in the neonicotinoid class (Figure 13). The use of these chemistries should be targeted to afflicted plants and based on thorough scouting. Avoid application of insecticides by calendar schedule without checking for the presence of pests.

Insecticide Management of Common Insects	
Aphids	Bifenthrin, cyfluthrin, permethrin, pyrethrins, imidacloprid, azadirectin, insecticidal soap
Thrips	Bifenthrin, cyfluthrin, permethrin, pyrethrins, imidacloprid*, Beauvaria bassiana*, azadirectin, insecticidal soap, Spinosad
Whiteflies	Bifenthrin, pyrethrins, imidacloprid, azadirectin,horticultural oil, insecticidal soap
Fungus gnats	Bifenthrin, cyfluthrin, imidacloprid, thiamethoxam, pyriproxiyfen, azadirectin, *Bacillus thuringiensis* ssp*. Israelensis*
Leafhoppers	Bifenthrin, cyfluthrin, permethrin, pyrethrins, imidacloprid, azadirectin, insecticidal soap
Cutworms	Bifenthrin, , imidacloprid, azadirectin, *Bacillus thuringiensis,* insecticidal soap, Spinosad

**not comprehensive list; refer to label for restrictions and usage*

Figure 13. Some insecticide options for the most common insects of fall cut flowers grown in high tunnels.

Diseases

Most disease management strategies focus on the prevention of pathogen introductions and manipulating environmental conditions to remain unfavorable to pathogens.

- Scouting can be effective for common leaf spot diseases such as powdery mildew and Septoria leaf spot, with fungicide applications beginning when the disease first appears. Visual inspection of crops should be a routine task.
- Many leaf and flower diseases can be prevented or reduced by cultural methods. Maintaining relative humidity below 70% is an effective disease management strategy. Use plant spacing, the opening of sidewalls, and avoidance of overhead watering to keep humidity as low as possible.
- Soilborne pathogens, if present, should be managed preventatively and not wait until disease symptoms develop.
- Deep tillage and crop rotation (nonhost plants for 2 to 3 years) are often necessary to disrupt life cycles of persistent soilborne pathogens once they appear.
- Disease symptoms alone cannot always be used for diagnosing plant diseases; microscopic propagules such as spores may need to be examined for confirmation. Management recommendations for most diseases will be dependent upon diagnostic confirmation.
- Some flower cultivars have resistance to certain diseases. Review cultivar descriptions when purchasing seed for resistance traits.
- Use proper sanitation for all tools and equipment.

Fungicide applications for both tomato and cut flowers are preventative treatments based on known disease risks (Figure 14). However, some diseases are predictable and occur yearly; a regular fungicide schedule for cut flowers should focus on powdery mildew (cosmos, zinnia) and Septoria leaf spot (sunflower). Spray intervals ranging from 7 to 14 days are based on the product label. Outbreaks of uncommon diseases such as Fusarium crown rot, southern blight, or timber rot are only targeted if the disease is confirmed or if the high tunnel has a history of disease.

Fungicide Management of Common Diseases	
Powdery Mildew	Azoxystrobin (FRAC 9)
	Myclobutanil (FRAC 3)
	Thiophanate methyl (FRAC 1)
Septoria Leaf Spot	Copper (FRAC M)
	Mancozeb (FRAC M)
	Thiophanate methyl (FRAC 1)

**not comprehensive list; refer to label for restrictions and usage*

Figure 14. Some fungicide options for the most common diseases of fall cut flowers grown in high tunnels.

Weeds

Grassy and broadleaf weeds that occur in high tunnels are typically the same species that are present in nearby fields. These weeds can compete for light, nutrients, and water, as well as harbor insects and disease. There are no herbicides labeled for high tunnel or greenhouse vegetable or flower production.

Sanitation, exclusion, and mechanical methods are the best options for weed management.

- Keep area in and around tunnels clean and weed-free.
- Avoid introduction of weed seeds with low quality compost or planting stock.
- Do not allow weeds to grow around tunnels.
- The use of black plastic or woven weed mat can significantly decrease weed pressure.
- The use of various tools or small walk-behind tractors may be appropriate depending on tunnel size.
- Good quality hand tools are also appropriate for hand-weeding.

Conclusion

High tunnels make it possible to produce profitable crops year-round. A tomato-cut flower rotation may start as early as March and end in late November (Figure 15). There are many considerations to make before deciding to produce a new, unfamiliar crop. Although cut flowers offer many potential benefits, including more potential revenue, they do require additional labor and materials compared to vegetable crops. Each grower will need to assess their own market, labor availability, and time before deciding whether fall cut flower production is right for them.

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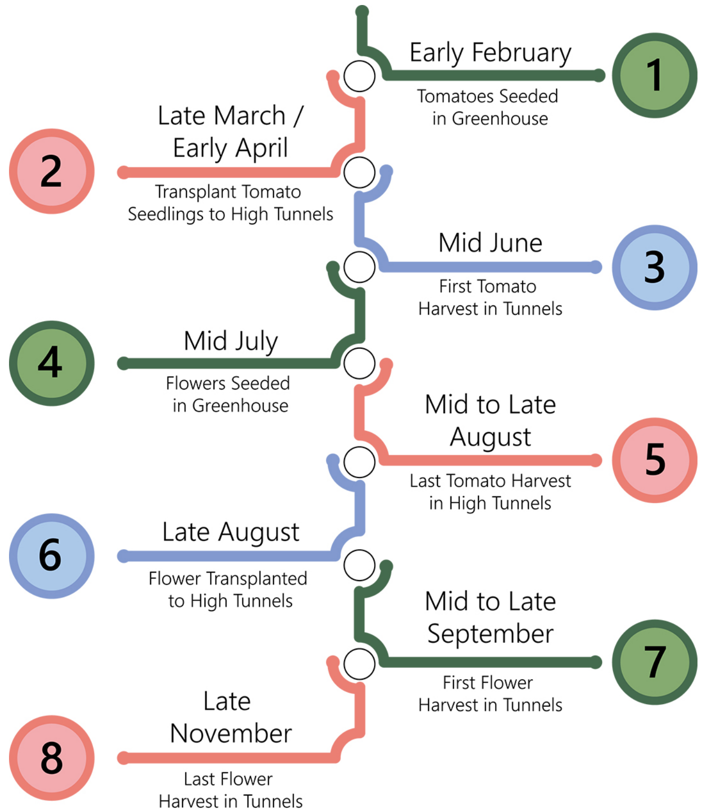

Graphic by Hal Baillie

Figure 15. Example timeline indicates typical planting and harvesting of spring/summer tomatoes followed by fall cut flowers.

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For additional information, contact your local County Extension agent

Appendix 1. Budget template for high tunnel and cut flower rotations.

High Tunnel Tomatoes & Cut Flowers

		Quant.	Unit	Price			Total	Per Sq Ft
Gross Returns								
Tomatoes								
	Total Marketable Pounds		Lbs					
Total Tomato Gross Returns								
Cut Flowers								
	Sunflower Bunch (10 stems)		Bunches					
	Amaranth Bunch (10 stems)		Bunches					
	Zinnia bunch (10 stem)		Bunches					
	Cosmo bunch (10 stem)		Bunches					
	Strawflower bunch (10 stems)		Bunches					
Total Cut Flower Gross Returns								
Total Returns								
Variable Costs Per High Tunnel								
Tomato Variable Costs								
	Transplants		plants					
	Pre-Plant Soil Fertilization		Lbs					
	Drip Tape		feet					
	Weed Mat		Ft					
	Trellis		tunnel					
	Row Covers		feet					
	Soil Test		tunnel					
	In-Season Fertilization		lbs		**# of Events**			
	Water		gallons		**# of Events**			
	Chemicals		tunnel					
	Labor		hours					
	Unallocated Labor		hours					
	Crop Insurance		acre					
	Supplies		tunnel					
	Interest on Operating Capital		dollars		**# of Months**			
Total Tomato Variable Costs								
Cut Flower Variable Costs								
	Tranplant Costs		plants					
	Direct Seed Cost		seeds					
	Pre-Plant Soil Fertilization		lbs					
	Drip Tape		feet					
	Weed Mat		tunnel					
	Soil Test		tunnel					
	In-Season Fertilization		lbs					
	Water		gallons		**# of Events**			
	Chemicals		tunnel					
	Labor		hours					

	Unallocated Labor		tunnel					
	Crop Insurance		acre					
	Supplies		tunnel					
	Interest on Operating Capital		dollars		**# of Months**			
Total Cut Flower Variable Costs								
Total Variable Costs Per High Tunnel								
Returns Above Variable Costs Per High Tunnel								
Fixed Costs								
	High Tunnel Depreciation		tunnel					
	Rototiller Depreciation		tunnel					
	Misc Equip		tunnel					
	Taxes & Insurance		tunnel					
	Other Fixed Costs		tunnel					
	Operator Labor (Fixed)		hours					
	Storage		tunnel					
	Land Cost (Owned)		tunnel					
Total Specified Fixed Costs								
Returns Above All Specified Costs								