Growing Cucumbers in High Tunnels

Cucumbers are a high-value crop that is grown in a variety of systems including high tunnels. Here, we are presenting the basics of high tunnel production for beginning farmers or those looking for a refresher.

Cultivar Selection

Successful production often starts with cultivar selection. In the case of cucumbers, specialized terminology exists to describe plants and types. Below are some of those terms defined.

Terminology associated with cucumber cultivar selection

**Slicing cucumbers** (aliases: field cucumbers, American slicers) – This type of cucumber is commonly grown in the field for fresh market use. They can also grow well in high tunnels. Fruit, usually a minimum of 5 inches long, have seeds and thicker skins relative to European cucumbers and beet alpha cucumbers. **Trellising is optional for slicing cucumbers** but will improve yield and quality.

**European cucumbers** (aliases: Japanese cucumbers, Dutch cucumbers, hothouse cucumbers) – This type of cucumber is commonly grown in greenhouses for fresh market use. Fruit are commonly 12 – 14 inches long, weigh about 1 pound, and are parthenocarpic (seedless). Fruit skins are thin making peeling optional. They can lose weight rapidly and are therefore individually shrink-wrapped or wrapped in groups to delay water loss and maintain firmness. Trellising is used for production. It has been suggested that European cucumbers are not suited to high tunnels (Growing Cucumbers within a High Tunnel and Best Management Practices in High Tunnel Production for Cucumbers). However, they were grown in one trial with success (2016 Cucumber Variety Evaluation in a High Tunnel at Southwest Indiana). In that trial yields were lower than for other types of cucumbers; however, fruit were well-liked for their taste.

**Beit alpha cucumbers** (aliases: mini cucumbers, Persian cucumbers) – This type of cucumber is commonly grown in greenhouses for fresh market use. They also grow well in high tunnels. Fruit are parthenocarpic (seedless) and not as long as European cucumbers at about 5 to 8 inches long. Fruit skin thickness is between slicing cucumbers and European cucumbers. Skins are tender and, as with European cucumbers, peeling is optional. Individually shrink-wrapping fruit is not needed; however, they should be stored in containers that prevent moisture loss. As with slicing cucumbers, **trellising is optional**, but will improve yield and quality.

**Monoecious** – Monoecious describes the sexual state of cucumber plants. Monoecious plants have separate female (pistillate) and male (staminate) flowers on a single plant. Compare this to a tomato which is synoecious, meaning female and male organs are in the same flower on a single plant.
**Parthenocarpic** – Parthenocarpic means that fruit are seedless. Therefore, pollination is not needed for fruit set. If pollination does occur fruit can be seeded, bitter, and misshapen. Parthenocarpic cultivars are also gynoecious (see gynoecious below).

**Gynoecious** – In a typical cucumber plant, several male (staminate) flowers are produced before any female (pistillate) flowers are produced. Then, for every female flower produced, several male flowers are produced. With gynoecious cucumbers, the plant produces mostly or only female flowers. This can result in early fruit production and higher yields. With some gynoecious cultivars, pollination is needed for fruit set. In this case, pollinator seed is generally provided with gynoecious seed. It is also possible for a gynoecious cultivar to also be parthenocarpic. With these cultivars, pollination is not needed, fruit are seedless, and yields can be higher than standard monoecious cultivars.

Select high tunnel cucumber cultivars based on consumer demand and your management style. Look for options in greenhouse, high tunnel, or protected culture sections of seed company offerings. We recently surveyed 192 farmers attending the Mid-Atlantic Fruit and Vegetable Convention (www.mafvc.org). The top sources respondents used when selecting cultivars, in order, was other farmers (24%), seed company representatives (22%), and university trials (14%). Talking to your neighbors and attending conferences to talk to other farmers and seed company representatives about what cultivars they have had success with and are recommending are good strategies for selecting cultivars. For non-biased, science-based recommendations, results of several high tunnel cultivars trials are on the web including one conducted at Penn State.

- **High Tunnel Trellised Cucumber Variety Trial: 2013 (Penn State)**
- **Growing Cucumbers within a High Tunnel (Missouri)**
- **2016 Cucumber Variety Trial in a High Tunnel at Southwestern Indiana (Indiana)**

### Systems

Cucumbers grown in high tunnels are generally trellised. Trellising is a good way to efficiently use space in high tunnels, eliminates yellow ground spots that develop when fruit rests on the soil surface and can result in straighter fruit. Additionally, it encourages airflow throughout the planting which is a good strategy to avoid/prevent some diseases.

There are a few main strategies farmers are using for trellising. In one strategy, secure plastic netting (for example, Hortonova netting) or wire mesh to support posts. Plants are allowed to grow up the netting or wire mesh without any clips, ties, or other means of securing them. Additionally, little, if any pruning is done. This method is commonly used for slicing cucumbers as they produce fruit on lateral branches.
Another strategy is single-string trellising. This is used commonly for beit alpha types. If you are growing European types, this system would also work. In this system, plants are pruned to a single stem and trained to a single trellis string. Flowers are removed from plants on the first 4 nodes (Note: a node is the point on a stem where a leaf is attached). After that, flowers are allowed to develop. Some cultivars will set several fruit in a single location. It is up to you to determine how many to keep. Commonly, 1 or 2 are kept and the rest are pruned off. All lateral branches (suckers) are removed. Plants can either be wrapped to the trellis string or secured with plant clips or both. Once the plant reaches the top wire, a few main options are commonly used. Depending on the height of the top wire, the crop may be ready to be terminated due to problems including powdery mildew and/or boron accumulation. Another option is to simply allow the main stem to grow back down toward the ground.

Another option is to use an umbrella system. Many variations of the umbrella system exist. In one variation, once plants reach the top wire they are trained to hang down, making one side of the umbrella. Then, a lateral branch near the top wire is allowed to grow and also trained to hang down, making the second side of the umbrella. Another variation of this system is to cut the plant off at the top wire and allow two lateral branches to make up each side of the umbrella.

The umbrella system being employed in a greenhouse for beit alpha cucumbers. Note that the plants have reached the top wire and main stems are being directed down. The yellow arrow is pointed to the main stem as it is trained to be one side of the “umbrella”. The orange arrow is pointed to a lateral branch being allowed to grow on the same plant. It will form the other side of the “umbrella”. Photo: Elsa Sánchez
In some cases, it is not possible to grow directly in the ground in high tunnels. We have seen this be the case when soluble salts levels are very high and also when soil drainage is very poor. Growing in bags containing soilless media (potting soil) has been successfully used in these situations.

Pollination

In the field, cucumbers are pollinated primarily by bees. If you are growing parthenocarpic cultivars, fruit will develop without pollination. As mentioned before, seeded, bitter, and misshapen fruit can be produced when pollination occurs. If this is a problem, excluding insects, for example, with insect screening, can help. For cultivars that are not parthenocarpic, we have had sufficient pollination without introducing pollinators. If you are having issues with pollination, a couple of options are to bring in bees or to plant pollinator strips. For more information please visit Penn State’s Center for Pollinator Research.

Pest Management

(Margaret Skinner and Cheryl Frank Sullivan at the University of Vermont contributed to this section)

Several pests can be problems in high tunnel cucumber production. If you have grown cucumbers in the field, many will be familiar to you. Some of these problems are more commonly encountered in greenhouses. For a review of insect pests that can be problems in high tunnel cucumber production see Clemson University factsheet - Cucumber, squash, melon, and other cucurbit insect pests. For a review of diseases that can occur see: Clemson University factsheet - Cucumber, squash, melon, and other cucurbit diseases.

High tunnels are well suited to the use of biocontrols. We recently completed a 3-year study focused on using habitat plants and banker plants in a biocontrol program to manage aphids in high tunnel cucumber, tomato, pepper, and winter greens crops (For more information see University of Vermont's factsheet on Attracting and Sustaining Aphid Natural Enemies in High Tunnels- Update ). As a rule, when using biocontrols, it is essential to properly identify what species of pest you have. Many natural enemies such as parasitic wasps are host-specific, attacking a narrow range of species. When you are unsure of the identity of an insect, collect several individuals and place them in a bag or vial or
take a clear picture of them. Bags/vials and/or pictures can be sent to your local Extension educator for identification. You can also purchase mixes of parasitic wasps if you are unsure of what aphid species you have. Information about aphid identification, biological controls, and scouting are available at the University of Vermont’s High Tunnel Pest Management Resources.

Other biocontrols for managing aphids include flies such as *Aphidoletes aphidimyza* and syrphids, predatory bugs such as *Orius*, lacewings, and lady beetles. It’s important to know what life stage the biocontrol attacks and kills its host. For example, parasitic wasps and flies kill their hosts in their larval stages. Adult flies lay eggs around aphid colonies where their larvae/maggots consume the aphids. Several parasitic wasps lay eggs within aphids. Their developing larvae turn the aphid into brown or black “mummies”. Predatory bugs and beetles are predatory as both adults and immatures. Selecting which biocontrol to use at a specific time depends on what aphid species are present, infestation level (high or low), environmental conditions, and time of year. It’s also important to release biocontrols at the proper rate for the area in terms of pest infestation level. If you are unsure, contact your biological control supplier for general guidelines.

Habitat plants, such as alyssum, promote the establishment of natural enemies and encourage them to come in from outside the high tunnels. They provide pollen and nectar to adults of several biocontrols that require floral resources to reproduce. They can also provide attracted pests/hosts. Caution should be used to make sure these systems are not attracting too many unwanted pests. This is a reason why routine scouting should be conducted as part of a biocontrol program.

Success when using biocontrols to manage insect pests relies heavily on finding the problem before it reaches damaging levels. Early intervention is crucial to release biocontrols so they can become established at the onset of an issue. Monitoring insect pests and biocontrols after releases are made is essential to observe biocontrol efficacy and to determine if additional releases are needed or an insecticide application warranted. Over time, your biocontrol plan will be adapted to reflect your specific operation and your experiences. Allow time to fine-tune your plan.

**Weeds**

Most high tunnel farmers are managing weeds with plastic and organic mulches, landscape fabric, and hand weeding.

Landscape fabric can be placed between rows to suppress weeds. This can be used in combination with plastic-covered or bare rows. The landscape fabric can be rolled up after the cropping season and reused multiple years.
In 2005 and 2006, we evaluated the use of different types of organic mulches for suppressing weeds for two cultivars of standard slicing cucumbers, one beit alpha cucumber, and one specialty cucumber. The mulches we used were wheat straw, sheets of newspaper, and shredded newspapers. Sheets of newspaper were applied 5 sheets thick and straw and shredded newspaper were applied at a depth of 4 to 6 inches. Mulches were compared to hand weeding once about 1 month after planting transplants. Weed populations at the end of the growing season were highest in the hand-weeded control, followed by sheets of newspaper, then straw, and were lowest when shredded newspaper mulch was used. Cucumber yields were not different regardless of weed management strategy.

**Nutrient Management**

Nutrient recommendations specific for high tunnel cucumber do not exist yet. One option for approaching nutrient management is to use recommendations developed for field production. Conduct a soil test and use recommendations for phosphorus, potassium, calcium, and magnesium which account for existing soil levels. For nitrogen, the research-based recommendation from Penn State’s Agricultural Analytical Services Laboratory for slicing cucumbers is 75 lbs/acre. This can serve as a starting point. Apply all the recommended phosphorus, potassium, calcium, and magnesium before planting. Apply a portion (50 to 60% for the heavy soils we generally have in Pennsylvania) of the nitrogen before planting. Then, add additional amounts of nutrients based on in-season tissue analysis. In-season fertilizers can be side-dressed or supplied through the drip irrigation line using fertilizer injectors.
Another option is to use programs or recipes developed for greenhouse cucumbers. For more information see Nutrient solution programs and recipes: fertilizer, concentration, purity, solubility, compatibility. In-season tissue analysis is also used with this option to fine-tune amounts of nutrients supplied.

Regardless of whether you are using organic or inorganic nutrient sources, we have found that nutrients and organic matter accumulate in high tunnel soils in a way that they do not in the field. In a 2017 and 2018 survey of soil from 27 high tunnels across Pennsylvania, 96% of phosphate levels, 81% of potash levels, 100% of magnesium levels, and 85% of calcium levels fell into the “exceeds crop needs” (above optimum) category. Soluble salts levels averaged 2.02 mmhos/cm, which was well above levels where yields of salt-sensitive crops are reduced. Organic matter content for the 27 high tunnels ranged from 2.4% to 15.5%, with an average of 6.3%. In the field in Pennsylvania, we generally consider a range between 2% and 5% to be a good target for our soils high in clay. When organic matter content is too high problems from nutrient imbalances can occur. When values reach about 15% or more, the soil acts more like soilless media or potting soil. Many farmers participating in the survey were unsatisfied with yields, mostly of tomatoes, from their high tunnels, and in some cases, high tunnels were taken out of production. Most of these farmers were unaware of the fertility and high soluble salts issues, and organic matter content in their tunnels.

Excessive soil nutrient levels and organic matter content are difficult problems to solve quickly. We strongly recommend using soil testing to track existing nutrient levels in high tunnels to adjust the amount of nutrients you apply before they reach very high levels. Additionally, the standard soil test at Penn State’s Agriculture Analytical Services Laboratory does not include organic matter content or soluble salts levels. These can be analyzed for an additional fee. We strongly recommend tracking these levels in high tunnels.

Irrigation

Cucumbers require a lot of water. They originated in pantropical areas and will take a lot of heat, but only when they have enough water. Infrequent watering can result in misshapen fruit. Depending on conditions, watering may need to occur daily to avoid this. In general, vegetables need 1 – 2.5 acre-inches of water every week. Determine how much water to apply based on several factors including the age of the plant, time of year, and weather conditions. You will use the lower end of the range when plants are small. Generally, use the upper range during summer compared to the fall and when it is very sunny, and temperatures are high.

Soil moisture sensors can be used to determine when to irrigate. For more information on soil moisture sensors visit the University of Minnesota’s Crop News article on Soil moisture sensors for irrigation.

The most common method used to irrigate high tunnels is drip irrigation. Determining How Long to Run Drip Irrigation Systems for Vegetables contains more information on determining how long to run a drip irrigation system to apply 1-acre inch of water. Adjust the time the system is operating based on how much water you want to apply. For example, if you want to apply 1.5 acre-inches of water, multiply values by 1.5. If you want to apply 2 inches, multiply by 2.
Harvest and Fruit Quality

Fruit can be harvested any time before they turn yellow. Harvest when they reach the desired length. For slicers and beit alpha types, this is generally when they are at least 5 inches long. For European types harvest when they are at least 12 inches long. Harvest when fruit are still slender, but the ridges have just filled in. For slicers, harvest when seed are still immature. Fruit ripens quickly. Be prepared to pick regularly, 2-3 times a week, for maximum quality and yield.

Troubleshooting

High temperatures – Temperatures above about 90° F can result in a reproductive failure in cucumbers. Fruit set will decline; however, it will resume once temperatures fall below 90° F.

Low temperatures – Being a warm-season crop, cucumbers are very sensitive to cold and will die when soil temperatures are below about 60°F.

Misshapen fruit – Misshapen fruit can be caused by moisture stress. Adjusting irrigation scheduling to provide uniform soil moisture can remedy this issue.

Misshapen fruit can also be a sign of poor pollination. Choosing a parthenocarpic cultivar, introducing habitat for pollinators, or purchasing bees can resolve this problem. If you are growing a parthenocarpic cultivar, pollination can result in misshapen fruit. In this case, exclude pollinators from the high tunnel.

Some viruses can also cause fruit to be misshapen.

Other reasons for misshapen fruit include air temperatures below 65°F and mechanical injury. For further explanations see Purdue University Plant and Pest Diagnostic Laboratory’s 'Curved Cucumbers'.

Over-application of boron – Cucumbers are very sensitive to the over-application of boron. Symptoms of boron toxicity are yellow and dead spots on leaf margins. You may also see reduced root growth. Being immobile in plants, boron symptoms will accumulate and show symptoms of excess first in older leaves at the bottom of the plant. Monitor soils and conduct plant analysis to avoid over application.

Fruit abortion – Cucumber plants abort fruit for a variety of reasons including poor pollination, light levels, and elevated boron levels.

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