



High Tunnel Strawberries

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Introduction

High tunnels are relatively simple polyethylene-covered unheated structures placed over irrigated ground beds. Also known as hoop houses, high tunnels can be used to extend the production season of a wide variety of crops in Kentucky, including strawberries. A plasticulture system with drip irrigation is recommended when using high tunnels for strawberry production.

High tunnels provide protection from unfavorable weather conditions, including wind, hail, frost, and excessive rainfall. This can translate into a better survival rate of strawberry plants, as well as earlier berries. Some states report higher yields in tunnels; however, that has not consistently been the case in University of Kentucky research trials. High tunnels also provide a sheltered environment for pickers during harvest.

Marketing

Early crops can attract consumers to a farm operation, and growers able to provide the earliest locally grown strawberries can often demand a premium price. Producers who capture the early market with a quality product may also gain loyal season-long customers for field-grown strawberries and other produce crops.

Direct markets such as on-farm retail markets, roadside stands, farmers markets, and community supported agriculture (CSA) may provide the greatest premiums to producers of early strawberries. Smaller wholesale volumes of early season strawberries could also be marketed to restaurants, local groceries, and through produce auctions. U-Pick is not as popular with strawberries as U-Pick is for other types of berries and the volume of



pickers that can be supported from an average tunnel is very limited; however, Kentucky growers reported steady to increasing demand for pre-picked strawberries in 2017.

Market Outlook

Strawberries are popular with consumers. Fresh strawberry use increased in the U.S. from 6 to 8 pounds per person from 2006 to 2012, remaining at 8 pounds through 2017. Strong quantity demand for strawberries resulted in a national average fresh market grower wholesale price of \$0.90 to \$1.05 per pound from 2010 to 2014. Although national average prices declined in 2015, local fresh market strawberry prices remained steady in Kentucky. National average fresh market grower prices rebounded after 2015, and stood at \$1.25 per pound in 2017.

About 196 acres of strawberries were



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harvested in Kentucky in 2017, according to the Census of Agriculture. Locally produced strawberries are plant-ripened and full-flavored, which often sets them apart from those that are shipped in, and that may be a favorable factor for increases in strawberry acreage for local sales.

Production Considerations

High tunnel strawberries in Kentucky should be produced using a raised bed system for perennial plants or the annual plasticulture system. For more information on the latter, refer to the CCD crop profile on that subject, [Plasticulture Strawberries](#) (CCD-CP-16).

Site selection and tunnel construction

While site selection for high tunnel strawberries is similar to that of strawberries planted in an open field, there are important considerations unique to high tunnel production. Tunnel location and orientation, in addition to soil conditions, are important for success. The production site should be selected sufficiently in advance to allow for tunnel construction and preparation of raised beds prior to a fall planting.

Avoid areas subject to high winds, or provide a windbreak to reduce the threat of structural damage to the tunnel. A relatively level surface is needed for the high tunnel frame. Strawberries prefer a deep, sandy loam soil well supplied with organic matter. For annual plasticulture production, this type of soil also works best for building and shaping the 4-8-inch raised beds critical for success. Fertility levels should be adjusted before setting plants. Avoid fields that have been in potatoes, tobacco, peppers, eggplants or tomatoes due to potential problems with *Verticillium* wilt. Placing the tunnel on ground that is slightly higher than the surrounding area helps prevent water from flowing into the tunnel during heavy rains. A reliable water supply needs to be available for irrigation.

Orienting the houses perpendicular to the prevailing wind on the farm will help facilitate air movement; however, placement in an east-west direction facilitates sun exposure. When constructing multiple tunnels, make sure that they do not shade one another. Once permanent tunnels are in place, laying plastic mulch, cultivation, and amending the soil can present a challenge unless access for equipment is provided by hinged or removable endwalls. Whether the tunnel is used for the annual system or for perennial beds, the

grower should be aware that salts can build up in the soil. The tunnel will have to be moved occasionally or the plastic removed to allow precipitation to flush salts from the soil.

Cultivar selection

Strawberries are commonly grouped as either June-bearing, everbearing or day-neutral. June-bearing varieties are recommended for early season strawberry production in a tunnel. Everbearing and day-neutral strawberries, which are very similar under Kentucky conditions, do not yield sufficiently for early season production in high tunnels.

Chandler and Camerosa are two of the most common varieties used in plasticulture systems in the Commonwealth, although Florida Radiance, Benicia and Camino Real also show promise. Standard eastern varieties do not work as well because of their long dormancy period. It is worth looking at varieties that perform well for growers in North Carolina, Virginia, Florida and California. Commercial growers should select well-adapted cultivars that have the necessary disease and pest resistance for their locale. Consideration should also be given to the qualities in demand by the intended market.

Planting

Four to six-week-old plug plants are recommended for fall planting to establish an annual plasticulture system in the tunnel. Dormant plants could also be used in the spring. Growers cutting their own runner tips from stock plants to make plugs need to make sure that the stock plants and tips are disease free. Plugs or tips are planted as staggered double rows in the prepared beds. Straw can be placed between the rows of plastic for weed management.

Growing environment and tunnel management

As indicated earlier, high tunnels provide a protective environment against adverse weather conditions. High tunnel temperatures and ventilation are manipulated by manually opening and closing sides, or by removing or opening the endwalls. This is critical because strawberries are sensitive to high temperatures. Because tunnels prevent natural rainfall from reaching plants, drip irrigation is essential. Moisture levels will need to be carefully monitored when using drip irrigation.

While insect pollination is not required for fruit development, berry size and weight are greater when insects pollinate strawberry flowers. High tunnel growers may need supplemental bumblebee hives if they do not observe sufficient pollinator activity within the tunnel. Honeybees do not effectively pollinate crops in a tunnel. Reportedly, mason bees may also be used as a supplemental source of pollination.

Pest management

Some diseases that plague field-grown strawberries may be less of a threat in high tunnels if the tunnel is properly managed. However, if disease does occur, there are limited numbers of fungicides labeled for high tunnel use. Because plants are protected from rainfall in tunnels, the foliage and fruit can remain dry during the growing season, but relative humidity can become high. Botrytis blossom blight and fruit rot is always a concern in strawberries, especially during wet or humid conditions. Stem and crown diseases, such as anthracnose, are transmitted through runners. Growers should carefully examine runner tips or plugs to make sure they are free of disease prior to planting.

Insects generally do not present a significant concern in Kentucky strawberry fields; however, greenhouse thrips and white fly are potential problems in a high tunnel environment. Aphid and spider mite infestations could also develop in this production system.

Frequent scouting to monitor insect populations and disease is essential to keeping these problems manageable.

Harvest and storage

A Western Kentucky grower using a raised bed plasticulture system in a high tunnel has had harvestable fruit as early as mid-March, well before local field-produced strawberries are usually available in early May. The harvest season for high tunnel strawberries lasts as long as the plants are kept healthy and the environment is appropriate. High temperatures will usually be the cause of the end of the harvest season. A four- to six-week season would be normal.

Only fully colored strawberries at their peak of flavor should be harvested because quality will not improve after harvest. The fruit shoulders and tip should no longer be green or white. Berries ought to be harvested every two or three days for the best quality and

peak freshness. Refrigeration will be needed for berries that are stored for a few hours or longer. Strawberries are usually sold in pint and quart plastic or fiber pulp containers.

Labor requirements

Labor requirements for high tunnel strawberries vary depending on the size of the structure, grower experience, and the production system. Producers new to high tunnel production may also require more time to refine production techniques.

The following estimates are provided for a 100-foot by 25-foot high tunnel. Producers can expect to spend five to eight hours for soil and site preparation. Planting times may vary from five to 10 hours according to the grower's planting method and experience. Growers should expect to spend at least 10 hours annually maintaining the strawberry crop in a high tunnel with more time needed in cases of disease or insect/mite outbreaks. The selection of weed control techniques will greatly affect the labor times; mechanical cultivation or manual hoeing will increase labor time for weed control. In addition, high tunnels will require daily labor to manually raise and lower sidewalls (15 to 20 hours annually). These structures could also require monitoring during heavy storms.

Harvest labor times will vary according to crop maturity and yield levels. Experienced pickers may pick 12 to 15 pounds (about 10 quarts) of strawberries per hour. Because strawberry yields may vary considerably, assume at least one hour of harvest and handling labor for every 10 quarts of berries picked.

Labor requirements may also increase with the selected marketing technique. Some direct marketing channels, such as farmers markets, may require more time to sell the crop than selling directly to a grocery chain or restaurant. Producers may be able to offer strawberries alongside other crops at farmers markets to reduce the direct marketing labor required to sell the crop.

Labor needs per 1,500 to 1,600 strawberry plants are approximately 45 to 60 hours for production, 75 to 150 hours for harvest, and 10 to 20 hours for packing and grading.

Economic Considerations

Estimated costs for high tunnel strawberry production

can greatly vary according to the production system employed. Annual plasticulture systems are more costly than raised bed perennial systems. Excluding labor, the approximate cost of erecting a high tunnel may range from \$1.30 to \$1.50 per square foot. Total costs, including labor and additional systems or technology desired by the grower, may add this same amount per square foot or more, depending on site preparation and other site-specific costs. Because of their simple design, high tunnel structures are not difficult to construct and manage. However, high tunnel production will represent a greater investment than growing strawberries in the field. Growers who already have a high tunnel in place from another crop will have an obvious economic advantage over growers who have to construct a new tunnel.

Initial investments include high tunnel construction, land preparation, raised bed preparation, and installation of plastic mulch and a drip irrigation system. Planting material costs will vary between cultivars. Strawberry production also requires cooling the crop after it is picked.

Production costs for 1,500 quarts of strawberries in a 100-foot by 25-foot high tunnel are estimated at \$1,575 per tunnel, with harvest and marketing costs at \$2,225 per tunnel. These costs include the costs of hired labor at a \$12.50 wage rate. Total expenses per acre, including both variable and fixed, would come to approximately \$4,135 per tunnel. Presuming gross returns of \$4,500 per tunnel (1,500 quarts sold at \$3 per quart), returns to land, capital and management would be approximately \$365 per tunnel. The Kentucky farmers market average strawberry price from 2014 to 2016 ranged \$4 to \$6 per quart from mid-April to mid-June, and prices remained at that level in 2018, indicating retail prices higher than \$3 per quart are feasible for early season strawberries.

These estimates indicate that for high tunnel strawberry production to be profitable to land and management, breakeven yields of about 1 quart per plant must be obtained. Field research in Ohio has also indicated this target yield is necessary for high tunnel strawberry

profitability. Producers should realize that yields and returns for high tunnel production will vary considerably depending on production system, variety and producer experience. Producers able to obtain higher prices of \$3 per quart or more may have a more favorable profitability outlook, and the profitability outlook for high tunnel strawberries increases when they are incorporated as one of multiple high tunnel crops.

Selected Resources

- Plasticulture Strawberries (University of Kentucky, 2019) http://www.uky.edu/ccd/sites/www.uky.edu.ccd/files/plasticulture_strawberries.pdf
- Day-Neutral Matted Row, Field and High Tunnel Plasticulture Strawberry Management Systems, p. 12 in 2010 Fruit and Vegetable Research Report, PR-608 (University of Kentucky, 2010) 1.21 MB file <http://www.ca.uky.edu/agc/pubs/pr/pr608/pr608.pdf>
- High Tunnel and Field Plasticulture Strawberry Evaluation, pp. 46-47 in 2007 Fruit and Vegetable Research Crops Report, PR-555 (University of Kentucky, 2007) 1.45 MB file <http://www.ca.uky.edu/agc/pubs/pr/pr555/pr555.pdf>
- High Tunnel and Field Plasticulture Strawberry Evaluation, pp. 27-28 in 2008 Fruit and Vegetable Research Report, PR-572 (University of Kentucky, 2008) <http://www.ca.uky.edu/agc/pubs/pr/pr572/pr572.pdf>
- Growing Strawberries in High Tunnels in Missouri (University of Missouri, 2006) <http://hightunnels.org/growing-strawberries-in-high-tunnels-in-missouri/>
- TunnelBerries (USDA website) www.tunnelberries.org
- High Tunnel Agriculture (Mielkes Farm, Wisconsin) <http://www.mielkesfarm.net/hightunnels.htm>

Suggested Citation:

Kaiser, C. and M. Ernst. (2019). *High Tunnel Strawberries*. CCD-CP-61. Lexington, KY: Center for Crop Diversification, University of Kentucky College of Agriculture, Food and Environment. Available: <http://www.uky.edu/ccd/sites/www.uky.edu.ccd/files/hightunnelstrawberries.pdf>

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Photo courtesy of John Strang, UK

May 2019

For additional information, contact your local [County Extension agent](#)