



High Tunnel Brambles

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Introduction

High tunnels are relatively simple polyethylene-covered structures placed over irrigated ground beds. Also known as hoop houses, high tunnels have been used to extend the marketing window of a wide variety of annual crops in Kentucky, such as vegetables and cut flowers. Perennial crops, such as brambles, can also be produced in high tunnels.

Advantages to high tunnel production include earlier yields and higher yields, protection from excessive rain, season extension, and potentially fewer pests, diseases and weed problems.

Marketing

Market growth for blackberries and raspberries in Kentucky has occurred in local market channels such as farmers markets, roadside stands, locally owned groceries, restaurants, and local retailers. Berries are also an attractive addition to a community supported agriculture (CSA) share. There is some limited wholesale berry marketing to large retailers in Kentucky. Smaller growers can investigate selling their fruit wholesale at Kentucky's produce auctions, where prices are usually strong for fresh berries.

Fresh fruit sales are the ideal market opportunity for brambles grown in high tunnels because of potential to receive higher, early season prices for fruit of outstanding quality. Growers could also explore processing opportunities, but if those opportunities require selling berries at wholesale prices, those prices are unlikely to generate profitable returns for bramble fruit grown in high tunnels. There may be potential profits in using high quality



berries grown in a high tunnel for small batch, value-added processing.

Market Outlook

Berries are a strong produce category, growing in popularity as a fresh fruit choice by U.S. consumers. Some increased consumption can be attributed to greater awareness of the nutritional benefits of consuming dark-colored fruits that are higher in antioxidants. Berry consumption also rose with the increased use of frozen product in smoothies and other popular food items, such as pies, cobblers, jams and preserves. Year-round availability, because of imports, also contributes to higher berry consumption.

Fresh blackberries and raspberries do not store or ship as well as blueberries, strawberries or grapes. This limits their market radius, but increases the demand for local, high quality fruit. Growers located near population centers will have a marketing advantage.

High tunnels can allow growers to ex-



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pand the marketing window for bramble fruits. This extended harvest season, along with higher yields of quality fruit, should provide high tunnel growers with a marketing advantage. Organic production could add further value to these already high-value crops. Maximum returns will be realized for exceptional quality fruit harvested when traditional open field production is over.

Production Considerations

Site selection and tunnel construction

As with any long-term perennial crop, selecting the planting site is a critical decision. While site selection for high tunnel brambles is similar to that of brambles 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 the year before planting to allow time for adequate preparation and tunnel construction. Avoid areas subject to high winds, or provide a windbreak to reduce the threat of structural damage to the tunnel. A level surface is needed for the high tunnel frame. Not leveling the surface could cause irrigation or fertility issues later on.

Soil that is well-drained, deep, fertile, and high in humus is best for blackberry and raspberry production. Fertility levels should be adjusted before setting plants. Eliminate wet spots at the site prior to construction and planting. Brambles can be planted in raised beds for improved soil drainage. Placing the tunnel on ground that is slightly higher than the surrounding area helps prevent water from flowing into the tunnel during heavy rains. Raspberries in particular are not tolerant of wet sites, which encourage the development of *Phytophthora* root rot.

Blackberries or raspberries should not follow solanaceous crops (such as tomatoes, peppers and tobacco), strawberries or other bramble crops for three to four years. Avoid fields with a history of crown gall. Because tunnels prevent natural rainfall from reaching plants, drip irrigation is essential for providing the large volume of water this crop requires for quality fruit production. Therefore, the site should be located near a water supply. Overhead irrigation is not recommended as wet fruit and leaves could lead to disease

and mold issues in the fruit, which will make it unmarketable.

Eliminating perennial weeds prior to planting and tunnel construction is critical. The first step is to avoid planting sites with high noxious perennial weed populations. Other pre-plant strategies include tillage, crop rotations designed to reduce weed pressure, and weed suppression via cover or smother crops. If left unchecked, weeds compete with plants for water and nutrients, harbor insect pests and disease, and reduce air circulation. Carry-over of certain herbicides, such as triazine, could create a problem for bramble production; these fields should be avoided. Make sure the production history of the site is known before building the high tunnel.

Generally, the tunnel should be constructed prior to planting. While plant spacing can be the same in the tunnel as in open field production, some growers prefer to use a tighter spacing in the tunnel. Since large equipment cannot be used in a tunnel, it is not necessary to allow equipment size to dictate plant spacing. However, tighter spacing could lead to an increase in pathogen pressure or disease incidence due to lack of ventilation and the microclimate the plants create. The type of tunnel selected should have sufficient height to accommodate the increased growth that can be expected of brambles in a high tunnel environment. In addition, the height of the sidewalls needs to be taken into consideration when planting along the tunnel edges.

How your tunnel should be oriented depends on multiple factors. If your site has only light winds, a north-south orientation will offer better light uniformity. If your site experiences high winds, an east-west orientation is preferred. The best orientation for your high tunnel will also depend on when you plan to produce crops. Although stand-alone greenhouses are normally oriented in a north-south direction in Kentucky, if you plan to grow year-round, orienting a high tunnel in an east-west direction will maximize the amount of low winter sunlight reaching plants. When constructing multiple tunnels, make sure that tunnels do not shade one another.

Placing tunnels over an existing planting as an afterthought is more difficult, but it can be done. In this scenario, the tunnel orientation is determined by the

direction of the rows and plant spacing cannot be altered. There is also risk of damage to plants during construction. In some cases, weeds, diseases and insect pests may have already gained a footing in an established planting, which could make pest management within the tunnel more difficult.

Once tunnels are in place, cultivation and amending the soil each year can present a challenge. Growers should make sure the doors or endwalls on their tunnels are designed to allow access for any equipment they plan to use.

Stock selection and planting

Blackberries and raspberries (both *Rubus* spp.) have a number of characteristics in common; however, they also have some distinctive qualities that should be taken into consideration when deciding which brambles to produce.

Both blackberries and raspberries have perennial crowns and roots that produce biennial canes; the canes bear fruit the second year (known as floricanes) and then die naturally after harvest. Some raspberries (known as ‘everbearing’ or ‘fall-bearing’) also produce fruit at the tips of the first-year canes (known as primocanes). There are also primocane bearing blackberries but they have not been studied for tunnel production in Kentucky. Everbearing red and yellow raspberries, June-bearing red raspberries, and purple raspberries can be successfully grown commercially in Kentucky.

Blackberries are grouped according to their growth habit: erect, semi-erect and trailing. Erect (thorny and thornless) and semi-erect (thornless) blackberries grow and yield well in most parts of the state. The trailing types, however, are not recommended for commercial production in Kentucky due to their lack of winter hardiness.

Bramble cultivars vary in fruit flavor, size, color and quality, as well as ripening period. Winter hardiness can also differ between varieties. Select well-adapted marketable cultivars suited for your location. When-

ever possible, choose varieties with resistance or tolerance to commonly occurring diseases and insects. Growers are encouraged to establish plantings from certified, disease-free, virus-indexed nursery stock purchased from a reputable supplier. Purchasing tissue culture plugs can help avoid virus problems.

Brambles may be planted in the fall or early spring; however, planting in the early spring before growth starts is preferred. Early spring plantings tend to yield more fruit during the first cropping season than do later plantings. The distance between plants and rows varies depending on the type of bramble, training method, and the size of the tunnel. If rows are placed too close together there will be inter-row shading limiting yields. Generally, rows should be greater than 5 feet



on center to reduce shading, increase airflow, and allow ease of movement. In-row spacing is dependent on bramble type, but planting closer than 18 inches for any type is not recommended.

Crop support and pruning

Brambles require regular pruning and training to ensure maximum fruit production. Because of the vigorous cane growth that generally occurs in the tunnel, overcrowding can become a problem (particularly with blackberries) if plants are not properly managed and trained throughout the growing season. Floricanes should be removed immediately after harvest and burned if it can be done without damaging the new emerging primocanes. Primocanes should be left and trellised. These will become floricanes in the spring and will produce fruit. Regular removal of dead, dying and broken canes will also be necessary. High tunnel bramble production generally requires the construction of a sturdy trellis either before planting or during the first season. Blackberries will require a much more substantial trellis than raspberries. The trellis will help support the subsequent crop load as well as keep the rapidly growing canes erect and the fruit off the ground. Supporting canes on a trellis also increases sunlight exposure, air movement, and spray penetration throughout the canopy.

Growing environment and tunnel management

High tunnels provide a protective environment against adverse weather conditions, such as frost and high winds. The high tunnel environment is manipulated by manually opening and closing the sidewalls, by removing or opening the endwalls, and in some cases, by removing the entire cover. The sidewalls can be left down in early spring, but may need to be rolled up as daytime temperatures rise. However, once the warmer weather of summer arrives, the sidewalls should be left rolled up day and night. Because tunnels prevent natural rainfall from reaching plants, drip irrigation is essential. The irrigation system can also be used to provide fertilization during the season. Moisture levels will need to be carefully monitored when using drip irrigation.

UK researchers left their Haygrove tunnel uncovered during the establishment year; however, the cover was in place from March to November in the subsequent year. Because the Haygrove is not an overwintering system, the cover is typically removed in the fall. This makes supplemental irrigation unnecessary during the winter months since natural rainfall and snow could then reach plants. Additionally, natural precipitation during the winter helps to leach out salts that accumulate in the soil during the growing season when drip irrigation is used as the principal water supply.

Brambles are pollinated primarily by honeybees; however, honeybees do not effectively pollinate crops in a tunnel. High tunnel growers may need supplemental bumblebee hives if they do not observe sufficient pollinator activity within the tunnel. Mason bees may also be used as a supplemental source of pollination.

Pest management

Plants grown in high tunnels are protected from rainfall; thus foliage and fruit remains dry during the growing season. This could mean a lower incidence of some diseases. However, because relative humidity can be high within tunnels, diseases such as *Botrytis* gray mold, powdery mildew and rust may become a problem. If these diseases do occur, there are limited numbers of fungicides labeled for high tunnel use.

Other important bramble diseases include anthracnose, cane and spur blight, crown gall, double blossom, *Phytophthora* root and crown rot (red raspberry), and *Verticillium* wilt. Diseases are managed by select-

ing resistant or tolerant cultivars, planting disease-free stock, proper site selection, and by following good cultural practices that promote healthy plant growth. Pruning out diseased canes and removing nearby wild bramble thickets are also critical aspects of disease management. Brambles infected with orange rust should be completely eradicated, roots and all; adjacent plants should also be watched. Root grafts between plants can allow orange rust to spread from plant to plant.

Mite infestations will become a more serious problem in tunnels than in open fields due to the drier tunnel environment. Spotted wing drosophila fruit flies (SWD) became established in Kentucky in 2013. This pest substantially increased the insecticide spray requirements for blackberries. Female SWD are able to lay eggs in otherwise undamaged fruit while it is on the plant. Eggs hatch and the fruit quickly deteriorates in just a few days. Raspberries and blackberries are at the top of the preferred list for this pest, and a weekly spray program is necessary once SWD is identified, normally in early to mid-July, as fruit begin coloring up. Thus, Kentucky growers are discouraged from producing fall-bearing raspberries. Some growers are looking at the possibility of exclusion netting but there is not enough data to recommend the cost-effectiveness of this practice.

Raspberry cane borer, aphids and Japanese beetles are some other pests that can cause damage in blackberry and raspberry plantings. Pruning, sanitation, weed control and insecticides aid in pest control.

Due to the relatively high density of plants in tunnels, pests and diseases tend to spread rapidly. Frequent scouting to monitor insect populations and disease is essential to keeping these problems manageable.

As plants mature and trellising structures are put in place, small tractors will have increased difficulty operating inside the tunnel structure. Rototillers and/or hand weeding will be needed for managing weeds in narrower spaces. Landscape fabric can be pinned down along tunnel edges, thus eliminating the need to maneuver a tiller in that tight area. Landscape fabric may also be used to cover the soil throughout the tunnel with holes or areas left open for plants.

Tunnels with covers left in place throughout the winter

will experience increased rodent activity when these animals discover the warm, sheltering environment that the tunnel provides. Traps can help control rodent populations in the tunnel and bait stations outside the tunnel will also help.

Harvest and storage

The first significant harvest occurs the third year for June-bearing red raspberries and the second year for everbearing raspberries. Blackberries will begin bearing during their second year. Raspberries are ready to pick when they easily pull from their receptacle, or core; blackberry ripeness is determined by fruit color and flavor.

Ripe berries should be hand-picked regularly, at least three times per week. More frequent harvests will be necessary during the peak of the season. Berries picked during the cooler morning and evening hours tend to have a better shelf life. To avoid excessive handling, berries are placed directly into the marketing container as they are picked, rather than harvested all into one large bucket, in order to preserve fruit quality and appearance. Cooling within a half hour of harvest is recommended. Because brambles have a short shelf-life, fruit that is not sold within one to two days will need to be processed or frozen.

Labor requirements

Labor requirements for brambles vary depending on the age of the planting and the type of bramble grown. Labor requirements will also vary with the size of the high tunnel. 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 in soil and site preparation. Planting times may vary from two to five hours according to the bramble variety planted, with more planting time required for higher population raspberries than for

blackberries. Growers should expect to spend at least 10 to 20 hours annually maintaining the bramble crop in a high tunnel. 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 25 to 30 pints of blackberries per hour. Picking times for raspberries may be slower due to smaller berries. Assume at least one hour of harvest and handling labor for every 20 pints 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 brambles alongside other crops at farmers markets to reduce the direct

marketing labor required to sell the crop.

Economic Considerations

Excluding labor, the approximate cost of erecting a high tunnel may start from around \$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. High tunnels made with more metal components will be more expensive, but will last longer. Many of the components are often reusable, making purchasing a used tunnel a possibility. 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 brambles in the field.

Estimated costs for high tunnel bramble production can greatly vary according to the bramble variety selected. Initial investments include high tunnel construction, land preparation, and installation of an irrigation system. Plant costs will also vary between cultivars. Additional start-up costs could include black plastic mulch and an inflation fan. Bramble production also requires a way of cooling the crop after it is picked. Some growers have found that constructing a cool storage room using a CoolBot® unit meets their needs. The cost of trellising can vary depending on bramble variety.

There is a significant startup cost, demanding management, and a time lapse before bramble crops can be harvested. Producers may expect more than two years after establishment before a full blackberry crop can be harvested and one to two years before harvesting a full raspberry crop.

Breakeven returns to cover both fixed and variable costs of high tunnel production could range from \$4 to \$7 per pound for raspberries and \$3 to \$6 per pound for blackberries during a seven-year period. These estimates assumed a cost of \$12.50 per hour for hired labor used in production, harvest and marketing. Detailed budgets developed for the northeast United States estimate a 7- to 10-year payback period for a high tunnel solely used for brambles. Breakeven price ranges indicate that producers utilizing high tunnels for bramble production will need to market berries at price premiums to recoup positive returns to land, labor and management. Direct marketing or other forms of marketing that may produce higher prices, such as producing certified organic berries, will increase the

likelihood of profitable high tunnel bramble production.

Selected Resources

- Growing Blackberries and Raspberries in Kentucky, HO-15 (University of Kentucky, 2005) <http://www.ca.uky.edu/agc/pubs/ho/ho15/ho15.pdf>
- Kentucky Blackberry Cost and Return Estimates ID-149 (University of Kentucky, 2017) <http://www.ca.uky.edu/agc/pubs/id/id149/id149.pdf>
- An IPM Scouting Guide for Common Problems of Brambles in Kentucky, ID-251 (University of Kentucky, 2018) <http://www2.ca.uky.edu/agcomm/pubs/ID/ID251/ID251.pdf>
- Midwest Fruit Pest Management Guide, ID-232 (University of Kentucky et al., 2019-20) https://ag.purdue.edu/hla/Hort/Pages/sfg_sprayguide.aspx
- Sustainable Blackberries & Raspberries: A Self-Assessment Workbook for Growers (University of Arkansas, 2016) http://hightunnels.org/wp-content/uploads/BlackberryWorkbook2016-2nd_final.pdf
- Cornell High Tunnels (Cornell University) <http://blogs.cornell.edu/hightunnels/>
- High Tunnel Raspberries and Blackberries (Cornell University, 2017) <http://www.hort.cornell.edu/fruit/pdfs/high-tunnel-brambles.pdf>
- HighTunnels.org (Kansas State University, University of Nebraska-Lincoln) <http://hightunnels.org/>

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