



Fall-bearing Raspberries in High Tunnels

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Introduction

High tunnels have proven to be an effective method for extending the raspberry growing season in Utah and other areas of the United States. Depending on the climate, outdoor fall-bearing raspberry yields can be reduced significantly by the first killing frost in the fall. High tunnels are one means of frost protection, and when used in conjunction with other frost protection methods can extend the growing season significantly. Researchers in New York have effectively extended the raspberry growing season through November (Heidenreich et al., 2008). While this may or may not be the case for climates with large diurnal temperature fluctuation such as Utah's high elevation desert valleys, the raspberry season can be significantly extended with the use of high tunnels.

Site Selection

Raspberries should be planted in well drained soils. Poorly drained soils often lead to plant disease problems. In marginal soils, raspberries can be planted on raised beds, which will increase soil drainage. Additionally, brambles should not follow crop rotations of tomato, potato, eggplant, or strawberry for at least four to five years to avoid phytophthora root rot (Bushway et al., 2008b). When growing raspberries in high tunnels, the high tunnels should be positioned to absorb maximum solar radiation from the south. When multiple high tunnels are used, there should be sufficient distance between tunnels to avoid one tunnel shading the next. High tunnels should always be located near a year-round water supply to provide for irrigation. High tunnels should also be located in areas that are protected from high winds to reduce the risk of structural damage.

Site Preparation

Establishing raspberries in a high tunnel is nearly identical to field establishment. Prior to planting, soil

samples should be taken and a soil test performed by a reputable lab. The Utah State University (USU) Analytical Laboratory located on the Logan campus provides soil testing services. To learn more, visit their Web site at <http://www.usual.usu.edu>. Based on test results, recommended amendments should be added and tilled into the soil to a depth of at least 1 foot. If the high tunnel is not yet in place, larger equipment can be used to work the soil up to a depth of 2 feet. Soil amendments can then be added and tilled in to a depth of 4 to 10 inches. Another important pre-plant consideration is weed control. Perennial weeds can cause significant crop competition and are difficult to control once brambles are in place due to a limited number of herbicides registered for use in established bramble plantings. Eliminating perennial weeds the year before bramble establishment can save time and money. Cover crops can be grown during the year prior to planting to reduce weed populations (Bushway et al., 2008b).

Plant Selection

Late-fruiting fall-bearing raspberry varieties should be selected for high tunnel environments to maximize late-season fruit production. In addition, preference should be given to varieties that produce large, high quality berries. 'Caroline' and 'Autumn Britten' are two varieties that have performed well in Utah high tunnels. Resistance to plant viruses and other pests should also be considered when selecting raspberry varieties. As with all fruit crops, start with pest-free plants from a reputable nursery.

Planting

Open-field raspberries are generally planted every 2 to 3 feet within the row and about 10 feet between rows to allow for movement of equipment (Bushway et al., 2008a). Large equipment is generally not used in high tunnels, so rows can be spaced closer together. When

planting raspberries in high tunnels, plants should be spaced 2 to 3 feet within rows and at least 6 feet between rows (Bushway et al., 2008a). Figure 1 shows a high tunnel raspberry planting on 7 foot row centers.



Figure 1. High tunnel raspberry planting on 7 ft row centers.

High Tunnel Design

There are many different high tunnel designs and manufactures. Designs can include single-bay and multi-bay structures. Designs also differ in structural strength. In selecting a high tunnel design, one should consider wind, snow load, and the crop to be grown. Tunnels best suited for production of raspberries are those with side walls at least 5 to 6 feet tall to allow for sufficient plant height and cross ventilation. Gable vents mounted in the top of the end walls can provide additional ventilation. If desired, bramble high tunnels can be built large enough to accommodate small machinery. The design of the end walls and layout of rows within the high tunnel will dictate the accessibility to small machinery within the high tunnel.

Raspberry Management

Although fall-bearing raspberries in the field are sometimes managed to produce both summer and fall crops, high tunnel production should focus on a fall crop, and are best managed accordingly. Pruning should be conducted after plants are completely dormant from late January to mid February. Care should be taken to ensure canes are pruned at ground level to prevent the cane stubs from sending out lateral fruiting branches that will produce small berries in the summer and remove energy from production of the fall crop (Bushway and Pritts, 2008).

Trellising: High tunnel raspberries require a trellis system to support canes and keep ripening fruit off the ground. While fall raspberries grown in the field are often not supported, canes in the high tunnels tend to grow longer and the closer row spacing is more

manageable if the fruiting canes are supported. While there are many trellising systems available, one of the simplest and most effective is the T trellis. The T trellis (Figure 2) consists of a vertical support post placed in the ground with a 2 foot crossbar fastened to the post approximately 5 to 6 feet above the ground. Wire or twine is threaded through the crossbars to support the canes. With posts placed every 20 to 30 feet, baling twine or other lightweight rope or wire provides adequate support. Additional crossbars added at lower levels can provide additional support. Generally, support posts can be made from lighter-weight materials; however end posts should be heavier or well-anchored to maintain tension in the twine or wire. Easily removable posts will simplify the pruning operations.



Figure 2. Example of T-trellis in a high tunnel.

High Tunnel Management: High tunnels can be managed to extend the berry production season both earlier and later in the year. However, when producing a fall crop of raspberries, the objective is typically to extend the season as late as possible into the fall. For this reason, high tunnels should be managed to maintain plant dormancy in the spring as long as possible. One method for doing this is to remove the plastic covering on the high tunnel after the plants have gone dormant for the winter.

Fertility: Prior to planting, soil tests should be performed and necessary soil amendments applied and incorporated (see Site Preparation for description of soil testing). Fertigation, applying fertilizer through the irrigation system, is an easy and effective way to fertilize raspberry plants. It is recommended that fertility programs be based on leaf tissue sample analysis. However, a good starting point is 3 oz actual N per 1000

sq ft (8 lbs / per acre) per week in the planting year from May to mid September. In the second year, the recommended rate is 2 oz actual N per 1000 sq ft (5 lbs / acre) per week from the beginning of May to the end of August, or as fruit begins to ripen, whichever comes first. The recommendation for the third year is 2.25 oz actual N per 1000 sq ft (6 lbs / acre) per week from the beginning of May to the end of August, or as fruit begins to ripen, whichever comes first (Pritts, 2008).

Ammonium sulfate and urea are both good sources of N. Potassium (K) and other nutrients may occasionally be needed, but their addition should be based on tissue tests. Leaf tissue samples should be collected from the youngest fully expanded leaf approximately 4 weeks prior to harvest. For more information on tissue tests, contact the USU Analytical Lab (see Site Preparation for contact information).

Pests

Raspberry Horntail: The raspberry horntail is a cane-boring wasp that can significantly reduce raspberry yields (Alston et al., 2009). The larva is white and can grow up to 1 inch long (Figure 3). The egg is laid by the female wasp in the lower cane in the spring. The young larva burrows upward and causes wilting of the cane tip and upper leaves. Sometimes a shepherd's crook is observed when wilting is severe (Figure 4). Presence of the horntail larva can be confirmed by carefully splitting open the cane. The larva has a small brown spine on the tail end. Application of contact insecticides to kill adults in the spring can reduce egg-laying. Effective insecticides include bifenthrin, carbaryl, diazinon, esfenvalerate, malathion, permethrin, and zeta-cypermethrin. Some of these insecticides are only available to licensed pesticide applicators and some are available for home use. Pruning out and destroying infested cane tips when larval tunneling is observed can also be an effective control strategy.



Figure 3. Raspberry horntail larva tunneling in a raspberry cane. The sawdust-like brown clump is insect frass, or excrement.



Figure 4. Shepherd's crook and wilting caused by the raspberry horntail.

Raspberry Crown Borer: The raspberry crown borer adult is a clear-winged moth with a two year life cycle (Alston, 2007). Females lay eggs on the underside of cane berry leaves in the late summer. After the eggs hatch, the larvae move down the outside of the cane towards the roots and the crown. During the first year, larvae burrow into the cane or find a protected area at the base of the cane to overwinter. The following summer larvae burrow into and feed on the crown. At the end of the first summer, larvae make their way into the roots and overwinter there. During the second summer, larvae make their way upwards into the crown where they continue feeding until mid summer when they pupate and emerge as adults in late summer. The moths then complete their life cycle and lay eggs in late summer/early fall (2008a). Infested canes can be wilted and sometimes have a shepherds crook (see Figure 4). Infested canes often break off at ground level with minimal effort where the crown has been girdled. Raspberry crown borers are best controlled while on the outside of the plant. This is best achieved with an early to mid October application of carbaryl, malathion, or esfenvalerate, which kill newly hatched larvae as they travel down the outside of the cane. Because of the two-year life cycle, good control will take multiple years of effective insecticide applications (Alston, 2007).

Fruit Feeding Insects: Some insects cause injury by directly feeding on the developing fruit. Fruit feeders in Utah include grasshoppers, earwigs, stink bugs, lygus bug, European paper wasp, and yellow jacket. These insects can be controlled with carbaryl, malathion, esfenvalerate, or spinosad (Alston, 2007). Grasshoppers and earwigs need to be treated before the adult life stage,

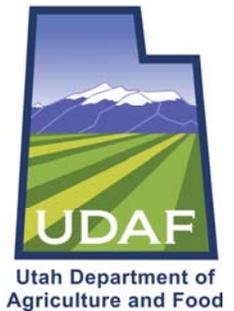
which means scouting and treating for these pests throughout the summer. Stinkbug and lygus bug should be treated when they pose an economic threat. Shaking canes over a light-colored tray will dislodge insects for easy counting. Paper wasps and yellow jackets can also be controlled with insecticides and traps. Several types of yellow jacket traps are commercially available. A simple, homemade juice trap can reduce European paper wasp populations (Alston et al., 2009).

Phytophthora Root Rot: Symptoms of phytophthora root rot include stunted canes, weak fruiting laterals, and premature yellowing of the leaves. To determine if canes are infected with phytophthora, dig up a wilted, but not dead plant and scrape off the outer bark of the crown and the main roots with a knife edge. Phytophthora causes the cambium and tissues just under the bark to turn a dark red to brown as compared to the white color of healthy plants. Chemical control is currently limited, thus making prevention a must. Raspberries should be planted in well drained soils. If heavy soils are present, the use of a raised planting bed should be considered. In addition, raspberries should not be overwatered, and standing water should be avoided. Growers should purchase clean planting stock from a reputable nursery (Celetti et al., 2008).

Raspberry Bushy Dwarf Virus: Symptoms of raspberry bushy dwarf virus (RBDV) include stunted plants and crumbly fruit. RBDV is virtually impossible to control after it has infected a planting. Growers should select varieties that are resistant to RBDV, and for those varieties that are not resistant, only plant stock that has been tested and found to be free of RBDV (Celetti et al., 2008).

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