

Growing Winter Raspberries in a Greenhouse

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Navigating snowy, ice-covered roads on the way to market is among the challenges facing a new type of raspberry grower. A few innovative producers are harvesting up to 60 flats (720 half-pints) of fresh raspberries from a 20 X 30 ft. house between February and May, and selling them for \$2,000. Greenhouses have been used for many years to produce tomatoes and cucumbers during winter, but these vegetables require relatively warm temperatures and high levels of light, making their production expensive. Raspberries, however, are uniquely suited for greenhouse production during the off-season. They grow best at cool temperatures (60 - 70°F) and do not require supplemental light to produce a crop, especially if production is targeted for May and June. In northern states, many greenhouses are empty during the winter months, but these could be used to grow raspberries with only moderate inputs, providing greenhouse owners with an opportunity to produce an extremely high value crop during a time of the year when they are realizing no return on their capital investment and when no domestic raspberries are available.

The vast majority of winter raspberries currently on the market are flown in from the Southern Hemisphere. Quality is generally poor, because raspberries have an extremely short post-harvest life and bruise easily during shipping. As a result, consumers are willing to pay between \$3.00 and \$6.00 per half-pint for fresh fruit of superior quality, and restaurant chefs seem willing to pay even more.

Local raspberry production is now possible because of two accomplishments in the area of entomology. First, bumble bees have now been domesticated and are available in small hives for pollinating greenhouse crops. Bumble bees perform better than honey bees in greenhouses, especially under the cooler temperatures used for growing raspberries. Second, predatory mites are now available that feed on phytophagous mites, and these can keep populations of damaging mites at low levels.

Compared to field production, greenhouse-produced berries are larger, firmer, and much less prone to fruit rot. Fruit tends to be slightly less sweet and more acid in the greenhouse, but well within the limits of acceptability. Varieties differ in performance and flavor, and what might do well in the field will not necessarily perform well in the greenhouse. According to our research and work done in Belgium, the variety Tulameen from British Columbia is the best floricane-fruiting raspberry in the greenhouse, although it will not survive most winters outdoors in northern climates. If temperatures drop from above freezing to below 10°F, canes can be damaged.

Production Basics

Tulameen tissue-cultured raspberry plugs are planted into 2-gallon pots filled with equal parts sand, peat, perlite, and vermiculite in May and allowed to grow outdoors on a gravel bed with irrigation. While outdoors, plants are fertilized while irrigating with a complete soluble fertilizer solution containing 100 ppm N, and pest outbreaks are managed using conventional practices. Rows of pots need to be spaced about 8 ft. apart so that sufficient light will be intercepted by the lower leaves on the canes. If the plants are too close together, the lower buds will not produce fruiting laterals once they are moved into the greenhouse. In October after leaf drop, pots are moved closer together and bales of straw are placed around the group of pots to help protect them from cold temperatures. Root systems are more sensitive to cold temperatures than canes, so temperatures near zero for an extended period of time will kill roots in pots that are setting on top of the ground. In late December, plants are moved into the greenhouse. (Plants may have to be moved earlier if late December temperatures are forecast to fall below 10°F. In this case, move plants into an unheated greenhouse until the end of December.)

Once in a warm greenhouse, canes are spaced pot-to-pot with 5.5 ft. between rows, trellised, and watered with a 100 ppm N complete fertilizer solution. Short or broken canes are removed. Household fans are used to circulate air down the rows to reduce pockets of high humidity (ideal is 65 - 75%) and the subsequent risk of fungal infection. Temperatures are maintained at 65 - 70°F during the day, and 50 - 55°F at night - ideal for raspberries but too cold for most other plants. Supplemental light can accelerate development by 2 to 3 weeks and increase yield by 20 - 30%, but may not be economical, depending on markets.

Six weeks after moving plants into a lighted greenhouse, they flower. Bumblebees are used to pollinate the flowers, and fruiting can begin as early as mid-February, about 10 weeks after moving plants indoors. Once flowering begins, the nutrient solution is reduced to 50 ppm nitrogen. With one-year-old plants, double rows (with row centers 5.5 ft. apart) and a pot-to-pot spacing are used so that approx. 20 plants are contained in each 10 ft. length of row. Each "baby" plant produces about two half-pints of fruit. All but four new canes (primocanes) are removed. These four will bear next year's crop.

After the first harvest is over (in April, May or June), plants are transplanted into 5 or 7 gallon pots (less sand is needed when transplanting into larger pots) with primocanes

intact and placed outside in full sun for the second growing season. Raspberry plants must be supported outdoors to prevent the wind from blowing them over. We use bamboo stakes to hold canes upright in the pots. When primocanes reach 6 ft., they are topped to retard growth. Plants are returned to the greenhouse in mid-December - after the chilling requirement had been fulfilled. Rapidly satisfying the chilling requirement is one advantage that northern growers have over more southern producers. Plants are watered regularly and fertilized once a week with a soluble balanced fertilizer (100 ppm N). In the second production cycle indoors, plants are spaced 22 in. apart in single rows, with 5.5 ft. between rows, and canes are trellised upright to a single wire. In the second and third fruiting years, both fruiting laterals and primocanes will be growing and competing for limited light. In order to regulate self-shading yet have large primocanes for next year's crop, we tip the largest four primocanes per pot at a 3 ft. height; the remaining primocanes are removed at ground level. This allows the fruit to be harvested without significant interference from the primocanes. Primocanes will begin regrowth after several weeks, and will continue growing once they are moved outdoors again. Raspberry plants will fruit for three years before beginning a decline.

If producers do not want to take the time to grow their own plants, full-grown raspberry canes dug directly from the field in early winter can be used to produce fruit that same spring. These plants will be slower to flower and fruit than full-grown potted plants, but are nearly as productive. If using "long-cane" plants, allow them to acclimate in pots in a cold greenhouse for two weeks before warming the house to 65°F.

Twospotted spider mites thrive in the warm, dry conditions of a greenhouse. To reduce the number of mites, we treat canes with horticultural oil within a few days of being moved inside the greenhouse. Since no pesticides have been labeled for greenhouse raspberry production, biological controls must be used for twospotted spider mites after plants are moved inside. Cool temperatures, high humidity, periodic releases of predatory mites, and removal of infested leaves help reduce numbers of pests.

Experiments

We are quantifying growth and canopy development, and responses to light, temperature and carbon dioxide, in an attempt to develop a model that describes and predicts growth and yield under various environmental conditions. This information will be useful for optimizing greenhouse-growing conditions. Cooperators in Minnesota are examining how changing the environmental conditions after flowering might enhance productivity, and cooperators in Alaska are trying to understand the chilling requirement.

We are also studying the effect of initial pot size and

transplanting on plant growth. Is it worth transplanting one-year-old plants after the first fruiting cycle to save space, or should they be planted directly into their "adult" containers? If planting directly into containers, what size should they be?

Are "long-cane" plants grown in nurseries in California as good as plants from Washington State? Our trials suggest that California plants are somewhat better.

We have also artificially chilled plants prematurely in coolers in mid-August and mid-September to determine if they would flower earlier than normal. After 8 weeks in coolers, plants chilled in both August and September produced flowers in the greenhouse as early as December. Defoliation of plants prior to chilling had no effect. This finding opens the possibility of significantly lengthening the fruiting season of greenhouse raspberries. Starting production earlier would have several advantages. Raspberry production would be complete before bedding-plant season begins in April, allowing more greenhouse space to be available for use. Also, vents are closed when the outdoor temperatures are cold, allowing the grower to supplement the atmosphere with carbon dioxide, enhancing plant growth. Once temperatures warm in spring, houses have to be vented to cool them and the carbon dioxide escapes. Again, an earlier start would improve efficiency of carbon dioxide use.

Researchers in Ontario are extending the season with primocane-fruiting varieties, moving them inside the greenhouse in early September before the onset of cold weather. These varieties continue to fruit during autumn, and by pruning them, it is possible to obtain continuous fruiting during the winter. However, production then is less than with florican-fruiting varieties.

Summary

Raspberries are the most perishable of all fruits, so even though they can now be grown close to market, they must still be handled with the utmost of care. Raspberries must be cooled quickly after harvest, and delivered to the customer as soon as possible. Most markets for winter raspberries are small, so a producer will need to line up and supply a larger number of smaller markets than typical.

Despite these challenges, the opportunities for producers are great. At this point, there exist only a few winter raspberry producers, so the market is open. Furthermore, the quality that can be produced is very high. Consumers and restaurant chefs are willing to pay high prices for high quality berries in winter. Further research will lead to an extended harvest season, and eventually, to year round production.

For more information on greenhouse raspberry production, visit the website: <http://www.hort.cornell.edu/department/faculty/pritts/greenhouse/Frontpage.htm>

