

Greenhouse Raspberry Production Guide



For winter or year-round production

CORNELL

Department of Horticulture. Publication 23
Author: Kurt Koester and Marvin Pritts, 2003
Online version at: www.fruit.cornell.edu/berry.html

About this Guide

The Greenhouse Raspberry Production Guide was originally written as a Project Report in partial fulfillment of the Masters of Professional Studies in Agriculture Degree and presented to the Faculty of the Graduate School by Kurt Donald Koester, August 2003. The members of his Special Committee were Dr. Marvin P. Pritts and Dr. John P. Sanderson.

Contributions to this production guide were made by Shirley Kline, Robert Langhans, John Sanderson, Alan Lakso, Tom Whitlow, Mary Jo Kelly, Heidi Noordijk, Rachel Kennedy, Aimee Roberts and Tom Wood. Thanks to Adam Dale, Kathy Demchak, Tom Walters, and Courtney Weber for helpful reviews.

Additional Copies

Additional copies of this publication can be purchased from:
Department of Horticulture
134A Plant Science Building
Cornell University
Ithaca NY 14853-5904

Table of Contents

Introduction	5
Advantages of Greenhouse Production of Raspberries	5
Biology of the Cultivated Raspberry	6
Choosing a Production Type of Raspberry	7
Preparing the Greenhouse Environment	7
Plant Container Spacing	8
Plant Selection	8
Plant Types: Tissue Culture Plants	8
Nursery Mature or Dormant Short Canes/Bare Root	9
Dormant Long Canes	9
Establishing Container Raspberry Plants	10
• Container and Potting Medium Selection	10
First Season Care and Management	11
• Location and Spacing	11
• Pest Control	11
• Moisture and Fertilizer Requirements	12
Late Season Care	12
• Chilling Requirements	12
Greenhouse Growing Conditions	13
Trellising and Cane Management	14
Primocane Management	15
Pollinator Management	15
Water Management	16
Irrigation System	16
Nutrient Management	17
Considerations for Pest Management	18
Harvesting, Handling, and Transporting Fresh Fruit	18
Post-Harvest Plant Care	19
Season Extension	20
• Staggered Production	20
• Primocane-fruiting	20
High Tunnels	21
Arthropod Pests	23
Disease Scouting and Management	29
Physiological Anomalies	30
Marketing Greenhouse Raspberries	31
Budgeting	31
Photo examples of independent grower operations	33
Suggested Readings	34
Sources for Biocontrols and Bumble Bees	34
Sources for Plant Material	35
Bibliography	35
Glossary	36

Introduction

At Cornell University in Ithaca, New York, researchers have been working on a production system for producing high quality, premium raspberries for the off-season market. In the Northeast, greenhouse growers often have crops that will take them from the late spring season with bedding plants, all the way through the early winter months with poinsettias. After the greenhouses are emptied in December, these greenhouses may sit empty until spring when bedding plants are once again started. With winter raspberry production, growers are able to keep their greenhouses in production, thus capitalizing on a time when fresh raspberry fruit is lacking locally, and also providing further profit for themselves and their families during a period that otherwise would be a downtime for the greenhouses. With the use of fall bearing raspberries, different cultivars, and storage of



planting stock in coolers, year around production of raspberries is possible in the greenhouse as well. Over the past several years, many growers in locations all across the country have started a greenhouse raspberry operation.

Field production of raspberries has certain considerations for management of plants and pests that differ from winter or off-season production, but many aspects of the production methods are similar.

Fresh, high quality raspberries are not readily available in the United States in winter because no significant domestic production system has been developed. Raspberries available in grocery stores during the winter months are mostly grown in Mexico, Central and South

America. The raspberries that finally arrive are very expensive and often of poor quality



due to being very delicate fruit that is shipped long distances. Fruit quality begins to degrade quickly after harvest and is often damaged in the shipping process. The fruit available in the grocery stores is often well into the process of decomposition and may be moldy. The fruit industry has tried to avoid this problem by harvesting the raspberries before they are completely ripe. Even though this will help to preserve the physical appearance of the fruit for display, the fruit is often lacking in flavor and the sugar content is extremely low because the ripening process is brought to a halt when the fruit is picked. The flavor quality of the fruit will not improve once the fruit has been picked.

Advantages of greenhouse production of raspberries:

- The grower is able to provide the consumer with a high quality fruit year-round that will both look good and offer excellent flavor.
- Compared to field production, greenhouse-produced berries are larger, firmer and much less prone to fruit rot.
- The grower is able to achieve a high level of quality because the fruit never becomes wet from rain or irrigation, thus greatly reducing the instance of fruit rotting infections, and the fruit can be harvested at the peak of ripeness for optimum flavor.
- The storage and shelf life of greenhouse raspberries under refrigeration is greatly increased because the fruit has been kept dry, and therefore, fruit rotting infections are much reduced.

- 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; varieties that do well in the field will not necessarily perform well in the greenhouse.
- Consumers are willing to pay between \$3.00 and \$6.00 per half-pint for fresh fruit of superior quality, and restaurant chefs are often willing to pay a premium as well.

This production guide is intended to be a comprehensive resource for both the novice and experienced grower to use in establishing a successful and profitable enterprise growing fresh, high quality raspberries for the off-season market. Included is information on greenhouse preparation, plant selection, planting, insect and disease control, nutrient and moisture management, harvest, economics, and marketing. A glossary, a list of supplementary materials, and general references are located at the end of this book.

Biology of the Cultivated Raspberry

Cultivated raspberries are of two basic types: primocane and floricanes fruiting. The primocane fruiting types produce fruit on the cane tips on the first year's growth, and a second crop lower down the cane in the following year. After the second year's crop, the canes will die and can be removed, as new canes will continue to grow from the perennial root system. Floricanes fruiting types produce fruit on the lateral branches that emerge from axillary buds on a second year cane. The cane will grow the first season (primocane), go through a winter dormancy period, and after the dormancy requirement has been fulfilled, the lateral buds will break and produce flowers that when pollinated will produce fruit. Similar to the primocane fruiting types, after the floricanes fruiting types have produced their crop, the canes will die and can be removed to make room for the new canes arising from the root system.

The canes typically exhibit an S-shaped growth curve, but this can be modified by the

environment. First year canes grow rapidly after dormancy, but during hot conditions extension growth slows. If adequate moisture is supplied, elongation can increase. Nodes on first-year canes form at a constant rate over time, and the variation in the growth rate of the cane leads to variation in internode length along the cane. The cane typically has short internodes at the base and tip, with long internodes in its mid-region.

Flower-bud initiation usually occurs under short days and cool temperatures, but with some varieties, initiation will occur once the cane reaches a certain height regardless of day length. If initiation occurs before the first year canes stop growing, the primocane fruiting trait occurs.

Fruiting lateral branches (laterals) elongate rapidly after bud break, and continue to extend until the terminal fruits begin to form. The flower buds on the laterals may or may not develop into fruit depending on cane vigor and weather conditions in the fall during flower bud initiation. A vigorous cane and a mild fall results in more flowers per bud (node) and more nodes with flowers. Thirty or more flowers may be produced on a single flowering lateral. Most buds that reach a diameter of 2 mm continue to develop, set and mature fruit. Insect pollination is essential for good fruit set. In the absence of pollinators, drupelet set can be 80% lower. Raspberry flowers produce copious quantities of nectar which attract pollinators. The stigmas may remain receptive for only about six days, so it is important to have the pollinators available in time to set the fruit.

The structure of the fully developed fruiting lateral varies depending on its position on the cane. On untipped fruiting canes (canes that have not been pinched or trimmed back to a given height), the laterals at the tip are short, have few nodes and bear a low yield of small fruits. They become progressively more vigorous with higher yields over the middle two-thirds of the cane, although yield of the bottom laterals on the cane is decreased. Yields may be greatest in the mid-section or in

the top section of a tipped cane, depending on the cane height. Short canes with many nodes tend to have high yields on the laterals in the mid-region, whereas tall canes with few laterals and long internodes tend to produce high yields at the top of the cane. Increased cane diameter has been associated with increased yield. However, fruit numbers differ only slightly between thin and thick canes after they have been tipped. Thicker canes generally have more berries per lateral but fewer laterals per cane than thinner canes. Thicker canes tend to be taller, and tend to take longer to break dormancy than thinner canes.

Bud break to flowering may take one to two months, depending on accumulated chilling and greenhouse temperature. Fruits take between 30 and 45 days to develop from flowering, depending on the cultivar and the environment. Most of the increase in fresh weight takes place in the last 7-10 days of development. When the fruit becomes over-ripe, some of the weight is lost. The yield of fruit increases rapidly during the first few harvests to a peak, and then declines fairly slowly although the size of the peak and rate of decline vary with cultivar. Individual fruit weight remains fairly constant through the major part of the season and then drops towards the end.

Choosing a Production Type of Raspberry

There are advantages and disadvantages for both primocane and floricane raspberries in the greenhouse. Some producers use a mixture of both types.

Primocane-fruiting

Advantages

- long harvest season from the same plant
- less movement of plants into and out of the greenhouse
- shorter time from transplanting to first full harvest
- simple trellis is required
- higher density of plants

Disadvantages

- mites and other pests build up during the long harvest season
- yield per plant is low
- bees must be active for months at a time

Floricane-fruiting

Advantages

- short harvest season with high yields
- easy to schedule production cycles
- pests easier to control
- only one bee hive required per harvest
- superior flavor and size

Disadvantages

- requires extensive manipulation of plants and canes
- may be two years before full harvest is realized
- significant chilling is required to break dormancy
- plants require trellising
- larger plants take up more space

Preparing the Greenhouse Environment

A greenhouse with a heat source will be required for maintaining warm temperatures of up to 70°F (20°C) inside while the weather is cold outside. Coolers and venting may be necessary for late spring production. Other materials needed include a clean water source with low salinity, a fertilizer injector, an irrigation system, growing media and at least 3 gal (13 L) containers. Other supplies that are optional include growing lights, a weed barrier for the greenhouse floor to suppress weeds and keep the plant containers from directly contacting the earth, and temperature and humidity gauges. Humidity levels will vary when the greenhouse floor is gravel vs. when the floor is concrete. Concrete floors tend to absorb moisture much more and therefore may need to be sprayed with water during the day in order to maintain sufficient humidity. The target range for the relative humidity is between 65-75%.

The greenhouse can be an excellent environment in which pests and disease

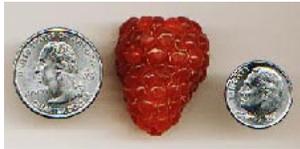
organisms thrive. The greenhouse must be thoroughly cleaned before any raspberries are moved in. Remove any plant debris. In the summer, maintaining temperatures at greater than 104°F (40°C) and relative humidity at less than 50% for 3-4 days in a greenhouse that is completely void of plants (weeds, “pet” plants, unsold plants, stock plants, etc.) will eradicate many insects.

Plant Container Spacing

Measure the available greenhouse space to determine how many containers can fit in rows about 2 ft. apart (0.6 m) with a minimum of 5.5 to 6 ft (1.6 to 1.8 m) between rows for floricane fruiting varieties and 4 ft (1.25 m) for primocane varieties. Closer spacing may result in higher yields per house, but disease pressure will be greater. Remember to leave about 3 ft (1 m) to access both sides of the outside rows so the fruit can be harvested. Estimate how many containers will be needed, and decide how many extras are desired for replacements in case a few plants in the rows do not survive.

Plant Selection

Obtaining high quality, virus-indexed planting stock is an important step in developing a successful bramble operation; poor plant material guarantees a poor planting. Plants should be ordered from a reputable source, preferably a nursery that sells plants from “certified” virus-indexed stock. Virus-indexed plants have the best growth and productivity and will generally live longer. Field-grown nursery stock has a greater chance of being infected with disease, such as crown gall or *Verticillium* wilt, than greenhouse stock straight from tissue culture, particularly if it is uncertified.



A typical Tulameen raspberry fruit

For reasons not yet understood, cultivars that are proven to be reliable producers of high quality fruit in the field do not necessarily perform similarly in the greenhouse. Some varieties that have performed well include

the primocane varieties: ‘Autumn Bliss’, ‘Autumn Britten’, ‘Josephine’, and ‘Caroline’; and floricane varieties such as: ‘Cascade Delight’, ‘Chilliwack’, ‘Encore’ and ‘Tulameen’. In side by side tests, ‘Tulameen’



has proven to be an outstanding variety that consistently produces a high quality raspberry in the greenhouse and also has few insect and pathogen pests.

Plant Types: Tissue Culture Plants

Tissue culture plugs provide the grower with a consistent stand of plants as well as certified virus-free plant material. They are grown under very strict propagation conditions of sanitation. The tissue culture plugs are grown under aseptic conditions to be free of known viruses, insect pests and soil borne pests and pathogens. The plantlets are all clones of the same mother plant. Therefore, all plantlets will be nearly identical in performance and will fruit at approximately the same time. Tissue culture plants are grown for one season and fruited in the second season, with the largest crop in the third season. This means there will be no fruit to harvest and sell until the second year of for floritime-fruiting varieties. To ensure an order is available to be shipped in full, contact the nursery six months to a year in advance of when planting is expected to begin.

Growth of tissue-cultured plugs is more uniform and vigorous than traditional plant material. When planting, the top of the root ball should be covered with soil media to a depth of ¾ in (2 cm). Media should be pressed to ensure good contact with the root ball. Tissue-cultured plants have never been exposed to the outdoors,