Raspberry Propagation and the Washington State University Breeding Program©

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The Washington State University red raspberry (*Rubus idaeus* L.) breeding program develops new cultivars that are suited to the needs of local growers. In the process of developing new cultivars the program has to deal with various propagation issues including: controlled pollinations, seed germination, micropropagation, and traditional raspberry propagation from root cuttings. The breeding program will describe the flow of plant material through the process of developing new cultivars.

The Washington State University (WSU) raspberry breeding program began in 1928 with the first crosses made in 1929. The program has released 11 raspberry cultivars since then. Dr. C.D. Schwartze released six cultivars, including 'Meeker', in 1967. Over 40 years since release, 'Meeker' is still the most widely planted raspberry in the Pacific Northwest, with over 50% of the commercial plant sales. Recent releases from the program include 'Cascade Delight' and 'Cascade Bounty'. 'Cascade Delight' is a large-fruited, root-rot tolerant, fresh-market cultivar that is finding acceptance in the Pacific Northwest for fresh market as well as worldwide interest. 'Cascade Bounty' is a very productive, machine-harvestable raspberry with excellent root-rot tolerance. Plant sales of 'Cascade Bounty' in the Pacific Northwest are still increasing.

In 2009, Washington produced 65,700,000 pounds of red raspberries, leading the U.S.A. in raspberry production (NASS, 2010). Only 700,000 pounds of this were sold fresh with 98.9% of the production being used for processing uses. All processed berries are machine harvested. Only a very small segment of the Washington raspberry industry would benefit from a new cultivar suited only to the fresh market. Therefore, developing machine harvestable raspberry cultivars is an extremely high priority of the WSU raspberry breeding program. Other high priorities are breeding for root-rot tolerance and raspberry bushy dwarf virus (rbdv) resistance, two of the major diseases affecting commercial raspberry production in the Pacific Northwest.

Over the past 5 years, the breeding program has averaged 95 raspberry crosses per year. Parents have been selected to combine machine harvestability, root-rot tolerance, and rbdv resistance. The seed from the crosses is cleaned from the fruit by the use of pectinase. The fruit from a cross is placed in a small bottle, covered with water and 1–2 drops of pectinase per 50 ml of water is added. This is incubated overnight at 37 °C. The bottle is shaken and the seeds settle to the bottom of the bottle. The remaining pulp from the fruit is removed by rubbing the seeds in a strainer in water and floating the pulp away. The seeds are air-dried and then stored in a refrigerator until needed. Prior to sowing, the seeds are acid-scarified and then cold-stratified. Dry seed is treated with concentrated sulfuric acid for

15–20 min, washed in running water, and then soaked in 1% calcium hypochlorite with excess calcium hydroxide at room temperature for 6 days with the solution being changed after 3 days. After this treatment the seeds are rinsed and then given 6 weeks of moist, cold (4 °C) stratification.

The goal for each cross is to produce 200 seeds and have those seeds produce 100 seedlings. Over the past 5 years, the program has planted an average of 7,100 raspberry seedlings each year.

Two years after the seedlings are planted in the field, selections are made. Seedlings are evaluated weekly for vigor (especially root-rot tolerance); yield; growth habit; fruit color, size, appearance; fruit firmness and ease of fruit harvest; and flavor. Superior seedlings are propagated for further evaluation. The next year (3rd year after planting) additional seedlings are selected in the same seedling field, independently of the previous year's evaluations. Approximately 1% of the seedlings are selected for further evaluation.

The selections are propagated by micropropagation. Shoot tips (1–4 cm long) are collected from 1st year canes;, expanded leaves are removed and then surface sterilized with 0.5% sodium hypochlorite with Tween 20 as a surfactant for 16 min. The shoots are transferred to 0.05% sodium hypochlorite solution for at least 5 min and then placed on growth medium. The advantage of micropropagation is rapid propagation of small numbers of plants and greatly reducing root-rot contamination of the plants. Each year the program has over 100 different raspberry selections and cultivars in propagation. When a selection is not micropropagated successfully, roots of the selection are dug in early winter; roots are washed and placed in vermiculite in the greenhouse. The shoots that are produced are rooted in pumice on a mist bench. The plants produced this way are grown in the greenhouse and shoots from these plants are then collected for micropropagation.

The next stage of evaluation of a selection is machine-harvest evaluation. Ten plant plots of each selection and standard cultivars are established with a cooperating grower. These plantings are grown using commercial methods. Two and three years after planting these plots are machine harvested with commercial harvesters. The selections are evaluated weekly during the harvest season. Fruit of the selections is evaluated as it passes over the belt on the harvester. Selections are subjectively evaluated for the stage of ripeness of the harvested fruit, fruit size, integrity, firmness, flavor, and yield. The selections that appear to machine harvest well are evaluated further.

The advanced selections are planted in another machine harvesting planting and replicated plots at WSU Puyallup where they are hand harvested and data is collected. The advanced selections may be evaluated for root-rot tolerance in a field naturally infested with *Phytophthora rubi*. The selections may also be evaluated for resistance to rbdv by graft inoculations.

If selections appear promising after these evaluations, they are commercially propagated and planted in grower trials with intellectual property protection. Finally, a selection may be named and released as a new cultivar or discarded. The average amount of time from when the cross was made to when the 11 cultivars were released from the WSU program is 14 years.

LITERATURE CITED

National Agricultural Statistics Service. 2010. Non-citrus fruits and nuts 2009 Summary. <http://www.nass.usda.gov/Publications/Todays_Reports/reports/ncit0710.pdf>. Accessed 8 September 2010.

QUESTIONS AND ANSWERS

Gayle Suttle: How are the selections evaluated for resistance to root rot and is the field test selective enough for the correct disease.

Patrick Moore: A few years ago, we did a study comparing the field response to root rot to the response of the same raspberries in the greenhouse. The plants in the greenhouse were inoculated with *P. rubi*. There was a significant correlation of about 0.7 between the field response and the greenhouse response. So the field response was similar to the response of plants inoculated with *P. rubi*, even though the greenhouse study used small tissue cultured plants and the reaction occurred in just 3 weeks and the field response was a slow decline over the course of several years, with relatively woody plants. We also collected samples from the field site that we use for screening and DNA tests indicated that *P. rubi* was present in that field. A researcher in British Columbia has identified several different fungi that are pathogenic on raspberry. The last I heard about his work was that *P. rubi* appears to be the major disease-causing fungus for raspberry root rot. Additionally, selections and cultivars that have performed well on our root-rot site at the Goss Farm, have generally survived well on most sites in the Pacific Northwest.

Kristen Yanker-Hansen: What kind of taste testing are you conducting?

Patrick Moore: I taste many of them. My goal is to have the best tasting one in the whole field. What I do when testing for flavor is to throw out those that taste bad and as the testing process continues more people will taste them so that it's more than just my opinion.

Dharam Sharma: Are there viruses affecting raspberry and are you testing for all of them?

Patrick Moore: No. The big one is bushy dwarf requiring some growers to replant every 5–6 years instead of the normal 10–12 years. It's a high priority for those growing the high-end fruit. There are many other viruses. Before we release a selection we send it to a U.S.D.A. lab in Corvallis, Oregon, for virus testing to be sure we have clean planting stock. Most other viruses are vectored by something you can get around. If you control aphids you can control viruses spread by aphids. The same goes for those spread by nematodes. Those spread through the pollen are difficult to control so we need to develop selections that are resistant.