PROJECT NO.: 8201 (Termination Report)

TITLE: Powdery Mildew-Resistant Cherry Cultivars

YR INITIATED: 1998-99 **CURRENT YR:** 2000-01 **TERMINATING YR:**1999-00

PERSONNEL:
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REPORTING PERIOD: 1998-2000

ACCOMPLISHMENTS AND RESULTS:

1. Mildew Screening Test Development

Natural infections of powdery mildew are influenced by climatic conditions, quantity of inoculum present, and stage of leaf development, so objective screening of cherry cultivars or breeding populations can be problematic. The first step in this project was to develop an objective, repeatable laboratory-based screening technique that could be used to quickly quantify mildew infection severity with a minimum of plant material and space requirements (compared to orchard observations). Such resistance screening can then be used to rank the various levels of genetic resistance or susceptibility to mildew in commercial cultivars or in breeding populations of seedling progeny form 'PMR-1', the mildew-resistant parent in the WSU-Prosser breeding germplasm collection.

A series of experiments were undertaken during spring and summer 1998 to examine leaf age, leaf area, incubation temperatures, incubation media components, and incubation illumination parameters to determine conditions for optimal growth of powdery mildew after artificial inoculation. The resulting screening test conditions use a spore settling tower for uniform controlled inoculations; a disk of leaf tissue to provide a uniform quantified area for infection to develop; and optimized culture media and environmental conditions to not only sustain the leaf tissue disks, but to also optimize fungal growth.

2. *Mildew Screening of Existing Cultivars*

The lab screening technique developed above was then tested on a range of cherry cultivars during mid- and late summer 1998, using inoculation with a composite of powdery mildew conidial sources. The quantified infections were used to develop ranked orders of powdery mildew susceptibility, allowing estimates of the range of natural levels of resistance in current commercial cultivars (see Table 1) These results suggested that 'Bing' and 'Rainier' are among the most susceptible cultivars to powdery mildew, followed by 'Van' and 'Lapins'. Besides the 'PMR-1' breeding line, the only current PNW cultivar among the apparently immune selections was 'Chelan'.

These objective lab results are consistent with our limited 1998 field screening observations of natural mildew infections among 70 cultivar accessions in the NRSP5/IR-2 collection at WSU-Prosser. In addition to those cultivars ranked in Table 1, others that appear to be resistant to powdery mildew included 'Hedelfingen' and several cultivars which have 'Hedelfingen' as a parent. This was seen as further evidence that resistance to powdery mildew can likely be bred into future cultivars.

3. *Computer Image Analysis to Quantify Powdery Mildew Area*

Visual estimation is the standard method to determine diseased area in many breeding programs. However, reliance on such visual estimates is highly subjective. The rapid advances in computer technology have made hardware such as scanners, digital cameras, and video acquisition systems routinely available in research laboratories. A method of quantifying powdery mildew area on diseased leaves through precise computer imaging could eliminate the subjectivity of visual estimation. The detached leaf disk test described above was used to investigate the use of computer image analysis for quantifying powdery mildew area. Leaf disks with varying levels of powdery mildew colonization were scanned directly into a computer using a flatbed scanner. Image files were then analyzed for percent powdery mildew area with a commercially available image analysis software program. Using such image analysis, the ranking of cultivar susceptibilities was consistent with visual estimates. However, the image analysis software showed no improvement in the accuracy and precision of measurement of powdery mildew area, likely due to the lack of color contrast between much of the powdery mildew and certain colors of the leaf surface.

4. *Mildew Screening of 'PMR-1' Breeding Populations*

During spring 1998, approximately 10,000 hand pollinations were made on reciprocal crosses between 'PMR-1' and the moderate-to-highly susceptible commercial cultivars 'Bing', 'Rainier', and 'Van'. Since the pollen compatibility genetics of 'PMR-1' were not known, and spring pollinating conditions were challenging (windy, rainy, cool), these crosses resulted in varying numbers of seeds (281 with 'Bing', 372 with 'Rainier', and 123 with 'Van'). Seeds were cold stratified for approximately six months and planted in January 1999. All populations had a relatively high germination rate (~60% with 'Bing', ~75% with 'Rainier', and ~70% with 'Van'), a result similar to high germination rates seen with our previous open-pollinated 'PMR-1' populations. At present, 137 seedlings from crosses with 'Bing', 230 seedlings from 'Rainier', and 79 seedlings from 'Van' survive.

A majority of the seedlings were screened for powdery mildew resistance in the summer of 1999, using the detached leaf disk test described above. Results from the leaf disk test were confirmed with measurement of both greenhouse mildew incidence and field screening for mildew colonization. Similar to the resistant parent ('PMR-1'), resistant progeny showed no signs of infection, even at 30 times magnification. In each of the three populations, the segregation pattern of resistant and susceptible genotypes showed good fit to the 1:1 genetic inheritance model. Therefore, it can be assumed that 'PMR-1' carries a single dominant gene for powdery mildew resistance. Our results show that this powdery mildew resistance trait is easily transferred to subsequent generations, developing a pool of powdery mildew resistant germplasm available to cherry breeding programs. All progeny screened for powdery mildew resistance to date are in the field, and fruit quality evaluations will begin in approximately three years.

Conclusions

In less than two years, a rapid, repeatable, and space conserving test was developed to screen existing cultivars and breeding populations for powdery mildew resistance. Approximately 400 seedlings from crosses with the powdery mildew resistant parent ('PMR-1') were developed, with slightly more than half carrying the trait for powdery mildew resistance. The resistant seedlings have been tested for foliar resistance to powdery mildew, and although resistance of the fruit from these seedlings to powdery mildew has yet to be tested, it has not been observed on the fruit of 'PMR-1'.

Leaf tissue has been collected from all seedlings screened for powdery mildew resistance, and an effort to develop a molecular genetic marker for resistance will begin in fall 1999. Other potential sources of powdery mildew resistance, identified in the above research, will be evaluated in a similar manner.

PUBLICATIONS:

Lang, G. and J. Olmstead. 1999. Cherry genetic resistance to powdery mildew. *Good Fruit Grower* 50(9):42-43.

Olmstead, J.W., D.R. Ophardt, and G.A. Lang. 1999. Sweet cherry breeding at Washington State University. *Acta Horticulturae* (in press).

Olmstead, J.W., G.A. Lang, and G.G. Grove. 1999. A leaf disk assay for screening sweet cherry genotypes for susceptibility to powdery mildew. *HortScience* (in press).

Olmstead, J. W., G.G. Grove, and G.A. Lang. 2000. Measuring powsery mildew infection of sweet cherry leaf disks with computer image analysis. *Plant Disease* (in review).

Olmstead, J.W., G.A. Lang, and K.K. Kidwell. 2000. Inheritance of powdery mildew resistance in sweet cherry. *J. Amer. Soc. Hort. Sci.* (In preparation).

Table 1. Average powdery mildew infection and genetic susceptibility rankings for 14 cherry cultivars, using the leaf disk screening method.

Cultivar	% Mildew	Genetic Susceptibility
Bing	67.5	Highly susceptible
Black Republican	61.0	Highly susceptible
Sam	57.0	Highly susceptible
Rainier	36.5	Moderately susceptible
Lapins	22.5	Moderate to slightly susceptible
Van	21.0	Slightly susceptible
Tieton	20.0	Slightly susceptible
Stella	19.5	Slightly susceptible
Black Tartarian	11.5	Slightly susceptible to moderately resistant
Lambert	3.9	Moderately resistant
Chelan	0	Highly resistant
Moreau	0	Highly resistant
PMR-1	0	Highly resistant
Venus	0	Highly resistant

Table 2. Number of seedlings susceptible and resistant to powdery mildew in three different sweet cherry populations.

Susceptible Parent	Resistant Parent	No. of Seedlings Screened	No. of Seedlings Susceptible	No. of Seedlings Resistant
Bing	PMR-1	126	61	65
Rainier	PMR-1	197	89	108
Van	PMR-1	76	36	40