ANNUAL REPORT FOR CALENDAR YEAR 2008
USDA ARS
National Clonal Germplasm Repository

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ISHS 9th *Vaccinium* Symposium tours the NCGR blueberry field

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Sugae Wada, GRA, Horticulture
Tomihiro Yanagi, Japan

Collaborators
Francis J. Lawrence
Maxine Thompson
Melvin Westwood

Annual Report for Calendar Year 2008

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Major Accomplishments for 2008

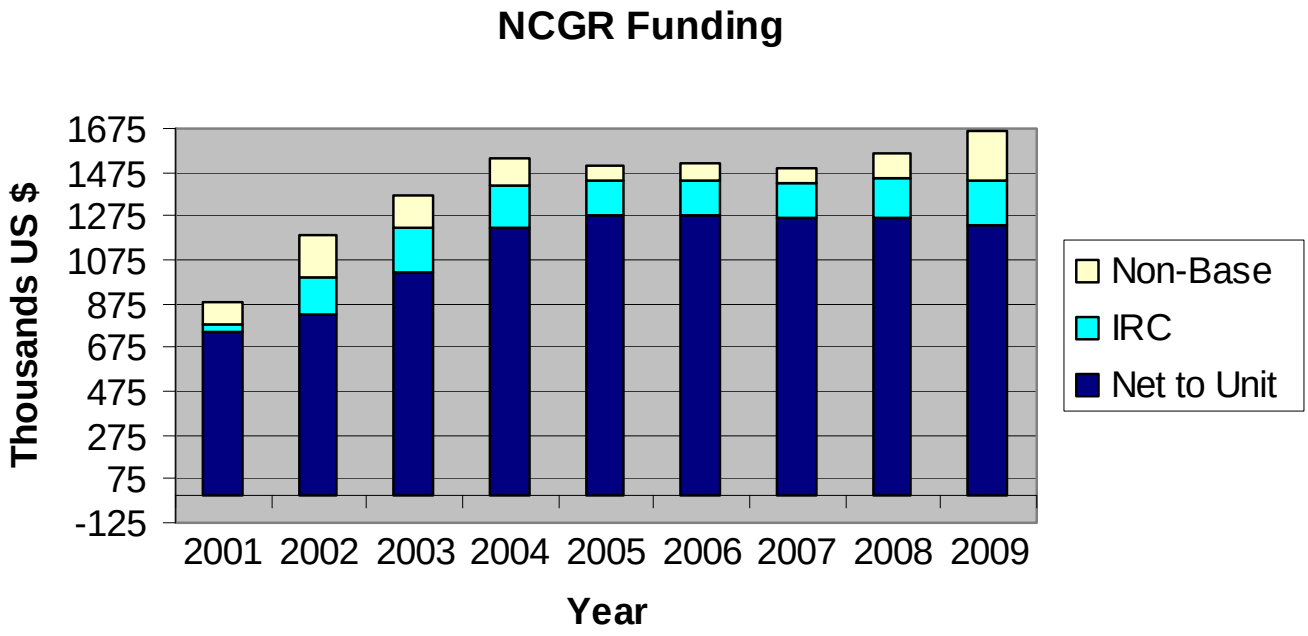
Service

- We received 740 plant requests and 5,054 items were shipped in 2008. Each year more people find our repository through our website and the GRIN shopping cart so our order processing is up. Less than one fourth of our distribution was international.
- NCGR staff co- hosted 9th ISHS *Vaccinium* Symposium from 15 – 18 July in Corvallis, Oregon. More than 333 participants toured the repository and the blueberry collections.
- NCGR staff with OSU Department of Horticulture, and the Horticultural Crops Research Unit hosted an open house on 26 July 2008. More than 900 public attendees toured the Lewis Brown Horticultural Research Farm and the Repository collections of blueberries and pears.
- Barbara Reed is continuing to work with scientists in Almaty, Kazakhstan on developing *in vitro* and cryostorage of fruit crop genetic resources. The project now has a large *in vitro* collection of apples, pears and cherries and is developing systems for other crops. Cryopreservation of *Ribes* and *Malus* was successful. Wild apricot seeds were provided for the Davis Repository and are now in quarantine.
- NCGR scientists collaborated with NCGRP on the long-term storage of our *in vitro* and cryogenic accessions. We provided techniques and plant materials for cryopreservation of the shoot tips in liquid nitrogen. We collaborated with NCGRP (Fort Collins) on trials to test cryogenic storage of dormant pear buds.
- Monitored NCGR *Vaccinium* field collection for Blueberry Shock Ilarvirus, Blueberry Scorch Carlavirus and Peach Rosette Mosaic Nepovirus. No Blueberry Scorch or PRMV were detected in 2006. Spread of the pollen borne blueberry shock ilarvirus from nearby commercial fields has increased during the past few years to the point that we will no longer attempt to remove infected plants as they are discovered.

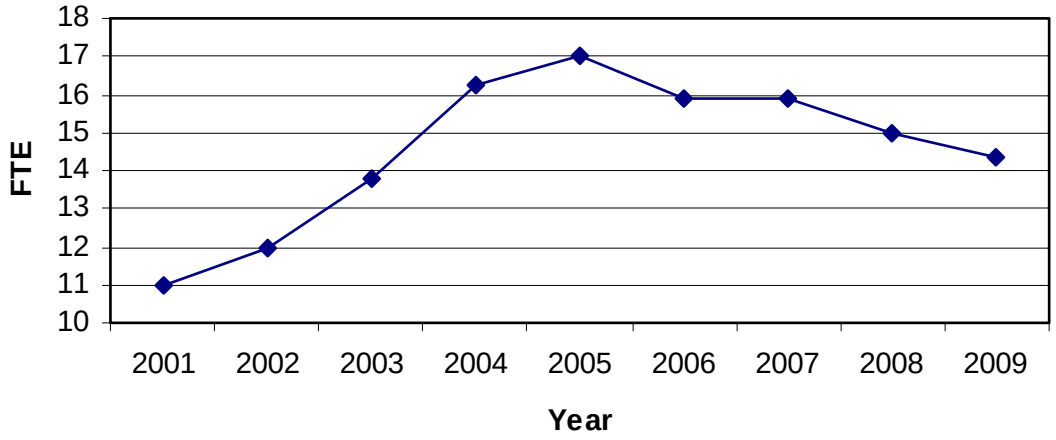
Research

- Determined that *Fragaria iturupensis* is decaploid, not octoploid, as was previously reported.
- Found that a basic image-analysis screening technique for evaluation of *in vitro*-stored plantlets was equivalent to subjective human evaluation. The image analysis technique would require further development to be as efficient as the visual analysis.
- Studied the surface morphology of *Rubus* seed coats from 10 subgenera. Details of one seed accession indicate that it should be included in a different subgenus from its present classification.
- Continued and expanded our collaboration with the US Dept. of Interior, National Park Service (NPS) on identification of historic fruit trees in National Parks. DNA fingerprints were generated from pear samples collected by NPS colleagues at the John Muir National Historic Site in California and from the San Juan Island National Historic Park in Washington. SSR marker analysis recognized 27 of the 31 National Park pear trees as either identical to known cultivars, or identical to other trees sampled.
- Evaluated the NCGR quince (*Cydonia oblonga*) collection for incidence of Fabraea leaf spot and cedar-apple rust. Potential sources of disease resistance were observed.
- Identified 22 out of 72 SSRs to use in studying genetic diversity in *F. nipponica* and *F. iinumae* collected in Hokaido, Japan (collaboration with Kim Hummer and Tom Davis).
- Developed microsatellite markers for use in different species of *Fragaria*.
- Developed unique genetic profiles for 144 NCGR pear accessions using 9 SSR loci.
- Developed 12 new SSR loci in *Rubus* using SSR-enriched genomic libraries and used them to fingerprint 48 raspberry and 48 blackberry cultivars
- Used 10 SSR loci and 10 AFLP primer pairs to evaluate the genetic stability of four accessions of cryopreserved *Rubus* meristems
- Identified sixteen blueberry microsatellite markers for fingerprinting cranberry cultivars.

Administration



Budget and Staffing at the NCGR Corvallis



NON-BASE FUNDING FY 2008

Amount	*Purpose*	*Source*
45,000	Sprayer, Microscope, growth chamber, pathogen testing	Nat. Program Leader, End of Year funds
14,500	White pine blister rust on Ribes - KH	NW Center Small fruit
10,000	Azores cooperative grant - KH	OIRP
17,000	Pear identification through SSR – NB and JP	Pyrus CGC; Nat. Prog. Staff
19,800	Tissue culture of pears - BR	OAN- ODA
29,156	Tissue culture of hazelnuts – BR	Oregon Hazelnut Com.
12,000	Blackberry seed study – BR	Ag Research Foundation
7,700	Rubus genetic analysis - NB	Oregon Blackberry and raspberry commission
155,156	Total	

Administrative Overview

Staffing Changes

We lost term support staff positions in FY 2008. Jack Peters, our Seed Lab Manager finished his term position, and we had no funds to replace it. Graduate Student, Sugae Wada, has been assigned to fill in minimally, cleaning new seedlots as they arrive, and preparing seed for plant distribution requests. These duties must be performed to keep the NCGR in operation. Two student helpers, Sonja McMackin, in the tissue culture laboratory, and Alicia Leytem, in the field, graduated and have moved on to other employment. The following staff members were promoted during FY 2008: Kim Hummer Research Leader/Curator; Missy Fix, Agricultural Science Research Technician.

Budget and Fiscal

Our base funding has remained at about $1.4 million for the past five years. Our last significant increase was between FY 2003-2004, which came through executive request of congressional sources as a result of lobbying efforts by the American Seed Trade Organization. With promotions, within grade increases and pay-act increases our salary costs are more than $1.1 million. Our administrative overhead charges (IRC) have been roughly the same for the past 3 years. Our scientists have been working hard to apply for soft funding to supplement our base.

For FY 2008, we reduced the level and amount of temporary salary FTE, so that we could project our discretionary funds as “adequate” for the next two years. The financial flexibility to do this means that we had fewer staff for the increased expectations. Our inventory is up about 110% over two years ago. The requests of resources are up 220% over two years ago and shipping is up by 134% for that same period. In the next fiscal calendar, because of the lack of available funds, our next step has to be to eliminate additional temporary staff. We will have great challenges facing us as the operational expectations by our stakeholders and the actual germplasm on hand are increasing.

We are greatly appreciative for the $155K facilities repair funding from headquarters and our area office. We also received $45K from our national program staff for new equipment.

View from the Front Office

Our staff members have great hearts! They understand the long term humanitarian responsibility that we have, as our unit motto states, “to preserve plant genetic resources for all people for all time.” Our staff enjoys their assignments, but is concerned about the increasing expectations placed on their shoulders as the total FTE is dropping due to fewer technical helpers being supported by base funding.

The scientists have risen to the cause and in FY 2008 applied for not only berry, hazelnut, and pear commission research funding, but for 4 Specialty Crop Research Initiative (SCRI) Grants, as this granting opportunity came open. Our staff was more successful than most applicants, wining two SCRI grants, one in collaboration with Dr. Francis Zee, working on the tissue culture, identification, and composition of Ohelo, *Vaccinium reticulatum*; and a second in collaboration with blueberry breeders across the country, working on the molecular marker identification for genetics applications.

Our program and area administrators have encouraged our scientists to continue applying for SCRI and other non-base funding sources. Our questions remain concerning how do we address the hole in the base funding needed for our core service responsibility of maintenance and distribution of plant genetic resources? While we are now employing stop gap measures to accomplish seed management, for example, longer term base needs must be addressed with appropriate funding.

We are encouraged by efforts of the National Clean Plant Network. Joseph Postman is our unit's and the NPGS representative on this important committee. He will bring our needs for improved testing of clonal genetic resources in the US genebanks to the awareness of plant pathologists at the national level.

EEO/CR/Outreach

- In 2008, the 1890's Capacity Building Grant that we developed for Dr. Bobby Phills, Florida A&M University, concerning development of low chilling *Rubus*, was selected for 3 year funding. We have provided plant materials for his program.
- We at the Corvallis location established CODEOC, an EEO outreach committee. Dr. Nahla Bassil from our unit is the chair of the committee.
- Through Research Support Agreement with Oregon State University three female and one male graduate student were trained. Two of these students were women of color; one Asian; one disabled.
- During the winter, 15 disabled high school students (program was funded through local school district grant) were trained in greenhouse management activities.
- During the winter an additional 3 disabled individuals from a local private organization (Work Unlimited) were trained in strawberry greenhouse activities.
- Three disabled individuals have temporary federal technical appointments on our staff.
- We are training one individual from LBCC work-study program from their career counseling center.

Facilities - by Dennis Vandeveer

We are working within the federal mandate to have "greener" operations. We received $96 K funding from headquarters and area office to upgrade our boiler to a more energy efficient one. The new boiler (shown at the right) was installed at the end of 2008 and is much more efficient than our old

boiler. It will provide energy savings over the years to come.
During 2008 we replace vinyl on sections of the main building and replace rotted T-111 on the north side of the main building. Additional vinyl replacement is needed on the main and shop buildings and will be repaired as funding comes available in future years.

We also received money to replace our fire alarm system which had old wiring that was frequently failing and was causing false alarms. **The image to the right shows the new front panel of the fire alarm.**

We replaced three water meters and back flow valves on our north farm irrigation wells. Also, two well pumps were removed and replaced due to failure.

All four greenhouse cooler controls were converted over to Wadsworth computer control from the old pneumatic system. This work was performed by the facilities manager Dennis Vandeveer. In addition all HAF fans were placed on the Wadsworth system. The heating control 2 way valve was replaced with a new electronically controlled valve in greenhouse 1. This provides more environmental control and energy savings in all the greenhouses.

A new 5‘ x 8 ‘ dump trailer was purchased to aid in the removal and hauling of plant debris to a collection area for proper disposal. The old trailer was unsafe for road use.

We met with a local solar company “Solar Summit” to discuss the feasibilities of installing solar panels in an effort to go green. We gained some real knowledge on installation and payback potentials on energy cost savings. This information was used as a foundation of understanding for the possibilities of future installation.

Maintenance was provided for six vehicles and five tractors plus numerous pieces of farm equipment and small engines. Although our vehicle fleet is aging it has continued a 95% operational status through the year.

Other projects included painting of doors, cabinet construction for the TC lab, re-striping of all parking lots to include handicapped parking, plumbing repairs, minor electrical repairs, lighting upgrades and security badging and coding. Monitoring and adjusting the Lenel security systems. Point of contact, technical consultant and initial SOW generation for the boiler and FACP contracts.

Accession Summary – as of June 1, 2007

	Number of Taxa	Total Accessions	Seed Accessions	Field Plants	Screen-house Plants	in vitro Plants
Major Genera						
Actinidia (Hardy Kiwi)	34	160	22	125	52	0
Corylus (Hazelnut)	23	607	2	639	136	27
Cydonia (Quince)	3	87	14	98	32	0
Fragaria (Strawberry)	53	1491	377	0	1933	177
Humulus (Hops)	6	510	273	17	398	51
Mentha (Mint)	37	482	55	0	512	172
Pyrus (Pear)	46	1820	327	1930	628	146
Ribes (Currant/Gooseberry)	119	996	487	1132	437	40
Rubus (Blackberry/Raspberry)	174	1513	1131	190	1680	105
Vaccinium (Blueberry/Cranberry)	82	1237	771	640	756	72
Amelanchier (Serviceberry)	15	71	51	16	1	8
Total Major Genera:	**592**	**8974**	**3510**	**4787**	**6565**	**798**
Minor Genera						
Asimina (Pawpaw)	4	50	8	67	10	5
Chaenomeles (Asian Quince)	3	6	0	23	4	0
Crataegus (Hawthorn)	7	6	6	7	0	0
Duchesnea (False Strawberry)	1	4	1	0	9	0
Gaultheria	19	33	26	0	1	0
Gaylussacia	7	16	12	0	6	0
Intergeneric Hybrids	13	27	3	16	13	2
Juglans (Butternut)	2	60	0	21	2	0
Lonicera	13	52	28	31	22	0
Mespilus (Medlar)	3	46	18	24	43	0
Peraphyllum	1	6	5	0	0	0
Potentilla	1	2	1	0	1	0
Pycnanthemum (Mountain Mint)	27	94	69	0	67	30
Sambucus (Elderberry)	33	143	114	42	12	0
Sorbus (Mountain Ash)	68	227	161	59	8	0
Miscellaneous Other Genera	27	98	48	52	91	0
Total Minor Genera:	**229**	**870**	**500**	**342**	**289**	**37**
Total All Genera:	**821**	**9844**	**4010**	**5129**	**6854**	**835**

Awards 2008

Compiled by: Yvonne Pedersen

Joseph Postman – Performance Bonus Award for superior performance for the rating period of 01/01/ 2008-09/30/2008.

Nahla Bassil – Quality Step Increase for outstanding performance of molecular genetics work during the rating period of 01/01/2007-12/31/2007 and Performance Bonus Award an outstanding performance during the rating period of 01/01/2008-09/30/2008.

Kim Hummer – Performance Bonus Award for outstanding performance for the rating period of 01/01/2008-09/30/2009.

Bruce Bartlett– Performance Bonus Award for superior performance for the rating period of 04/01/2007 – 03/31/2008 and Performance Bonus Award for an outstanding rating for the rating

period of 04/01/2008-09/30/2008 and a Spot award for 15 years of sustained service and excellence in efficient distribution of plant materials for the USDA ARS NCGR-Corvallis during the rating period of 01/01/2007-05/01/2008.

Jeanine DeNoma – Quality Step Increase for outstanding performance of duties during the rating period of 04/01/2007-03/31/2008 and a Performance Bonus Award for highly superior performance during the rating period of 04/01/2008-09/30/2008.

April Nyberg – Performance Bonus Award for outstanding performance during the rating period of 04/01/2008-09/30/2008.

James Oliphant – Performance Bonus Award for superior performance during the rating period of 04/01/2007-03/31/2008 and a Performance Bonus Award for superior performance during the rating period of 04/01/2008-09/30/2008.

Yvonne Pedersen – Quality Step Increase for outstanding performance during the rating period of 04/01/2007-03/31/2008 and a Performance Bonus Award for superior performance during the rating period of 04/01/2008-09/30/2008.

Joe Snead – Performance Bonus Award for superior performance for the rating period of 04/01/2008 – 09/30/2008.

Barbara Reed – Performance Bonus Award for superior performance during the rating period of 01/01/2007 to 12/31/2007 and a Performance Bonus Award for superior performance during the rating period of 01/01/2008-09/30/2008.

Andrew Brooks – Spot award for extra effort in field collections maintenance at the USDA ARS NCGR during July through September 30, 2008.

Alicia Leytem – Spot award for extra effort in field collections management at the USDA ARS NCGR during June 1 through September 26, 2008.

Training 2008

Compiled by: Yvonne Pedersen

Bruce Bartlett – Personal Protective Equipment; December 2007.

Missy Fix, Jim Oliphant, Bruce Bartlett – Seminars on the Production and Maintenance of Small Fruits (credit towards pesticide applicators license renewal); January 2008

Bruce Bartlett – Entomology & Plant Pathology Short Course (credit towards pesticide applicators license renewal); February 2008.

Bruce Bartlett, Joe Snead, James Oliphant and Deb Tyson – CPR/1st Aid Training; February 2008.

Joe Snead and Missy Fix – Non Crop Vegetation Management Course; February 2008.

Jim Oliphant – Farwest Show Seminars; August 2008.
Jim Oliphant – Nursery Research Day; September 2008.

All employees completed the annual AgLearn training of Information Systems Security Awareness, Civil Rights, and Re-inventing Diversity for Today's USDA Training in 2008.

Joseph Postman and Yvonne Pedersen continue to participate in the monthly ARS Site Publisher teleconference/training.

Travel 2008

Compiled by: Yvonne Pedersen

Kim Hummer – State College, Pennsylvania, to attend the NCCC-22 (Small Fruit Crop Germplasm Committee Meeting); October 2007.
Missy Fix, Jim Oliphant, Joe Snead – Wilsonville, Oregon, to attend the Safety Stewardship Seminar; November 2007.
Kim Hummer – Portland, Oregon, attend the PWA Leadership Conference; November 2007.
Joseph Postman – Denver, Colorado, to attend the NPGS Curator Workshop; December 2007.
Joseph Postman –Portland, Oregon, to attend the Western Orchard Pest Conference; January 2008.
Nahla Bassil – San Diego, California, to attend the Plant and Animal Genome Meeting; January 2008.
Missy Fix, Jim Oliphant, Bruce Bartlett – Canby, Oregon, to attend the NWHS Berry Day; January 2008.
Bruce Bartlett – Eugene, Oregon, to attend the Entomology & Plant Pathology Short Course class; February 2008.
Missy Fix, Joe Snead – Corvallis, Oregon, attend the Non-Crop Course; February 2008.
Barbara Reed, Joseph Postman – Wenatchee, Washington, to attend the Crop Germplasm Committee Meeting; February 2008.
Nahla Bassil, Barbara Reed – Aurora, Oregon, to visit the North Willamette Station; February 2008.
Kim Hummer – Azores and Spain, site visit and to attend the Strawberry Symposium; February 2008.
Jim Oliphant – Portland, Oregon, to attend the Home Orchard Society meeting; March 2008.
Barbara Reed – Aurora, Oregon, to attend the Hazelnut Propagation Committee meeting; March 2008.
Joseph Postman – Parlier, California, site visit; March 2008.
April Nyberg, Jeanine DeNoma – Portland, Oregon, to attend and participate in the Career Fair; April 2008.
Nahla Bassil – Paris, France, invited to present research results and USDA-ARS-NCGR genebank management information at the European organized genetic workshop; May 2008.
Kim Hummer, Joseph Postman, Barbara Reed – Fort Collins, Colorado, attend the PGOC meeting; June 2008.
Alicia Leytem, Deb Tyson, Jim Oliphant, Andrew Brooks, Maxine Thompson and Joe Snead – Aurora, Oregon, attend Berry Days; June 2008.
Joseph Postman – Washington, DC, attend the Woody Landscape Crop Germplasm meeting; June 2008.
Barbara Reed – Tucson, Arizona, to attend the World Congress on In Vitro Biology meeting; June 2008.
Kim Hummer – Hilo, Hawaii, to attend the W-6 Germplasm Meeting; June 2008.
Kim Hummer – Orlando, Florida, to attend the ASHS Conference; July 2008.
Nahla Bassil – Orlando, Florida, July 2008.

Joseph Postman – College Station, Texas, to attend the Northern Nut Growers Association meeting; August 2008.
Jim Oliphant – Portland, Oregon, to attend the Farwest Show/Seminar; August 2008.
Kim Hummer – Belgium and Germany, convene meeting and present research plus site visit to the German Fruit Genebank; September 2008.
Jim Oliphant – Aurora, Oregon, to attend the Nursery Research Day; September 2008.

Visitors 2008

by: Yvonne Pedersen

During Calendar Year 2008, 481 people came through the Repository's front door. Guests arrived in large or small groups, or as individuals. In addition to the 481 people, approximately 330 scientists attended the *Vaccinium* Symposium field trip and 900 people attended the 2008 Open House held in July.

The Open House was a combined effort between NCGR, HCRL (Hort Crops Research Lab) and OSU's Department of Horticulture for a "Fruit and Veggie Taste Tour.

Some groups used the Repository for their annual meetings such as the Oregon Hazelnut Commission, the Oregon Sweet Cherry Commission, and the Oregon Processed Vegetable Committee. Educational tours ranging from groups of 8 to 20 came from Willamette University, Home Orchard Society, Master Gardener Group, Oregon State University, Philomath School District, Evergreen University, various garden clubs, Corvallis School District, Linn Benton Community College, as well as the Greater Albany Public Schools to tour the facility for their horticultural experience. In addition, the Corvallis Outreach Diversity and Equal Opportunity Committee arranged a tour to visit the three ARS Corvallis units for students and others interested, to see what the other units are researching.

There were also numerous general visitors from around the world: 1 each from Brazil, the Philippines, Germany, Thailand, Korea, Japan, Portugal, Estonia, Sweden, and Ecuador; 2 from Switzerland, Turkey, 3 from Australia, China, India; 4 from New Zealand; and 5 from Chile. Also, there were graduate students working at the National Clonal Germplasm Repository from Kenya, Nigeria, and Japan.

In 2008 there were four different visiting scientists:

2 from Japan working with Kim Hummer on strawberry karyotyping, 1 from Germany, and one from India working with Barbara Reed in the tissue culture and seed labs; 1 from Turkey working with Nahla Bassil in the molecular lab.

Root tip chromosome squash of *Fragaria iturupensis* showing $2n = 10x = 70$ chromosomes. Image by P. Nathawet, K. Hummer, and T. Yanagi.

Plant Pathology by Joseph Postman

Collection Summary:

5100 field plants, 7200 screenhouse plants, 1100 in vitro plants

genus	total accessions	seed accessions	clonal accessions
Corylus	**756**	**12**	**744**
Cydonia	**149**	**21**	**116**
Fragaria	**1784**	**420**	**1364**
Humulus	**891**	**238**	**603**
Mentha	**500**	**54**	**446**
Mespilus	**59**	**18**	**41**
Pyrus	**2211**	**318**	**1893**
Ribes	**1502**	**513**	**987**
Rubus	**1926**	**1057**	**869**
Vaccinium	**1707**	**773**	**934**

Virus Status Summary for Clonal Accessions:

genus	clonal accessions	% tested	% infected	core clones	core % tested	core % infected
Corylus	744	84%	1%	173	99%	0%
Cydonia	116	30%	3%	75	47%	4%
Fragaria	1364	56%	15%	515	77%	14%
Humulus	603	31%	8%	90	89%	9%
Mentha	446	3%	4%	51	14%	2%
Mespilus	41	46%	24%	31	48%	29%
Pyrus	1893	72%	8%	219	86%	10%
Ribes	987	3%	7%	231	4%	12%
Rubus	869	69%	8%	274	84%	10%
Vaccinium	934	47%	1%	245	84%	2%

Fireblight lesions in standard apple (A), pear (P) and quince (Q) cultivars following greenhouse inoculations. Results from one of several inoculation trials demonstrate that response of many quince clones to shoot inoculation with a severe isolate of *Erwinia amylovora* is similar to that of apples and pears considered to be intermediate in susceptibility. The conventional wisdom has been that quince is much more susceptible to fire blight than the other two pome fruit hosts.

genus	plantname	mean %
A	G-41	**0.0%**
A	Robusta 5	**0.0%**
A	Empire	**5.6%**
A	Jonathan	**35.4%**
P	Harbin	**0.0%**
P	Old Home	**0.9%**
P	Anjou	**7.8%**
P	Aurora	**10.0%**
P	OHxF 333	**20.9%**
P	Kieffer	**26.6%**
P	Forelle	**77.1%**
Q	Aromatnaya	**29.0%**
Q	Quince A	**31.3%**
Q	Pigwa S-3	**33.5%**
Q	Smyrna	**38.1%**
Q	Van Deman	**44.1%**
Q	Limon	**51.9%**

New Accessions in 2008:

Corylus

- *C. avellana* from Azerbaijan (M. Aradhya & M. Scanlon)
- Eastern Filbert Blight resistant selections developed by Dr. Shawn Mehlenbacher from Oregon State University, Department of Horticulture

Cydonia

- Fire blight resistant quince selections from Bulgaria

Pyrus

- *P. salicifolia* from Azerbaijan
- *P.* x *sinkiangensis* (Fragrant Pear) from Asian Market

Rubus

- R. saxitillis from Armenia (Joseph Postman)
- R. leucodermis from Pacific Northwestern US (Michael Dosset)
- R. deliciosus (Mark Widrlechner)
- Cultivars/Selections (Chad Finn, Kim Lewers)

Vaccinium

- Highbush selections – North Carolina (Jim Ballington)
- *V. calycinium* and *V. reticulatum* – Ohelo from Hawaii (Kim Hummer)

Molecular Genetics **By Nahla V. Bassil**

Continuing Graduate Student

- Wambui Njuguna, PhD, student in Horticulture at OSU is actively working on three projects that use molecular markers to answer different questions in *Fragaria*. The objective of the first project is to evaluate genetic diversity in *F. nipponica* and *F. iinumae* collected in Hokaido, Japan (collaboration with Kim Hummer and Tom Davis) using twenty microsatellite markers. Three possible interspecific hybrids between these two Asian species were identified from intermediate memberships (<80 %) in the two diploid species groups using the clustering program STRUCTURE. The second project evaluates bar-coding for species identification in *Fragaria*. Wambui continues her work on identifying a strawberry microsatellite fingerprinting set.
- In a collaboration with Chad Finn and Kim Lewers, PhD student Michael Dossett has tested transferability of *Rubus* SSR primer pairs into black raspberry. Transferability of SSR markers was better for those developed in red raspberry than blackberry. The percentage of polymorphic markers among those amplifying products was also higher for markers developed from red raspberry genomic libraries (35%) than from blackberry genomic libraries (29%) while the percentage for those developed from cDNA was similar (20% and 19% respectively).

Projects in Progress 2008

Genetic diversity of Corylus species using trinucleotide microsatellites. We are using 15 trinucleotide SSR markers to fingerprint 169 *Corylus* accessions including five shrub species (*C. avellana, C. americana, C. cornuta, C. heterophylla*, and *C. sieboldiana)*, and five hazelnut tree species (*C. colurna, C. jacquemontii, C. chinensis, C. ferox* and C. *papyraceae*). Data was collected and will be analyzed shortly.

Genetic fingerprinting of the pear core collection. We are optimizing multiplex PCR conditions for fingerprinting the entire core collection using a universal fingerprinting set developed at East

Malling. Different hot start polymerases, dNTPs and sources of primers are being tested to minimize sample failures.

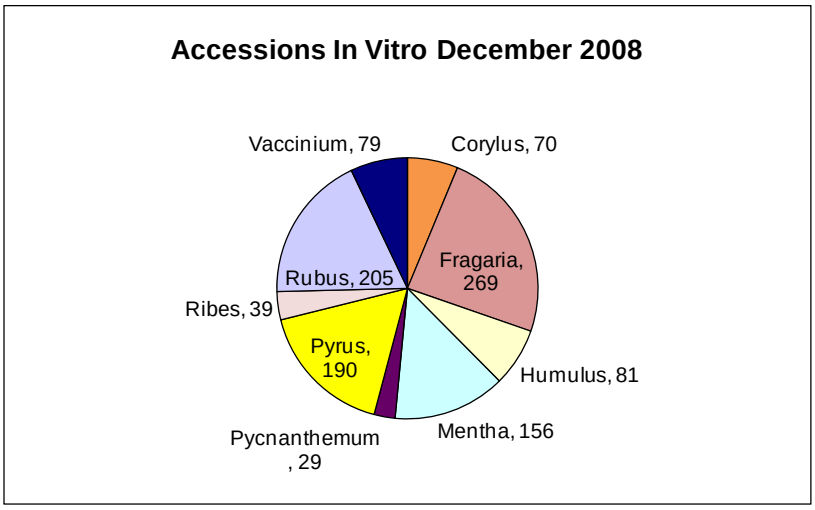
Linkage mapping in hops. In collaboration with USDA-ARS hop breeder John Henning, we are adding SSR markers to two linkage maps segregating for powdery mildew and to downy mildew.

Genetic fingerprinting of cranberry. While fingerprinting the cranberry core collection using a set of four blueberry microsatellite primer pairs, we identified multiple genotypic variants in 'Pilgrim' and in 'Stanley' indicating a need to determine genetic heterogeneity between the clones representing each cultivar in the cranberry collection.

Fingerprinting of Ohelo Berries. SSRs from *Vaccinium corymbosum* that are transferable to the *Myrtillus* section were identified and are being used to identify three Ohelo berry clones from Hawaii.

Tissue Culture and Cryopreservation

By Barbara M. Reed



Projects in progress 2008

Mr. G.P. Rao, scientist at the Rubber Institute of India, visited the lab for 2 months to study *in vitro* culture and germplasm preservation. He also completed a preliminary study on cold storage of rubber scion wood. Jeanine DeNoma and student helpers Sonja McMackin and Erin Conley collected materials as plants were available. The spring and summer explanting season resulted in over 300 accessions successfully initiated into culture and cold stored. By December 1118 accessions were in culture.

Medium Optimization for *Pyrus*

Large scale medium optimization experiments were initiated with a grant from the Oregon Association of Nurseries and the Oregon Department of Agriculture.

Objective: Determine the effect of mineral nutrition on plant appearance, shoot initiation, and elongation of pear.

The tissue culture team (Barbara Reed, Sugae Wada, Emily Beezhold and Jeanine DeNoma) evaluating pear cultures at the end of the experiment (October 2008).

The shoot multiplication, shoot height, overall

quality, shoot tip necrosis, callus, number of nodes, leaf necrosis, leaf size, physiological abnormalities, and chlorophyll content were evaluated. From these responses we will determine mineral nutrient formulations that result in optimal individual responses and the best overall growth. Genotypes tested were two very slow growing genotypes (*P. dimorphophylla*, *P. ussuriensis* 'Hang Pa Li') and 3 moderately growing genotypes (*P. communis* 'Winter Nelis', 'OH x F 87' (Daytor) and 'Horner 51').

Conclusions: We first tested five thiamine concentrations with four pear genotypes. This test determined that there were significant differences among the genotypes for all the growth parameters evaluated, but the thiamine concentration was not a significant factor for any of them. This meant that we could use our standard thiamine concentration in the main trial. The five main stock solutions used in MS medium have definite impacts on the growth of diverse pear genotypes. Both positive and negative influences were seen in this study. These results indicate that several factors need further evaluation and analysis of the data is ongoing.

Impact: From this first test we identified several "test media" that improved the growth of most of the cultivars. One of these was chosen for use with our "difficult to grow" accessions and greatly improved the growth and development of 20 genotypes. We are continuing this study with 10 genotypes and one of the more influential factors. Pears tested included two very slow growing genotypes (*P. dimorphophylla*, *P. ussuriensis* 'Hang Pa Li') and three moderately growing genotypes (*P. communis* 'Winter Nelis', 'OH x F 87' (Daytor) and 'Horner 51').

Illustration of examples of poor and good treatments in the pear study.

Corylus Culture. With funding from the Oregon Hazelnut Commission we are beginning a study to improve Corylus in vitro culture and eliminate bacterial contaminants. This study will involve advanced selections from the OSU breeding program as well as named cultivars.

Cryopreservation of shoot tips. Ph.D. student Esther Uchendu (studying at OSU on a Ford Foundation Fellowship) completed a study comparing three cryopreservation techniques for the long-term storage of blueberry (*Vaccinium)* shoot tips. She is continuing with protocol experimentation with cranberries as they have low viability with standard techniques. Esther's main study on the addition of antioxidants to four steps of the cryopreservation protocol for *Rubus* shoot tips is producing promising results for several of the antioxidants tested.

Field Collections and North Farm Management 2008 by Joe Snead

In last year's 2007 annual report I spoke at length about the increasing field collections size and the smaller labor force and the strain of trying to keep up. I also spoke about the increasing number of outside users on the North Farm that that required farm support from the small field labor force. We have only one pesticide applicator for the field operations. There used to be two applicators. It takes one person a considerable amount of time to do all the applications.

Several things have changed this year to make the field operations management better. The biggest relief is that we no longer provide farm support to the outside North Farm users. This eliminated about six acres of farm support for the field labor pool. Several of the researchers are either done with their projects or are moving to a different site. The rest have chosen to do the farm support activities from within their own unit's resources.

Another area that changed is the nature of our labor force. This year we hired four work study students to do field, greenhouse, and distribution work at the repository. The students all come at varying lengths of time throughout the work week. The field operations have the first option of using the students. The greenhouse operations have the second option and then the distribution has the final option of using the students. It is more like a labor pool where varied task can be accomplished. Some large field tasks were accomplished in a timely manner because there was someone almost always working on the task. Each year rootsuckers need to be pruned from the three acre Hazelnut collection. Trimming rootsuckers requires kneeling under the tree canopy and making many cuts and then pulling the whips out. It is tiring work and with just one or two people working the task drags on. With five people working short shifts the project moved along quickly. The work study student pool also pruned the Ribes, Raspberries, and Hardy Kiwi fields

The drawback to work study students is in experience and training. I have trained many people to prune. People with a horticultural or agriculture interest or background generally are easier trained and do a better job. I have had to dial back my expectations of job quality in favor of getting the task accomplished. Another downfall to using work study students as your labor force is that they usually run out of work study funds in the early spring. This is when the need for the field workers really increases.

The operating budget available for the field operations is a concern. By early spring of 2008 the Repository was running low on budget money for supplies. This is right when the field operations need supplies the most. Our farm equipment is getting older and requires more repair. Breakdowns occur when using the equipment in the spring and summer, not in the winter sitting in the barn. Our Airblast sprayer was breaking down repeatedly and opportunities for critical applications missed. In the fall we purchased a new Airblast sprayer with funds from the

National Program Leader, Dr. Peter Bretting. The sprayer was greatly needed. The new unit is 50% bigger. This is a real time saver since less time is spent loading and mixing and driving back and forth to the field. The new unit has a small computer monitor and GPS. This makes calibration very easy and the proper amount of material is applied. With the expense of pesticides it is important to put on an accurate amount.

This year more concessions had to be made in collections management. Sometimes these concessions are not popular afterwards. Irrigation was reduced further in the pears this year which resulted in smaller, shorter scion wood for distribution. Time was spent preparing the Vaccinium field collection for the 2008 ISHS Vaccinium Symposium rather than doing irrigation work. The Vaccinium collection was brought up to a manicured garden level of presentation. It has never looked so good. There were about 150 Vaccinium specialist, growers and breeders that toured the collection. They were so impressed and enjoying their visit it was hard to get them on the buses for their next appointment. Many came back later to visit. Our research leader received many compliments on the collections.

A week after the symposium there was an USDA ARS-Oregon State University Horticulture Field Day for the general public. There were six stations on a self guided tour. The Repositories pear field and blueberry fields were two of the stops. More than 1000 people toured these fields. The blueberry field was very popular with the visitors because they could sample all the different varieties. The pear field is eight acres in size and absorbed the crowd well.

Blueberry field for ARS-OSU Field Day open to the Public

For each of these events extra effort started months before. Weeks before each event the small field crew focused on preparations for these fields. Besides less irrigation in the pears the *Ribes* field collection became weedy. The small field crew is hard pressed to keep up with normal operations. When special events or new large projects are planned normal duties have to be set aside.

Several new Integrated Plant Management projects were started this year. Several non-crop areas that are mowed several times during the growing season have been identified as areas that can be returned to native grass habitat. A half acre was planted in native grasses and flowers in the swale entering the pear field. Once established this area will receive less care and reduced time and energy spent on mowing. The area will be a reservoir for beneficial insects. There are two more areas that will be planted along the sides of the pear field in the future. One area has a Western Red Fox den in it and the native grasses should provide better cover for the litter of kits. The fox provide good control of rodents on the farm.

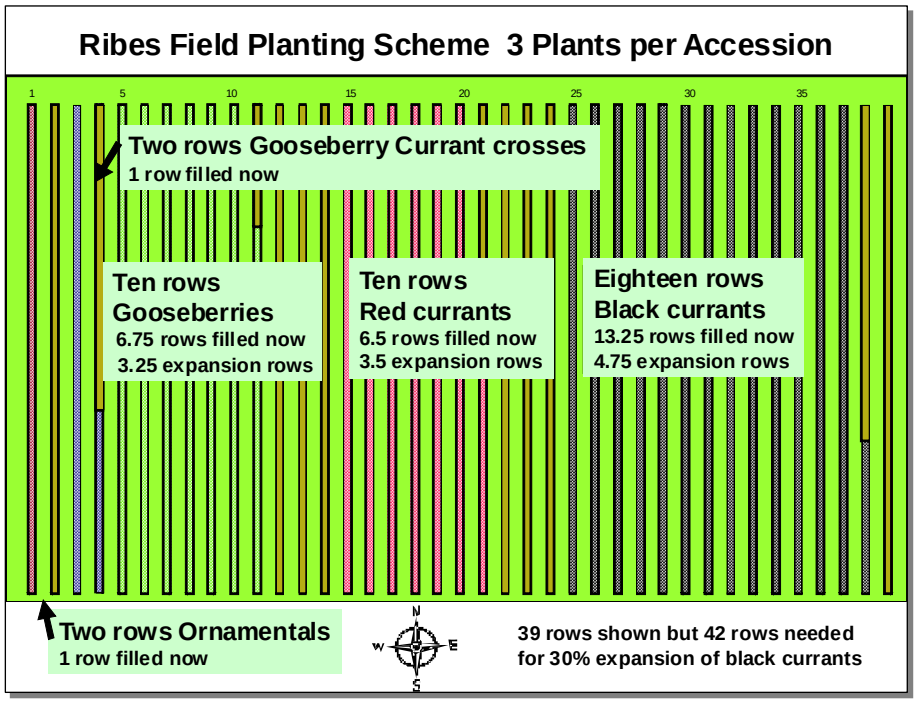
Three Beetle Banks were planted on the North Farm. A Beetle Bank is an area of tall native grasses that is left to grow unmowed. The tall grasses act as a home and protection for ground beetles. The ground beetles come out at night and move into our plantings and forage on insects on our plants. Our Beetle Banks also have a mix of native flowers that is attractive to beneficial insects during the day.

The NCGR repository has outside assistance for integrated pest management of rodents in the Pear field. The image at the right shows a Western Red Fox den in a Native Grass Prairie site on the research farm.

The mother fox with one of six kits is pictured below (photo by J. Snead, 2008).

Mulched expansion rows for new *Ribes* Field

In the fall plans were made for a new *Ribes* cultivar field. There have been several problems associated with the maintenance of this field. This field has more pest and disease problems than all the others. A compounding factor is that there are three different plant forms and each has its own particular problems. The different types are all mixed together making spot treatments difficult and time consuming. The new planting will have all the groups and subgroups separated out with 30 % expansion room between each group. The expansion areas will be used as Beetle banks until the space is needed for planting. Using the blank rows for Beetle banks will also cut down on herbicide use of repeated spraying of bare rows.



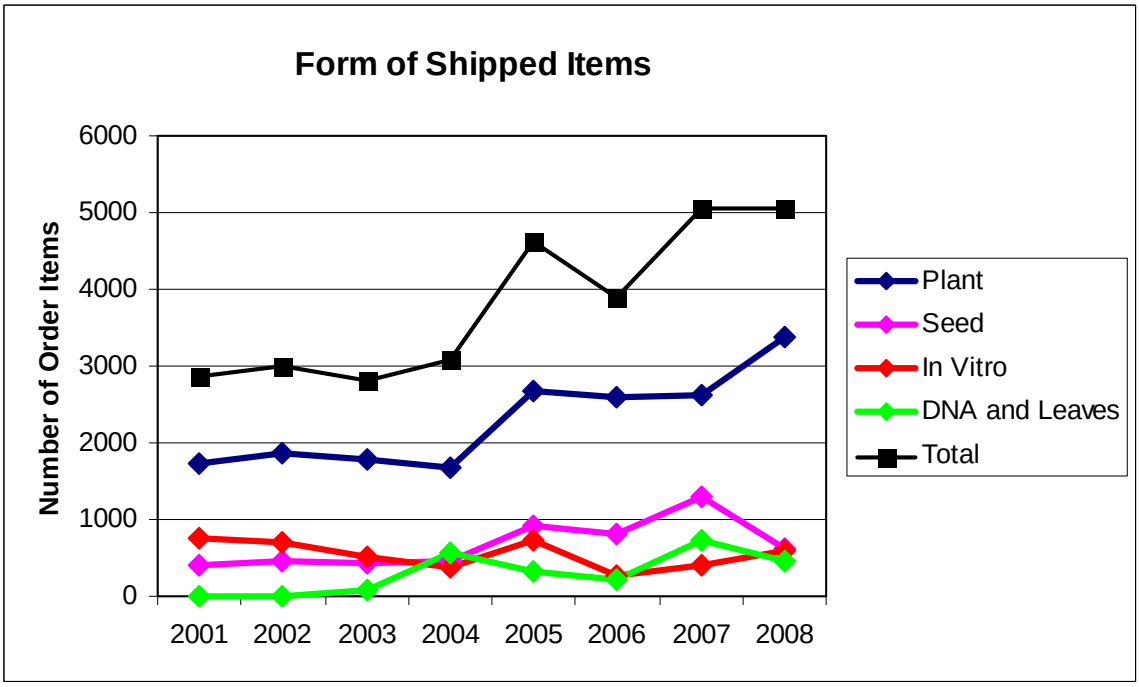
The field collections have shown well to the public and scientific community on two important occasions this last year. Several fruit and plant hobbyist groups have aided in evaluations or distribution collection in our fields this last year. These groups have been excited about our plant resources. The Beetle Banks and Native Grass Prairie are exciting new IPM and environmental projects. Renovation of the *Ribes* Cultivar Field is a positive step for the maintenance of this genus. The lack of adequate labor is a major problem to achieving these goals and maintaining the rest of the collections in a suitable manor as has been done in the past. I hope the future brings positive change.

Plant Distribution by **Bruce R. Bartlett**

"2008 Highlights"

- 5,061 items were shipped as seeds, cuttings, runners, scionwood, rooted plants, tissue culture and DNA.
- 524 tissue cultured accessions were sent to the National Center for Genetic Resources and Preservation (NCGRP) in Ft. Collins, Colorado as backup. This is 94% of all tissue culture accessions shipped to domestic requestors.
- 65% of accessions requested in 2008 have been shipped.
- 14% of all items shipped were sent to foreign requestors.
- Requests for DNA samples of our accessions, in the form of DNA and lyophilized leaves, were 471 or 9% of the total number of accessions shipped.
- Scion wood (18%), Hard Cuttings (17%) and Rooted Cuttings (Plant) (14%) were the top three forms sent to domestic requestors.
- DNA (extracted and lyophilized leaves) (28%), Seed (27%) and Hard Cuttings (16%) were the top three forms sent to foreign requestors.

The NCGR - Corvallis continues to distribute plant germplasm within the United States and internationally. The information supplied in this report reflects all items shipped in CY 2008 which represent some accessions requested from 2004 up to and including 2008. Information is also presented that represents all accessions requested only during CY 2008.

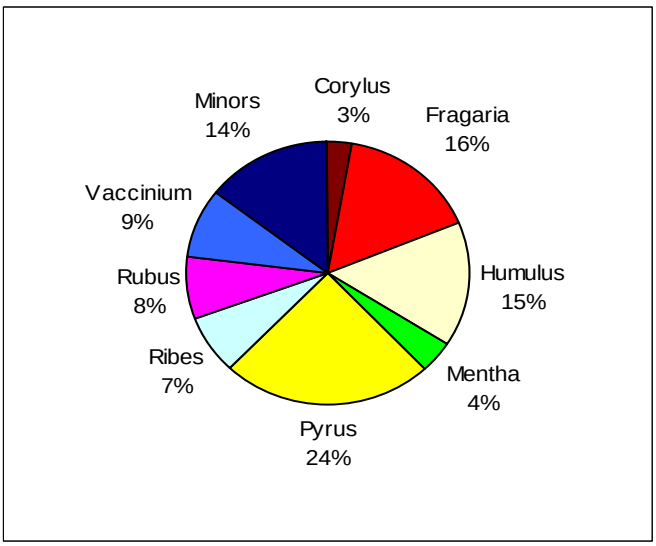


At the time of this printing, we have distributed 4,040 items as seeds, cuttings, runners, scion wood, rooted plants, tissue culture and DNA from 2008 requests. This represents 65% of the total number of items requested for 2008. Additional material will be shipped in CY 2009 from 2008 requests. An average of the total number of items shipped over the last seven years (not including 2008) show that we ship 91% of the total number of items requested from any given year.

CY 2008 saw an increase in the total number of items shipped to an all time high of 5,061. This total is only five items more than the amount shipped in 2007 but does represent the near maximum amount of items that can be shipped given the current FTE dedicated to Plant Distribution. Plants represented by rooted cuttings, soft and dormant cuttings, root cuttings and rhizomes remain the predominant category of material sent.

Material requested in a given year may require more than one year before the item is eventually shipped. This is due to the fact that we have very diverse holdings and are a clonal facility. At times plant material needs to be propagated from our mother plants in order to have items in a form that is sufficient for shipping. This is especially true for international requests. However, an average of 91% of items requested will be shipped within two years of the original request. Four items from 2004 were shipped, two from 2005, 83 from 2006, 1,765 from 2007 and 3,207 from 2008.

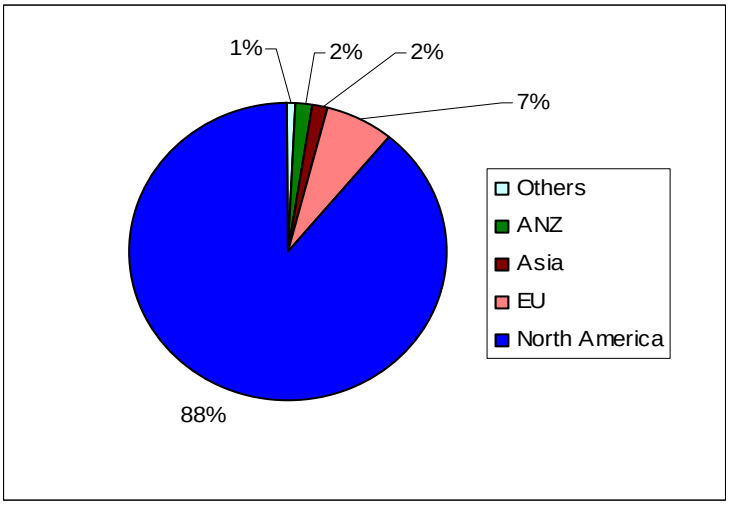
Domestically, plant items from *Pyrus*, *Humulus* and *Fragaria* in decreasing order were sent the most. Internationally, the order was *Pyrus*, *Fragaria* and *Mentha*. When considering all items shipped, regardless of destination, the order of the top three genera was *Pyrus*, *Fragaria* and *Humulus*. When all plant items from minor genera are considered collectively the group represents 14% of all items shipped. Continued interest in Hardy Kiwi Fruit (*Actinidia arguta*) accounted for 37% of all minor genera sent.



Over the last few years accessions of *Fragaria* and *Rubus* sent to European Union (EU) countries have dropped significantly. Due to the possibility of harboring viruses *Rubus* seed is prohibited. In addition the EU has increased the list of plant viruses that *Rubus* and *Fragaria* accessions arriving from the United States must be certified free. Because we primarily test for viruses important for American agriculture, this has resulted in a significant reduction in the number of accessions of *Rubus* and *Fragaria* approved for shipping to the EU. *Fragaria* seed is allowed entry to the EU. *Pyrus* shipments to the EU have for sometime been limited to seed and tissue culture since scionwood is prohibited due to fire blight (*Erwinia amylovora*). Japan, South Korea, and China have not been as restrictive and therefore reflect the high numbers of Rubus, Fragaria and Pyrus still being sent internationally.

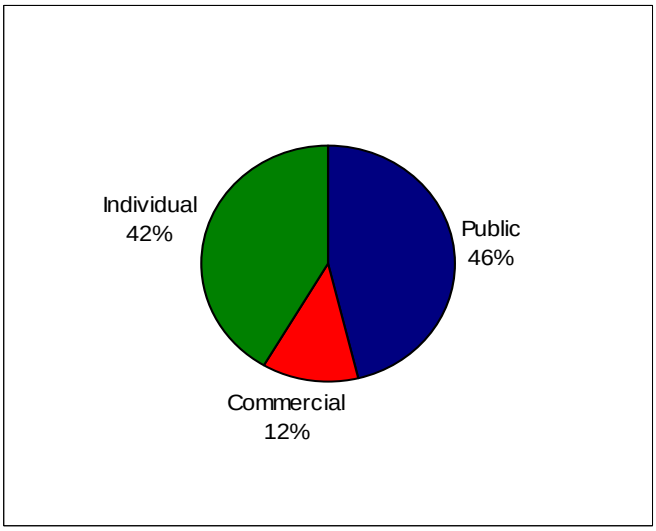
Humulus has increased from an average of 4% over the past three years to 15% of the total items shipped in 2008. This increase was due to a dramatic increase in domestic requests. There has been a national shortage in *Humulus* availability over the past few years and the general public

has turned to the NPGS to fill some of the void. To accommodate this increased interest we shifted to rooting summer cuttings instead of dormant rhizomes. A substantial increase in staff dedication was required to shift to rooting summer cuttings.



During CY 2008 we shipped plant accessions to twenty one countries including the United States.

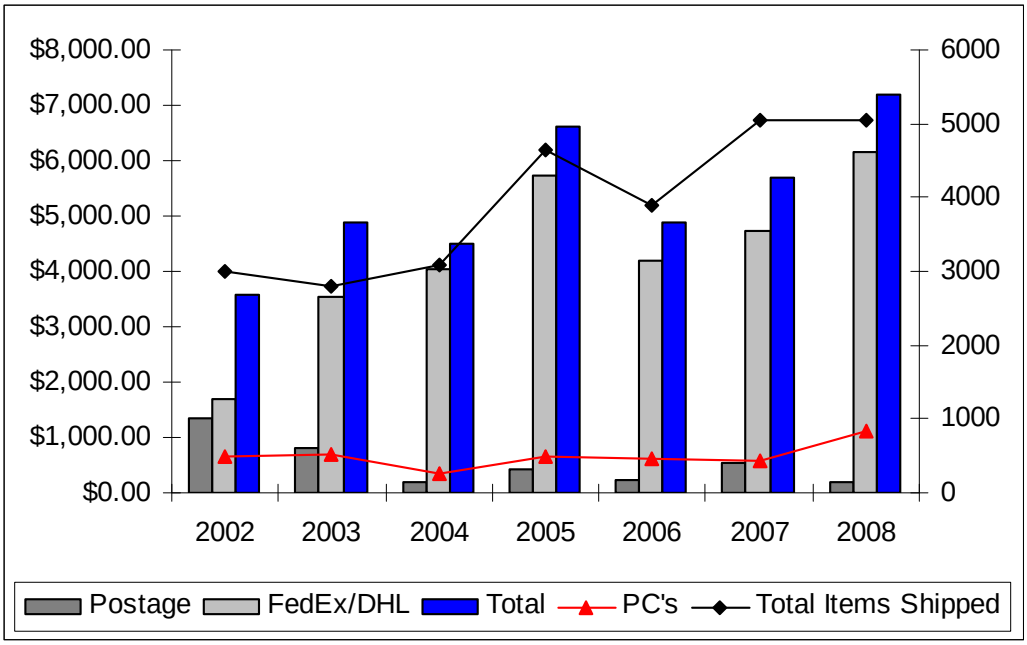
The chart at the left shows 2008 plant distribution by region. Most of the material was sent to North American destinations (88%). Of that total 3% was sent to Canada and 97% to the United States. The EU is represented by Belgium, France, Germany, Italy, Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Asia is represented by China, Japan and South Korea. The countries of Australia and New Zealand are representing the ANZ fraction of 2%. The 'Others' category of 1% represents material sent to Brazil, Chile, Peru, India and Iceland.



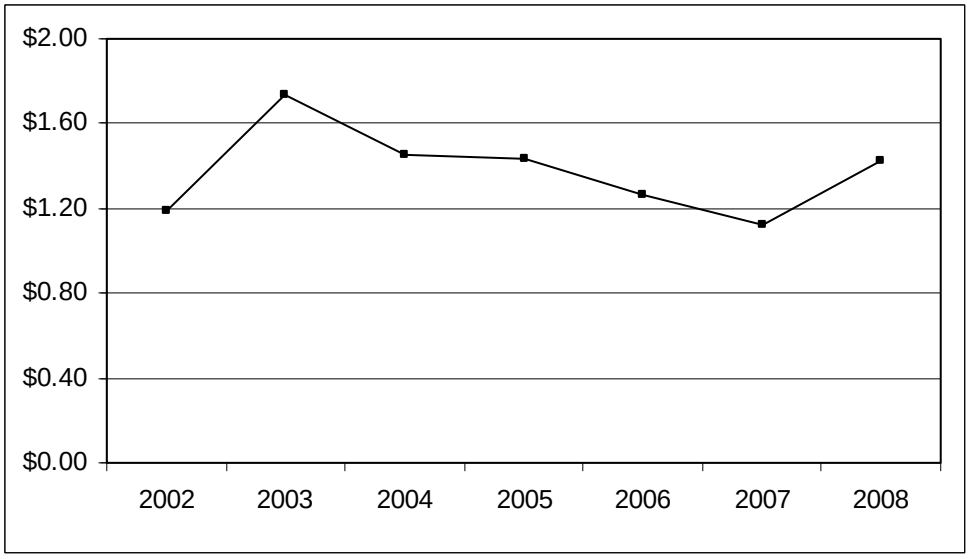
The chart to the left shows the 2008 total distribution by user group. Those organizations or individuals receiving plant material have been identified by the codes established by the Germplasm Resources Information Network (GRIN). These GRIN codes can be condensed into three user groups (Public, Commercial and Individual). Domestically the Public group represents state agencies, universities (public or private), the Agricultural Research Service of USDA, other Federal agencies, and non-profit or other public organizations (botanic gardens, arboretums, societies, centers, institutes). Internationally the Public group represents similar organizations of foreign origin. The Individual group represents persons with no affiliation and the Commercial group represents commercial companies domestic and international.

The total postage paid for domestic and international shipping was $190.10. The total cost for Federal Express/DHL was $6,142.13 and the total paid to the Oregon Department of Agriculture for 58 Phytosanitary Certificates was $850.00. The total cost of shipping plant material in CY 2008 was $7,182.23. This total is the most spent on any distribution year to date. Rising fuel costs continue to increase the shipping rates charged by the postal service and private carriers. The Oregon Department of Agriculture also increased the cost of writing Phytosanitary Certificates from $10.00 to $15.00 in January of 2008. The cost per item sent in CY2008 increased slightly from 2007 due to increases in fuel costs passed on to us by the postal service and private carriers.

Shipping Costs for Distribution from 2002 to 2008



Shipping Cost Per Item



We continue to use Federal Express (Priority Overnight) for most domestically shipped items and all plants sent to Canada (International Priority). Since September of 2003, we have been using DHL for all international plant shipments (excluding Canada). DHL has been the only carrier that consistently allows plant shipments to foreign destinations and is used by many facilities within the National Plant Germplasm System. The concern of having plant items arrive at their destination in a timely manner amid increased security precautions precipitated the change to using private carriers for most domestic and all international shipments.

Screenhouse/Greenhouse Collections
By Jim Oliphant and Missy Fix

• Establishment of modified climate zones to accommodate accessions originating in montane, high latitude, and subtropical regions (up to 20% of collections).
• Continued sanitation throughout facilities with an emphasis on weed control, in plant containers, floors inside the houses, and a wide buffer zone outside the houses.

ACTINIDIA

Actinidia is maintained in the screenhouse, as a back-up collection; at a minimum the accessions are housed for 3 years until the field plants are established. Currently, we have 31 backup accessions, there were no new accessions added in 2008. Nine accessions have been identified as Non-hardy, within this group five are identified as 'Tropical' and are being housed in greenhouse 1 which provides the climate needed for these plants. The remaining four accessions have been placed in greenhouse 3 which houses non-hardy genera.

CORYLUS

Temporary back-up trees of all new young field trees and virused clones of *Corylus* are maintained under screen. Before a new accession can be planted in the field it must be grafted and layered until the scion is on its own roots. Scionwood of core clones is also grafted and maintained in a greenhouse as needed for tissue culture source material. Currently, 90 accessions are being maintained for tissue culture.

FRAGARIA

All clonal accessions of *Fragaria* are maintained under screen. An additional backup set of Supercore is maintained in the greenhouse. We are continuing our 3-year re-propagation cycle using runners.

HUMULUS

All clonal accessions of *Humulus* are maintained in the screenhouse.

MENTHA

All clonal accessions of *Mentha* are maintained under screen. We are continuing our 3-year re-propagation cycle via cuttings.

PYRUS

Permanent back-up trees of all non-hardy clones, virus infected clones, and temporary back-up trees of all new young field trees of *Pyrus* are maintained under screen.

RIBES

All core or non-hardy clonal accessions of *Ribes* are maintained under screen. To date, 413 accessions are maintained as part of the permanent collection in screen house, of these 224 core accessions are established in the screen house and another 186 have been identified as non-cold hardy; these non-cold hardy are housed permanently in greenhouse. 75 finished *Ribes* were either introduced to the permanent screen house as new accessions or as replacement plants. Re-propagated accessions will be ready for screen house replacement in 2009.

RUBUS

All clonal accessions of Rubus are maintained under screen. Accessions from tropical, subtropical, and high latitude habitats are maintained in the greenhouse of which there are now 338 accessions. In 2008 22 new or replacement accessions were made ready for placement in the collection bringing the total number of accessions to 864 of which 269 are core accessions. 105 accessions that had a propagation date of four years or older were collected and re-propagated. Regarding the Rubus of Concern, 16 of the remaining accessions in this group, were prepped for placement back in the main collection; there are still 6 accessions that remain under this listing. In the Rubus collection there are 52 accessions represented by one plant; 26 of these were re-propagated this year and will be placed in collection in the fall of 2009; the remaining accessions in this group or group having a re-propagation date four years or older will be placed in 3 gallon containers with new soil which should encourage growth vigor.

VACCINIUM

Due to blueberry shock virus and Phytophthora ramorum concerns, we have established the primary collection in the screenhouse. We are growing vigorous stock plants to provide hard cutting material for distribution. We maintain under screen all core, named cultivars, and non-hardy clonal blueberry, as well as, all prostrate accessions, including lingonberry and cranberry. Additionally, we are maintaining 118 montane or non-hardy accessions in the greenhouse. All 250 core accessions have a plant under screen.

Clonal Accessions maintained in the Greenhouses and Screenhouses as of April 2009

	Total # Accessions	Core		Available		Single Plants With No Back-Up	
		# Ac.	%	# Ac.	%	# Ac.	%
Actinidia	43	11	26	40	93	10	23
Corylus	140	72	51	112	80	33	24
Fragaria	1389	528	38	1317	95	769	55
Humulus	383	87	23	244	64	108	28
Mentha	458	52	11	449	98	288	63
Pycnanthemum	34	18	53	34	100	0	0
Pyrus	325	23	7	195	60	94	29
Ribes	435	224	51	363	83	74	17
Rubus	864	270	31	773	89	67	8
Vaccinium	636	247	39	581	91	138	22
Other[2]	132	52	39	86	65	41	31
Total	**4839**	**1584**	**33**	**4194**	**87**	**1622**	**34**

JMO 04-08-09

1) includes: ASI, CYD, GAY, GAU, MES, SAM, SOR, and OTHINV

Quarantined Plants

At this time we have 292 accessions in quarantine.

Status of Quarantined Accessions at the Repository

Genus	Federal	State	In-House
Corylus	1 Post-Entry		2 NCGR
Cydonia	11 Provisional Release		
Fragaria	11 Departmental Permit		
Humulus	125 Post-Entry	20 Directors Exemption (seed)	
Pyrus	76 Provisional Release		
Ribes		17 Directors Exemption	28 NCGR
Rubus	1 Post-Entry		
Total	225	37	30

Seed Program

Ph.D. student Sugae Wada (OSU Horticulture Dept.) completed a study of seed scarification and germination treatments for additional species in the genus *Rubus.* She is testing additional dormancy breaking treatments and is determining the effect of seed anatomy on germination. Ms. Wada also determined that *Rubus* cultivars can be distinguished based on seed coat anatomy. The OSU Agricultural Research Foundation has funded additional study of blackberry cultivars and development of a brochure to assist with cultivar identification from seed. Sugae is also assisting with new seed accessions and distribution requests.

Computer/Information Management

By Douglas Cook

I. GRIN Records

TableGRIN Records Activity during CY 2008

GRIN Area	Created	Modified
Accession	1819	276
Inventory	1755	4818
Observation/Voucher	1729	623
Pathogen	0	0
Distribution	9	0
Cooperator	15	16
Total	5327	5733

This year there were 272 new accessions and other sub-tending data category records added to GRIN (1126 Accession Names, 42 Habitat, 10 Narratives, 4 Pedigree, 219 Source, 159 Source Members and 1729 Vouchers). There were 392 new Inventory items added, 446 Inventory records and 1309 Inventory Actions added to GRIN. For Distribution there were 9 Order Items and 15 Cooperator records add. Among 883 existing accession records, and other sub-categories,

modifications were made during the year (46 Accessions, 86 Accession Names, 41 taxon changes, 52 Habitat, 30 Narratives, 4 Pedigree, 623 Voucher and 17 Source). There were 2470 Inventory, 2348 Inventory Actions and 16 Cooperator records modified.

II. Hardware and Infrastructure

All workstations operate with at least a 1.0 MHz CPU, 1 GB of memory and use Windows® XP-Pro software. All workstations are equipped with uninterruptible power, anti-virus and the network is firewall protected. Two new workstations were purchased. Numerous minor computer software configurations and hardware repairs took place. The major events were the e-mail switch to the ARSNET Exchange accounts and the self destruction of our Fileserver's Backup Power Supply.

Publications Submitted in 2008

Journal Articles and Websites

Bassil, Nahla, Postman, Joseph, Hummer, Kim, Dolan, Susan, Lawliss, Lucy, and **Oda, Adrienne**, 2008. Molecular Fingerprints Identify Historic Pear Trees in Two US National Parks. Acta Horticulturae. 800:417-422.

Bassil, Nahla, Postman, Joseph, Hummer, Kim, Sezer, A., and Botu, M. 2008. SSR Fingerprinting Panel Verifies Identities of Clones in Backup Hazelnut Collection of USDA Genebank. Acta Horticulturae. (Submitted in 2008, to be published in 2009.)

Bassil, Nahla, Hummer, Kim, Postman, Joseph, Fazio, Gennaro, Baldo, Angela, Armas, Isabel, and Williams, Roger, 2008. Nomenclature and Genetic Relationships of Apples and Pears from Terceira Island. Genetic Resources and Crop Evolution. online at: http://www.springerlink.com/content/tw2774jk874q185g/ . Accessed 15 September 2008.

Brevis, Patricio, **Bassil, Nahla,** Ballington, James, and Hancock, James, 2008. Impact of Wide Hybridization in Southern Highbush Blueberry Breeding. Journal of the American Society for Horticultural Science.(Submitted in 2008, to be published in 2009.)

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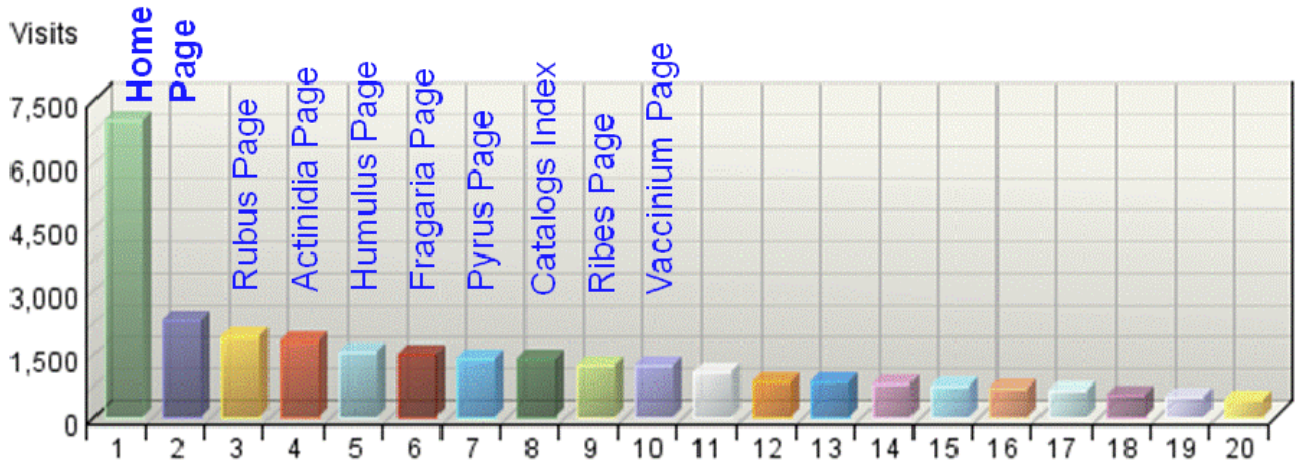
USDA ARS National Clonal Germplasm Repository - Corvallis

Website Statistics for 2008 from webtrends.com

– most visited NCGR web pages



– top 12 referring sites:

	Site	Visits
1.	Direct Traffic	7,942
2.	http://www.google.com/	5,134
3.	http://images.google.com/	1,705
4.	http://www.ars.usda.gov/	1,542
5.	http://www.ars-grin.gov/	1,486
6.	http://search.yahoo.com/	530
7.	http://search.usda.gov/	505
8.	http://www.google.ca/	311
9.	http://www.google.co.uk/	258
10.	http://search.msn.com/	253
11.	http://search.live.com/	221
12.	http://centralfloridagarden.blogspot.com/	206

***- top 25 search engine phrases that brought people to our website*:**

	Phrases	**Referrals**
1.	rubus	248
2.	national clonal germplasm repository	237
3.	actinidia	190
4.	kiwi fruit	176
5.	blue honeysuckle	160
6.	ncgr corvallis	153
7.	fragaria	150
8.	quince	143
9.	usda corvallis	137
10.	germplasm	129
11.	kiwifruit	97
12.	kim hummer	92
13.	hardy kiwi	80
14.	germplasm repository	76
15.	ribes	74
16.	rare fruits	57
17.	rare fruit	54
18.	mespilus	52
19.	wild hops	52
20.	nahla bassil	50
21.	hazelnut propagation	50
22.	endicott pear tree	48
23.	mentha	47
24.	corvallis germplasm	46
25.	pear germplasm	45