FINAL PROJECT REPORT

Project Title: Breeding and genetics program for PNW cherries

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Cooperators: Cameron Peace, Amit Dhingra, Dave Rudell, Amy Iezzoni, WTFRC

Total Project Funding: $93,893

Budget History:

Item	Year 1: 2008		
Salaries	12,240		
Benefits	10,894		
Wages	11,500		
Benefits	1,909		
Equipment	2,000		
Supplies	4,100		
Travel	7,750		
Virus-indexing services	3,000		
Plant material	5,000		
Plot establishment and maintenance	22,500		
Breeding consultant (MSU)	10,000		
Breeding consultant expenses (MSU)	3,000		
Total	93,893		

Footnotes: Salaries include a 1/2 time Associate in Research responsible for seed collection and greenhouse maintenance. Wages are for the equivalent of 4 temporary employees during bloom and 1 during the summer months. Equipment includes a high resolution digital camera, computer and refractometer. Supplies include soil, pots, stakes, tree guards and other lab consumables. Travel is $5,750 domestic and $2,000 international to attend RGC4 in Chile (2008). Virus indexing services include annual ELISA testing of parents used in the breeding program and establishment of virus-free clones in NRSP5 for WSDA virus-free certification status. Plot fees are for the establishment and continued maintenance of evaluation orchards at WSU-Prosser, WSU-Wenatchee and OSU-MCAREC ($2,500/acre); 7 acres at WSU-Prosser, 1 acre at WSU-Wenatchee and OSU-MCAREC. Breeding consultant (Amy Iezzoni, Michigan State University Tart Cherry Breeding and Genetics) will be active in design and implementation of crossing schemes and marker-assisted breeding.

OBJECTIVES

New sweet cherry cultivars with production and fruit traits superior to current cultivars are needed to provide differentiated products and production advantages that will allow the Washington and Oregon sweet cherry industries to remain competitive. Recognizing this, growers in Washington and Oregon have funded a sweet cherry breeding program that was initiated with the goal of developing high-quality sweet cherry cultivars ideally suited for Pacific Northwest growing regions. To meet this goal, we designed crosses to provide a series of new cultivars to extend the ripening season, minimize production costs, incorporate resistance to powdery mildew, and that have supreme fruit size, firmness, texture, and flavor. During the first three years of this project (2005-07), the comprehensive framework for a sweet cherry breeding and genetics program was established by the PI's in consultation with Dr. Amy Iezzoni, Dr. Fred Bliss, WTFRC and OSCC staff, and an Advisory Committee consisting of commissioners and cherry growers. Since the initial crossing year in 2004, 215 different crosses (including reciprocal crosses) have been completed resulting in over 6,500 seedling selections. The first of these seedling selections will begin fruiting in 2008, starting an annual cycle of review and renovation of the selection blocks. This proposal requests funds to continue evaluation of existing seedling selections, further develop the germplasm selection base through continued hybridization of elite selections and/or wild and related selections, and implement selection methodology to achieve improvement of targeted traits.

The specific objectives for this project were to:

1. Evaluate and renovate existing seedling selection blocks.

2. Produce through hybridization and selfing, genetically-variable sweet cherry selection populations that segregate for important target traits.

3. Select outstanding families and elite individual seedlings for important production and fruit traits.

4. Develop and implement rigorous selection methodology for important target traits for use in identification of advanced genotypes.

SIGNIFICANT FINDINGS AND ACCOMPLISHMENTS

- An additional 3,369 seedlings selections from crosses made in 2006 were planted in the field during 2008.

- A crossing plan was developed based on molecular genetic information generated in Dr. Iezzoni's lab that included specific crosses to increase fruit size, soluble solids content, and species diversity.

- Due to extremely challenging spring frost conditions, a limited number of seed (1,248) were generated from 2008 crosses.

- The first set of seedlings planted in the breeding program, from crosses made in 2004 began to flower, with 86% of the selections having at least lateral flower buds in the spring of 2008. However, spring frost eliminated nearly all the potential fruit from these trees, limiting our ability to perform any selection among the seedlings.

- Through collaboration with Conrad and Gilbert Fruit in Grandview, WA, small lots of fruit (4-5 packed boxes) from advanced selections were run over a commercial packing line to obtain surface pitting and postharvest performance estimates.

- Dr. Nnadozie Oraguzie was hired as Associate Professor of Stone Fruit Breeding and Genetics, and began May 1, 2008.

RESULTS AND DISCUSSION

This project was originally proposed for a three-year duration. Since the time of submission in November 2007, significant personnel changes have occurred that warrant early conclusion of the current project. The current PI's for this proposal (Olmstead and Whiting) are no longer responsible for the program as Washington State University hired Dr. Nnadozie Oraguzie to fill the role of Stone fruit breeder and geneticist effective May 1, 2008. Therefore, it was in the best interest of the program to terminate the existing project and allow Dr. Oraguzie to submit a new proposal. Thus, the final report herein is limited to findings during the year 2008 only.

The crossing plan for year 2008 had three goals: 1.) Increase numbers of progeny from key crosses made in previous years to enable efficient selection for priority traits, 2.) Perform crosses likely to generate a cultivar candidate in the first generation that had not been made previously (i.e, powdery mildew resistant parent x 'Regina'), and 3.) Incorporate genomic findings from Dr. Iezzoni's lab into the crossing scheme. For example, 'Glacier', an extremely large-fruited, early-ripening Prosser release was used extensively for the first time in 2008. 'Glacier' was identified in Dr. Iezzoni's research as having the most desirable genetic profile to increase fruit size. Additionally, Dr. Iezzoni's research identified 'Windsor', an eastern U.S. adapted cultivar that had not previously been used in the breeding program as having novel allelic diversity. Although not likely to generate cultivar candidates in the first generation, incorporation of this parent into the breeding program will infuse added diversity to the germplasm base in the breeding program, a long-term goal since crosses were first made.

Challenging crossing and pollination conditions due to repeated frost events limited the number of seed generated during 2008. A total of 1,248 seed were generated from crosses and are currently undergoing cold stratification prior to germination. The reliance on mother trees for crossing that are isolated and spread distantly around the WSU-Prosser research orchards increased the potential for frost damage as we were unable to provide effective frost control to all locations at the same time. Recognizing this, a consolidated crossing block with micro-sprinkler irrigation and located within range of existing wind machines has been identified as an objective in PI Oraguzie's new proposal.

Based on evaluation in the fall of 2007, the first seedling populations (from crosses made in 2004) appeared to have significant numbers of flowers. At bloom, flowering data were collected from all of the seedlings resulting from crosses made in 2004. 86% of these seedlings had some flowers in the spring of 2008, three years after planting in the field. The majority of these flowers were borne on single lateral flower buds rather than fruiting spurs. However, this is a much larger percentage than anticipated, particularly given the fact that no horticultural manipulations were performed to induce earlier fruiting on these seedling trees. This finding is particularly important as these seedlings are from 23 different families, and indicates the ability to begin selection as early as three years after planting. Unfortunately, spring frost and poor pollination conditions resulted in no fruit being available for evaluation and selection of outstanding families and individuals from these seedlings. However, one family ('Gold' × 'Dzherlo') exhibited wide branch angles in all progeny, a vegetative trait that may be valuable.

Additions to the seedling selection block included 3,369 seedling trees from crosses made in 2006. There are currently six acres of seedling trees from crosses made from 2004-2006 (Table 1).

Table 1. Summary of seedling material developed during 2004-2008 in the sweet cherry breeding program.

	Year				
	2004	2005	2006	2007	2008
No. of new parents used	19	21	14	9	4
No. of crosses made	61	90	109	49	24
No. seed	4,466	7,349	14,848	6,827	1248
% germination	5%	20%	34%	n.a.	n.a.
No. of seedlings	250	1,460	5,120	1272*	n.a.
No. of seedlings in field	243	1,088	3,369	n.a.	n.a.
No. of Full-Sib families >9 individuals	7	43	59	n.a.	n.a.

n.a.-not available. *Some seed are still being stratified in the cold room

Multiple trees from the advanced selections 9816-67 'AA', 9816-96 'JJ', 9816-104 'DD', and 9817-97 'GG' were propagated by C&O and Columbia Basin Nurseries on Mazzard, Mahaleb, and Gisela 5 rootstocks. These trees were distributed to grower-cooperators for planting at locations in Grandview, Zillah, Wenatchee, and Brewster. Additional trees propagated on Gisela 5 and 6 through an agreement with the Northwest Nursery Improvement Institute will be available for planting in the spring of 2009. These trees will be used by the current breeding program PI to establish permanent second-test locations in Oregon and Washington. Additionally, budwood from the selections 9816-104 'DD' and 9817-97 'GG', the most promising of the powdery mildew resistant advanced selections were entered into the NRSP5 program for virus certification. We hope to have certified virus-free mother trees established and ready for budwood distribution by the time a release decision is made for these selections.

To develop fruit surface pitting and postharvest performance information for advanced selections, we partnered with Conrad and Gilbert Fruit to run small lots of fruit over a commercial packing line. The advanced selections 9816-104 'DD' and 9817-97 'GG' were sampled for fruit quality data collected at harvest, and approximately 60 pounds of were packed at the beginning of shift changes. The packed boxes were stored for two weeks in cold storage and sampled again for fruit quality, surface pitting, and overall appearance (Table 2). Conservative estimates of fruit pitting were calculated by evaluating an ~200 fruit sample for any evidence of surface pitting (>1per fruit). Both selections averaged 35% pitting.

Table 2. Fruit quality measurements of the advanced selections 9816-104 'DD' and 9817-97 'GG' at harvest and after two-week storage.

	Date	Avg. size (g)	Avg. firmness (g/mm)	SSC (°Brix)	Malic acid equivalent (%)
PMR-1	6/30	7.8	293.6	22.6	1.88
Rainier	7/2	11.0	253.3	21.1	1.34
GG (harvest)	6/26	7.8	217.5	20.6	1.04
GG (2-wk storage)	7/11	8.8	317.5	18.2	1.06
DD (harvest)	7/8	9.8	295.3	19.3	1.72
DD (2-wk storage)	7/17	8.8	340.5	19.9	1.57

EXECUTIVE SUMMARY

The Pacific Northwest sweet cherry improvement program has been operational now for four years. With funding provided by both the Washington Tree Fruit Research Commission and the Oregon Sweet Cherry Commission, the program was established to provide a diverse set of plant material specifically adapted to Washington and Oregon growing conditions. In May 2008, Washington State University hired Dr. Nnadozie Oraguzie, Associate Professor in Stone Fruit Genetics and Breeding, to oversee the program. Transition from previous management of the program by Drs. Jim Olmstead and Matt Whiting is now complete, and the proposed three-year project (2008-2010) is being terminated early to offer the current PI an opportunity to develop a new proposal more suitable for his needs.

The specific objectives for this project were to:

1. Evaluate and renovate existing seedling selection blocks.
2. Produce through hybridization and selfing, genetically-variable sweet cherry selection populations that segregate for important target traits.
3. Select outstanding families and elite individual seedlings for important production and fruit traits.
4. Develop and implement rigorous selection methodology for important target traits for use in identification of advanced genotypes.

A summary of accomplishments from 2008 includes:

- An additional 3,369 seedlings selections from crosses made in 2006 were planted in the field during 2008, bringing the total planted in the selection block at WSU-Prosser to 4,700.
- A crossing plan was developed based on molecular genetic information generated in Dr. Iezzoni's lab that included specific crosses to increase fruit size, soluble solids content, and species diversity.
- 1,248 seed were generated from these crosses and are undergoing cold stratification.
- The first set of seedlings from crosses made in 2004 began to flower, with 86% of the selections having at least lateral flower buds in the spring of 2008. However, spring frost eliminated nearly all the potential fruit from these trees, limiting our ability to perform any selection among the seedlings.
- A trial of advanced selections from the breeding program were run over a commercial packing line to obtain surface pitting and postharvest performance estimates.

Through discussions and two workshops attended by genomics, genetics, and breeding scientists, program consultants, the WTFRC, and an industry advisory committee to the cherry improvement program, future priorities for the program were established. The strength of the program has and will continue to be the team effort to increase efficiency in the program through scientific discovery and effective management.