**Organic Seed Partnership Final Report**
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## Overview

The Oregon State University Vegetable Breeding and Genetics Program has a 60 year record of developing and releasing vegetable varieties for the Pacific Northwest fresh market and processed vegetable growers. During this time period, three breeders have been active. In the early 21st century, we saw the need to breed vegetable varieties for organic systems, and initiated breeding activities in broccoli, tomato, and summer squash. With support from the Organic Seed Partnership beginning in 2004, we have conducted breeding of these crops for organic production systems on five acres of the Lewis Brown Research Farm (in third year of transition to certified Organic). We also initiated a farmer participatory project to enable farmers to actively take a role in research activities. Breeding is a long term activity, and as such, significant progress was made with the three crops, with varietal release expected to come in the next few years.

## Objectives

The overall goal of the OSU breeding project was to breed vegetable varieties adapted to organic production. The specific objectives under the Organic Seed Partnership were: 1) Use a farmer participatory model to develop broadly adapted open-pollinated (OP) broccoli varieties. 2) Breed late blight resistant tomatoes adapted to organic production, and 3) Transfer the high quality Tromboncino summer squash fruit into a bush background suitable for organic production.

The rationale for the broccoli project was that no improved OP broccoli varieties exist today since essentially all contemporary broccoli varieties are hybrids. Secondly, nearly all varieties have been developed with selection in conventional systems, and may not show optimal performance in organically managed systems. Many organic growers would like a broccoli variety that is well adapted to their individual system and environment, and one of which they can save their own seed (seed from hybrid plants will not breed true whereas an OP will). The farmer participatory breeding program employed sending seed of an OP broccoli population to any farmer willing to grow the material, select for the best plants in their environment, allowing them to intermate, and saving seed. Growers would return a portion of seed to OSU, where samples received would be combined and then redistributed to farmers in the next growing season. During the OSP, three cycles were completed.

Late blight on tomatoes is a significant problem to organic growers, whether it be early season in tunnels or late season in the field. While NOP compliant fungicides are available, these are copper compounds with limited efficacy. They must be applied frequently and result in the accumulation of heavy metals in the environment. Resistance is the best option with several resistances available primarily from wild tomato species. OSU released 'Ledgend' tomato in 1995 with *Ph-2* resistance to late blight. This germplasm source was then crossed to *Solanum habrochaites* to bring in quantitative

resistance from a different source. In addition, these lines were crossed to Cornell material possessing *Ph-3* resistance. The intent was that by pyramiding genes, strong and broad resistance to a wider array of races could be achieved. Unlike the broccoli project, a farmer participatory approach to selection for late blight resistance is difficult to achieve in an on farm situation. Occurrence of disease in a particular season at the chosen location is difficult to predict, and inoculating a disease screening trial in a farmers' field where they are trying to grow their own crop of potatoes and tomatoes is out of the question. For this reason, we grew and selected our tomato material in an organically managed system, with inoculation using known races of the pathogen.

Most summer squash are *Cucurbita pepo*, but one *C. moschata* summer squash variety (Tromboncino) was developed in southern Europe and brought by immigrants to the U.S. Tromboncino is superior in fruit quality to the *C. pepo* summer squashes such as zucchini and yellow crookneck, with a long seedless neck, that is meaty and has unique flavor. The original variety has a vine habit, but growers prefer bush types which require less space and are easier to harvest. We crossed Tromboncino to sources of bush habit (Bush Butternut, and Puerto Rican tropical pumpkin germplasm) and selected for Tromboncino traits in a bush background. *C. moschata* is adapted to warmer growing environments compared to *C. pepo*, so a secondary objective was to select *C. moschata* lines that showed better temperate environment adaptation. Selection was practiced under organic conditions so that the finished lines would have adaptation to organic production systems as well.

**Activities and Results**

*Broccoli*: Three cycles of farmer participatory selection was practiced from 2005 – 2007. Varying numbers of farmers participated in each year with increased participation from the east coast in 2006 and 2007. In general, farmers at 40º latitude or above and located on the east and west coasts were able to mature seed, whereas farmers with a more continental or southerly location had difficulty producing seed. The combination of a mild but long season is required for broccoli seed production. All sites conducted selection based on early spring planting with evaluation during the summer and seed harvest in the fall, but for more southerly locations, an overwintering planting might have been productive. The three cycles were conducted on an OP population with a high degree of variability that increased over cycles (see 2008 report documenting this). For production purposes, growers need greater uniformity in an OP, so In 2007 and continued in 2008, we began selection for more uniform heading date, head size and appearance. This work was conducted with Common Ground Farm in Olympia, WA and at the OSU location. Also in 2008, we compared all seed lots that had been saved back to 2003 in a replicated trial to examine any changes in time with the population. Two main features were noted; first that variability increased over cycles, and second that there was a divergence in seed lots selected on the east and west coasts. The increase in variability can be attributed to spontaneous outcrossing with other *B. oleracea* not part of the original population, but present in farmer's fields. In particular, we observed the flowered Gai Lan types present in materials coming from the east coast. This introduced much earlier maturing material into the population but with smaller head size and coarser bead structure. The divergence in east-west populations appears due to different

preferences by farmers and researchers making selections (east coast material larger beaded with lighter color and west coast materials fine beaded with darker green color). During cycles of selection, we were able to select for heat stress resistance at many locations.

*Tomato*: Late blight resistant tomato lines were advanced to the $F_5$ from 2005 – 2008. Selection for late blight resistance was practiced in all years but 2006 and 2008, when environmental conditions were not optimal for late blight infection. By end of 2008, the populations had been reduced to 25 inbred lines, with selection for compact habit, and superior fruit characteristics (fresh market slicer types).

*Summer squash*: Tromboncino crosses were advanced from the S2-S5 under the tenure of the Organic Seed Partnership by self pollinating or sib mating individual lines. Thirty-three selections were available for the 2009 season. During this period, we found that most crosses to tropical pumpkin material were too late maturing, so the bulk of the material remaining comes from the Tromboncino x Bush Butternut crosses. We selected for bush habit combined with long, straight necked fruit and prolificacy. In 2008, soils were cooler than normal at planting, and we observed much variability among families for germination and emergence, and were able to select for lines more tolerant of these conditions.

*Vegetable variety trials*: The OSU program contributed to vegetable trialing in two ways. We contributed varieties and advanced breeding lines from the OSU program to be evaluated on farm around the country. The feedback to the OSU breeding program was useful in that most OSU material hade never been evaluated under organic production. Some material (stringless snap peas and certain tomato releases) did not appear well adapted to low input systems. Other materials (stringy edible podded peas, Oregon Spring tomato, OSU 19 stripped acorn squash) did perform well. As a result, the OSU 19 line is being prepped for release. It is a viny, early maturing C. pepo squash with high soluble and total solids, with a very pleasing flavor.

We also participated in a pepper trial to obtain data for release of a northern adapted bell pepper in 2006. We are supporting the release by Cornell of a variety (Peacework) from this material.

**Outputs and Impacts**

- We were able to advance our breeding populations under selection for adaptation to organic production systems for four generations. While no individual lines have been identified for release, we should be able to do so in the next year.

- We anticipate three or more releases from the broccoli program (depending on the number of cooperating growers); two or three tomato releases (cherry and slicer types) with improved levels of resistance to late blight; and one or two bush Tromboncino summer squash releases.

- This work has led to further collaborations in breeding for organic systems including:
    - An invited lecture on Farmer Participatory Approach to Breeding Vegetables for organic Systems (Issues in Breeding for Organic Systems class, Edith Lammerts Van Beuren, Wageningen University, Netherlands, April, 2008 (Course & teacher voted best of the year at the University).
    - Potential collaborative late blight tomato breeding project to evaluate organic production in high tunnels in Mt. Vernon, WA (Carol Miles, WSU).
    - Potential collaboration with the European Union ECOCROPS project to facilitate breeding for late blight resistant tomatoes. (Carlo Leifert, University of Birmingham, UK)

- We participated in several field days and winter lecture meetings including:
    - Lewis Brown/Clonal Respoistory Farm Tour (Breeding Vegetables for conventional and organic systems) 7/26/08.
    - Organic Broccoli Field Day at Gathering Together Farm in conjunction with Erica Renaud and Edith Lammerts Van Beuren 07/08/08.
    - Breeding vegetables for Oregon. Master Gardeners Minicollege, Corvallis, OR 08/02/07.
    - Organic Seed Partnership Field Day (Ken Ettinger, Long Island, NY) and Progress and planning meeting (Cornell University, Ithaca, NY) 7/23 – 27/07.
    - Master Gardeners field tour of Vegetable Farm research plots 08/04/07
    - Broccoli Field Day, Gathering Together Farm, Philomath, OR, 10/07
    - Breeding for Organic Systems. Organic Seed Partnership Co-PI meeting, Edgefield, OR 1/13/06.
    - New Veggies for the Willamette Valley. Master Gardener's Meeting, Corvallis, OR 02/12/05
    - Critical Issues in Bean Seed Production. Organic Seed Alliance Field Day, Bryant Ranch, Shoshone, ID 07/27/05
    - Vegetable Varieties for the Oregon Growers. Small Farm School, Clackamas Community College, Oregon City, OR 11/12/05.
- We were also invited to serve on the Organic Seed Alliance Plant Breeding Advisory Committee, 2008-present

**Publications**

Miles, C., D. Granatstein, D. Huggins, S. Jones, and J. Myers. 2009. Pacific Northwest USA. In: Stephen R. Gliessman, Martha Rosemeyer, and Sean Swezey (Editors). The Conversion to Sustainable Agroecosystems: Principles, Processes, and Practices. CRC Press Advances in Agroecology Series. (In Press).

Myers, J.R. 2008. Isolation and Contamination Issues in Organic Seed Production: Crops and testing methodology. Organic Seed Growers Conference. Salem, OR. Feb 13-15. (http://www.seedalliance.org/uploads/pdf/MyersIsolContamIssues.pdf).

Myers, J.R. 2008. University-based Public Plant Breeding: Past, present and future roles of public institutions in crop improvement. . Organic Seed Growers Conference. Salem, OR. Feb 13-15. (http://www.seedalliance.org/uploads/pdf/MyersUnivPubPltBreed.pdf).

Myers, J.R. 2008. BIC - the next 50 years: A public breeder's perspective Ann. Rept. Bean Impr. Coop. (http://www.css.msu.edu/bic/PDF/2007%20BIC%20 Workshop.pdf.)

Myers, J.R. and C.J. Peterson. 2007. Plant Breeding at Oregon State University. Plant Breeding Coordinating Committee meeting, Cary, NC. (http://cuke.hort.ncsu.edu/gpb/pr/pbccposters2007/pbccoregon.pdf)

Colley, M.R. and J.R. Myers. 2007. On-farm variety trials: A guide for organic vegetable, herb, and flower producers. Organic Seed Alliance, Port Townsend, WA. http://www.seedalliance.org/uploads/pdf/OVTguide.pdf.

Boches, P., P. Kuslowa, Kean, D. and J. Myers. 2007. Vegetable Variety Trials 2006. OSUES http://eesc.oregonstate.edu/agcomwebfile/EdMat/em8777E-06.pdf

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Baggett, J.R., D. Kean, D. Sullivan, A. Stone, and J. Myers. 2005. Vegetable Gardening in Oregon. OSUES EC871. (revised August 2005).