

## **Title: Organic seed potato production and participatory breeding**

### **Investigators:**

Amy O. Charkowski; UW-Madison Plant Pathology  
Ruth Genger, UW-Madison Plant Pathology  
Russell Groves, UW-Madison Entomology  
Shelley Jansky, USDA-ARS and UW-Madison Horticulture  
Douglas Rouse, UW-Madison Plant Pathology

**Project locations:** Wisconsin, Minnesota, North Dakota, Michigan, Ohio

Potato is the fourth largest food crop in the world and the leading vegetable crop in the United States. There are limited breeding and trialing efforts to identify potato varieties suitable for organic farms, in part because federal and state support for agricultural research continues to decline and public financial support for plant breeding is low. Since potato is genetically complex (an out-crossing tetraploid), vegetatively propagated, and almost an orphan crop with respect to privately-funded breeding efforts, development of improved potato varieties, especially for organic agriculture, has been slow. Our long term goal is to develop a self-sustaining, farmer-directed program that combines breeding for organic potato production and early generation organic seed potato production.

The objectives of this project were to: (1) trial heirloom and specialty potato varieties and breeding lines on organic farms in the Midwest; and (2) optimize organic seed potato production systems to maximize yield and tuber health. Thanks to continued support from The Ceres Trust, we are continuing with this work. This project will improve organic farming systems by continuing to develop a potato breeding program and seed potato system that serves the organic industry in the Midwest. Wisconsin organic growers continue to have difficulty obtaining seed potatoes for heirloom and specialty varieties, and are eager to find varieties suited to organic production. Availability of healthy planting stocks of potato varieties that perform robustly on organic farms will make organic farms more productive and profitable. The most effective and least expensive way to keep planting stocks healthy is to use varieties resistant to common potato diseases and pests. Our research greatly expands the research that has been done on the performance of potato varieties on organic farms, including the pest and disease resistance of potato varieties popular with organic farmers. We will continue our research into potato variety performance across multiple organic production environments, and extend this research into the development of “tomorrow’s heirlooms” – potato varieties that combine the sensory characteristics of heirloom varieties, including color, shape, taste and texture, with production characteristics desired by organic farmers.

**Objective 1: To trial up to 50 previously unavailable specialty and heirloom potato varieties and to trial seed potatoes derived from novel crosses on organic farms.**

**Farmer collaborations:** Over the course of this project, we collaborated with farmers to trial specialty and heirloom potato varieties on 26 farms – 6 in 2012, 19 in 2013 and 16 in 2014. Additional farms participated in 2013 (7 farms) and 2014 (10 farms), but were not able to provide data for a variety of reasons. Of the 16 farms that participated in 2013 trials, 14 continued in 2014. The continued participation and relatively high rate of data collection by collaborating farmers demonstrates the value of the project to them. In 2012, on-farm trials were planted, evaluated and harvested by researchers with in-season management by farmers. In 2013 and 2014, we transitioned to a more collaborative model, in which farmers choose a subset of varieties of interest to them, and plant these in addition to a

core set of varieties to allow comparisons across farms. Farmers planted and managed variety trial plots, evaluated them on a common metric, harvested and evaluated the harvest, with advice and assistance from researchers as requested. Feedback from collaborating farmers has been positive, with great interest in comparative variety performance across farms, requests to trial particular varieties (which we fulfil if possible – some varieties are not currently available to us due to Plant Variety Protection or unavailability in the US), and requests for additional information on pest insects and diseases.

**Varieties trialed:** Fifty-one heirloom and specialty varieties from Seed Savers Exchange, the USDA Potato Introduction Station, and other sources. Six breeding lines from our organic potato breeding program were advanced to field trials. Seven commercially available varieties were included as comparisons to heirloom varieties and breeding lines. Seed potatoes for varieties that were not commercially available were maintained in tissue culture on the UW-Madison campus, and multiplied as seed tubers in the campus greenhouses and on certified organic land at the West Madison Agricultural Research Station. Trials were conducted on-farm as indicated above, and on the West Madison Agricultural Research Station organic fields. Varieties are listed below:

**Fingerlings:** Corne de Mouton, Elmers Blue, Makah, Nosebag, Peanut

**White varieties:** Abnaki, Anson, Campbell, Houma, Irish Cobbler, Niska, Omega

**Yellow varieties:** Aylesbury Gold, Charlotte, Dore, Epicure Banana, GxB, Gold Coin, Goya, Hunter, Iker, Sweet Yellow Dumpling

**Red or Pink varieties:** Candy Stripe, Chieftain, Cherries Jubilee, Durango Red, Early Bangor, Poorlander, Red Dutch, Trina, Woudster, Yellow Rose

**Russets:** Butte

**Purple varieties:** Black Russian, BToes, Blue Tom Cat, Bora Valley, Cowhorn, Early Blue, Fenton Blue, Nova Scotia Blue, Purple Chief, Peruvian Blue, Purple Valley, Scotia Blue

**Multi-color varieties:** Australian Crawlers, Barbara, Early Epicure, Gui Valley, Picasso, Mark Warshaw

**Breeding lines:** 113 (blue), 118, 120, 135, 141, PxC (red)

**Commercially available comparison varieties:** Dark Red Norland (red), Langlade (white), Freedom Russet (russet), Papa Cacho (red fingerling), Austrian Crescent (yellow fingerling), Keuka Gold (yellow), Adirondack Blue (purple)

Outstanding varieties in on-farm field trials were:

Market class	Early vigor	Pest and disease tolerance	Yield	Tuber appearance
Fingerlings	Papa Cacho	Papa Cacho, Elmers Blue	Papa Cacho, Elmers Blue, Corne de Mouton	Elmers Blue
White	Langlade		Abnaki, Houma	
Yellow	Epicure Banana	Aylesbury Gold	Gold Coin, Iker, Hunter	Epicure Banana
Red/pink	Early Bangor, Candy Stripe		Early Bangor, Chieftain, PxC	Yellow Rose

Purple	Purple Valley, Blue Tom Cat	Blue Tom Cat	Bora Valley, Scotia Blue, Early Blue, Purple Valley	Early Blue, Purple Valley
Multi-color	Early Epicure, Australian Crawlers	Australian Crawlers	Early Epicure	Gui Valley, Mark Warshaw, Barbara

Although many purple fleshed varieties are available in the Seed Savers Exchange collection, almost all these varieties showed significant skin defects at harvest, either due to surface diseases such as common scab and silver scurf, or due to netting and roughening of the skin. Developing a purple fleshed variety with attractive skin appearance is a new breeding objective for us.

Several participating farmers have expressed interest in continuing to grow particular heirloom varieties, including Papa Cacho, Gui Valley, Mark Warshaw, Yellow Rose, and Elmers Blue. Through an NCR-SARE funded project, we are trialing seed potato production on several organic farms in the Midwest to support the development of organic seed potato production capacity in the Midwest, enabling local production of locally adapted varieties.



(Examples of potato breeding lines from UW-Madison organic potato research)



(Some of the heirloom and specialty potato varieties used.)

**Objective 2: To optimize organic seed potato production systems to maximize yield and tuber health.**

Weed control is one of the biggest problems faced by organic farmers. It is a particular problem for potato because weed roots can damage potato tubers, reducing quality and impeding harvest, in addition to directly competing with potato plants. Mulches can help control weeds and also aid in insect control through altering the albedo of the potato field.

**Trial design and results:** In each year from 2012-2014, treatment plots were 6 rows and 50 feet long. In 2012-2014, we planted Freedom Russet, a late maturing variety. In 2013 and 2014, we also planted Dark Red Norland, an early maturing variety. Plots were tine weeded and hilled at least once after planting, and mulch plots were then mulched with an 8-10 inch layer of winter rye or winter wheat straw. In 2012, unmulched plots were tine weeded and hilled an additional time, but in 2013 and 2014, wet weather prevented this additional mechanical weeding. In 2013, an additional treatment had straw placed only in the row. Weed and pest insect incidence were recorded through the season. Harvested tubers were weighed, separated into marketable and cull classes, and the marketable tubers were separated into A (>4 oz) and B (<4 oz) classes.

In all three years, straw mulch provided better weed control for both grass and broadleaf weeds at the end of the season when mechanical tillage was impossible, and potato vines were dying back. No significant differences in weed control were seen earlier in the season. The treatment trialed in 2013, straw mulch placed only in the row, was no more effective than mechanical weeding for grass control, and intermediate between full mulching and mechanical weeding for broadleaf weeds. This treatment was not attempted again. No significant differences in pest insect incidence was noted between mulched and unmulched plots, though Dark Red Norland plots experienced higher incidence of potato leafhoppers than Freedom Russet plots.

For Freedom Russet in the 2012 drought, straw mulched plots yielded 83 cwt/A more than mechanically weeded plots. In cooler, wetter 2013, Freedom Russet yields were not significantly different between treatments, but straw mulched plots showed the highest yields. In 2014, Freedom Russet yields were significantly higher in straw-mulched plots than in mechanically weeded plots, by 70 cwt/A. Unlike Freedom Russet, early maturing Dark Red Norland showed no differences in yields between mulched and unmulched plots. We hypothesize that the later maturity of Freedom Russet makes it more susceptible to late season stresses that reduce yield, whether this is due to higher weed incidence, higher soil temperature, and/or lower soil moisture levels in unmulched plots. We are continuing research into the effects of straw mulch on potato yield in organic systems, with on-farm and research station trials on-going in 2015.



(Mulched and unmulched potato plots in 2012.)



(Mulched and unmulched potato plots in 2013.)

**Dissemination of findings:** Our variety trial and mulch trial findings have been presented at several farming and scientific conferences, including the MOSES Organic Conference (2013-2015), the American Phytopathological Society Annual Meeting (2013-2014), and the Wisconsin Potato and Vegetable

Growers Association Grower Education Conference (2013-2015). We have also presented our findings at yearly Organic Field Days held at the West Madison Agricultural Research Station (2012-2014), and communicated them directly to participating farmers through the project blog and emailed reports. We are preparing two articles on this research, to be submitted to peer-reviewed scientific journals.