

Breeding Potatoes for the Eastern U.S.

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The USDA/ARS Potato Breeding Program, located in Beltsville, MD, develops new varieties and improves potato germplasm for disease resistance, processing ability and nutritional content in collaboration with numerous state scientists, primarily in the eastern half of the U.S. Today's presentation will cover three areas of on-going collaborative research: 1) an early generation study to identify broadly-adapted potential new varieties, 2) efforts to improve potato germplasm for resistance to late blight and early blight, and 3) efforts to improve tuber carotenoid content.

Early Generation Study

Potato production in the eastern U.S. occurs over a wide range of environments from Maine to Florida with several marketing outlets. Many eastern states do not have a potato breeding program, instead relying on northern-based breeding programs. Typically, in the USDA/ARS Potato Breeding Program, 30,000 – 40,000 seedlings are grown the first year in northern Maine, of which 1-3% may be selected. These are increased a second year (second-field generation), and 1/3 to 1/2 of these are selected for a third year of increase. After the third year of selection, scientists from other states have been able to choose clones for evaluation in their home state. By this time, few clones remain from the original population and those that do remain have been selected for adaptation to northern Maine. This may not be the most efficient way to select broadly-adapted potato varieties for the eastern U.S.

In the early generation study, multiple locations selected from the breeder's second field generation at their respective locations. For three years (2007-2009), the USDA/ARS breeder recorded saves and discards of all second-field-generation clones, however, all clones were harvested and seed of all clones was distributed to five locations (ME, NY, NJ, NC, FL) for selection the following year. All locations evaluated these clones in plots of 4-8 hills, depending on seed availability. In 2008, 2009 and 2010, selections were made among 340, 321, and 381 clones, respectively.

Agreement between the breeder selecting at the breeding location and the primary selector selecting at the non-breeding location followed a similar pattern in all three years of selection: about 1/2 of the clones were discarded by both, 8-13% were saved by both, and they disagreed on the remaining clones. About 1/4 of the clones selected by the breeder were not selected anywhere else.

Among the clones selected at three or more locations, 27% to 70% had not been selected by the breeder at the breeding location and represent potentially broadly-adapted clones that would have been eliminated from the normal varietal development process before the non-breeding location had a chance to evaluate them.

In each cycle of selection, parents that produced poorly- or broadly-adapted offspring were identified. The identification of parents that produced broadly-adapted offspring early in the breeding program would allow the breeder to utilize these parents in subsequent hybridizations.

Based on these results the breeding scheme for the production of new potato varieties is being refined to include: 1) smaller seedling generations, 2) less intense selection pressure on the seedling generation, 3) earlier evaluation of clonal populations, 4) evaluation of all clones at every location initially, and 5) elimination of clones lacking broad-adaptation earlier in the process.

Late blight and Early blight – A Tale of Two Diseases

Late blight and early blight are two foliar and tuber diseases well-known and feared by every potato producer. Because there is limited resistance to either disease in commercial varieties, we looked for and found resistance to both diseases in their closest relatives, the cultivated diploid potato species, *Solanum phureja* and *S. stenotomum*. Resistance to both diseases was a highly heritable trait. Through recurrent selection we were able to reduce the amount of foliar late blight in the population by 1/6 from the first to the second cycle population and by over 50% from the first to the third cycle population. However, starting with the same population and using the same selection strategy, the amount of early blight increased from the first to the second cycle population and the second cycle population was noticeably later in maturity. Late blight resistant clones from the third cycle population are currently being intercrossed with commercial varieties to develop future late blight resistant varieties. A different breeding strategy is being undertaken to develop early maturing, early blight resistant potatoes.

Carotenoids

Carotenoids impart yellow, orange, or red pigmentation to fruits and vegetables and have a number of human health benefits. In potatoes, the two carotenoids with known health benefits are lutein and zeaxanthin which are important in preventing age-related macular degeneration. Zeaxanthin has also been shown to improve mental acuity in elderly people. In the previously mentioned cultivated diploid potato species we found selections that had 13 times the amount of carotenoids as 'Yukon Gold'. Diploid clones with high, intermediate, or low carotenoid content were crossed with a light-yellow fleshed tetraploid clone. There were no differences in carotenoid content among the families. However, high, intermediate, and low carotenoid progeny were obtained in all families. The carotenoid content in 11 (out of 46) progeny was >50% greater than 'Yukon Gold'. Efforts are underway to develop potatoes with higher carotenoid content in general (more intense yellow-flesh) and higher zeaxanthin content (orange-flesh) specifically.