Bioengineered Potatoes for the US Potato Industry

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Combining Breeding and Bioengineering

At MSU, we run a comprehensive multi-disciplinary program for potato breeding and variety development that incorporates plant pathology, entomology, biotechnology and genomics to meet US potato industry needs, as well as improving the lives of small shareholder potato growers around the world. Our program integrates traditional and biotechnological approaches to breed for disease and insect resistance that is positioned to respond to scientific and technology opportunities that emerge. We are also developing more efficient methods to breed improved potato varieties at the tetraploid and diploid level.

Current MSU Bioengineering Projects

Invertase silencing for resistance to cold induced sweetening
Xerico expression for drought tolerance and higher starch content
PPO silencing for reducing blackspot bruising
R-genes for late blight resistance: 3 R-gene strategy
R-genes for PVY and PLRV resistance
Genes for bacterial wilt resistance
Gene-editing for self-compatibility

Cold Storage Chip Processing

In 2024, the MSU Potato Program was the first, non-industry organization to receive non-regulated status of a genetically modified vegetable crop by the USDA APHIS (23-340-01rsr). Using vacuolar acid invertase silencing (*VInv*) within the MSU scab resistant variety Kalkaska, the biotech event, Kal91.3 has shown excellent chip quality fried after nine months storage at 40 F. In 2025, MSU submitted an FDA Biotechnology Final Consultation Food Safety Evaluation for the Kal91.3 potato and awaiting approval.

Lamoka Kal91.3 Snowden

Chips made directly from 6 months storage at 40 F (4.4 C) degrees.

Kal91.3

Gene Editing in Potato

MSU is actively developing gene edited potatoes. Here are some gene editing challenges that we experience with potato:

- **Tetraploid genome:** The potato's genome is tetraploid (each gene has four copies), and for precise editing, all four copies must be edited, which is a significant hurdle.
- **High heterozygosity:** Cultivated potatoes are highly heterozygous, with many different versions of each gene. This complicates the process of editing and maintaining desired traits during breeding.

Reducing Blackspot Bruising

Mackinaw is a chip-processing potato developed by MSU with resistance to potato virus Y (PVY), late blight (Phytophthora infestans), and tolerance to common scab (Streptomyces scabies).

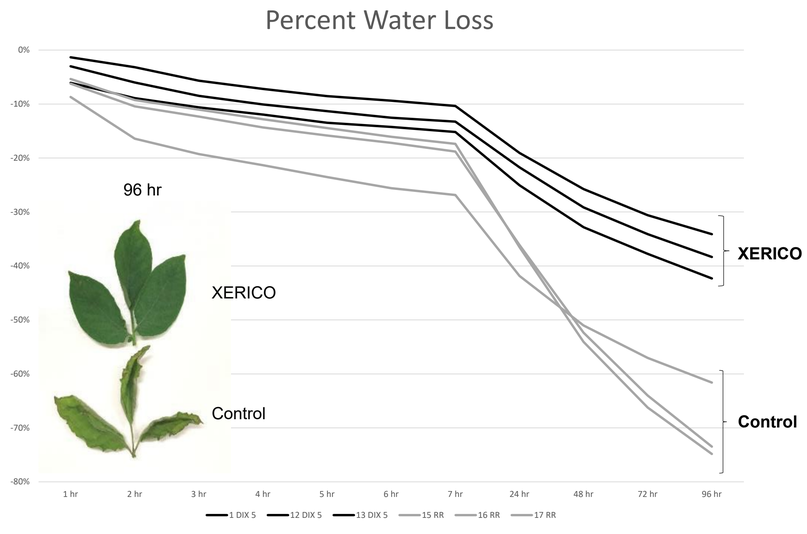
Mackinaw potato.

A weakness for Mackinaw is its susceptibility to blackspot bruise, a post-harvest physiological phenomenon primarily resulting from the handling of potato tubers during harvest, transport, and processing. Suppressing the polyphenol oxidase (PPO) gene via interference RNA has been demonstrated in commercial potatoes developed by the J.R. Simplot Co. and in the Arctic Apple by Okanagan Specialty Fruits, Inc. We have created a PPO RNAi binary construct which can subsequently be used to transform strategic MSU potato bred varieties, including Mackinaw.

Starch Increase and Drought Tolerance

XERICO: gene from *Arabidopsis* with similar genes in potato. We are using the drought-induced *XERICO* gene. Agronomic field studies demonstrated no yield penalty and increased starch content.

- Greenhouse studies verified drought tolerance.



R-Gene Disease Resistance

As part of our MSU led Global Biotech Potato Partnership , we have developed bio-engineered potatoes combining three Late Blight resistance R-genes and virus resistance R-genes to PVY and PLRV. In 2024, we obtained approval from the USDA-APHIS for Non-Regulated Status.

- MSU2DR-01 for Late Blight and PVY resistance: (*RpiAmr1, RpiAmr3, RpiVnt1* and *RySto*)
- MSU2DR-02 for Late Blight, PVY and PLRV resistance: (*RpiAmr1, RpiAmr3, RpiVnt1, RySto,* and *Rladg*)
- MSU2DR-07 for Late Blight: *RpiAmr1, RpiAmr3, RpiVnt1,* PVY resistance: *RySto,* PLRV resistance *Rladg,* Bacterial wilt resistance genes: EFR, Roc1 and JIM2

Preliminary analysis is showing that we are achieving high resistance levels for Late Blight and PVY. Analysis for PLRV and Bacterial Wilt is expected soon.

Acknowledgements

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