

Climate Resilient Potatoes Breeding for Heat Stress



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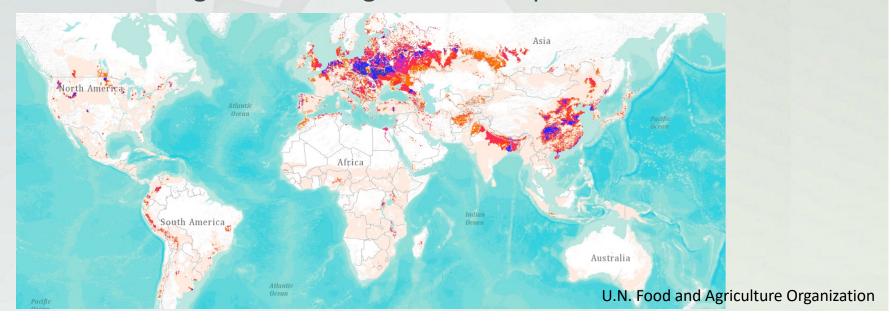
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Potato (Solanum tuberosum L.)

- Fourth in world production
- No. 1 Vegetable in the world

The potato produces more nutritious food, more quickly, on less land, and in harsher climates than any other major crop.

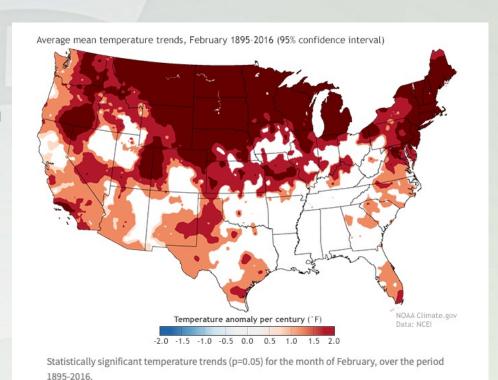
Potato is the most significant non-grain food crop in the world





Climate Resilient Potatoes

- What are the effects of increased temperatures and reduced water on potato productivity?
- Heat Stress Study
- Water Stress Study
 - Discontinued



Potato Heat Stress Studies at Montcalm Research Center

- Four Heat Stress Treatments (Timing)
 - Control No Heat
 - Heat 1 Early-tuber bulking
 - Heat 2 Early-Mid-tuber bulking
 - Heat 3 Late-Mid-tuber bulking
 - Heat 4 Late-tuber bulking
- Two potato chip-processing varieties
 - Mackinaw (PVYR, ScabR, LBR)
 - Snowden



Mackinaw

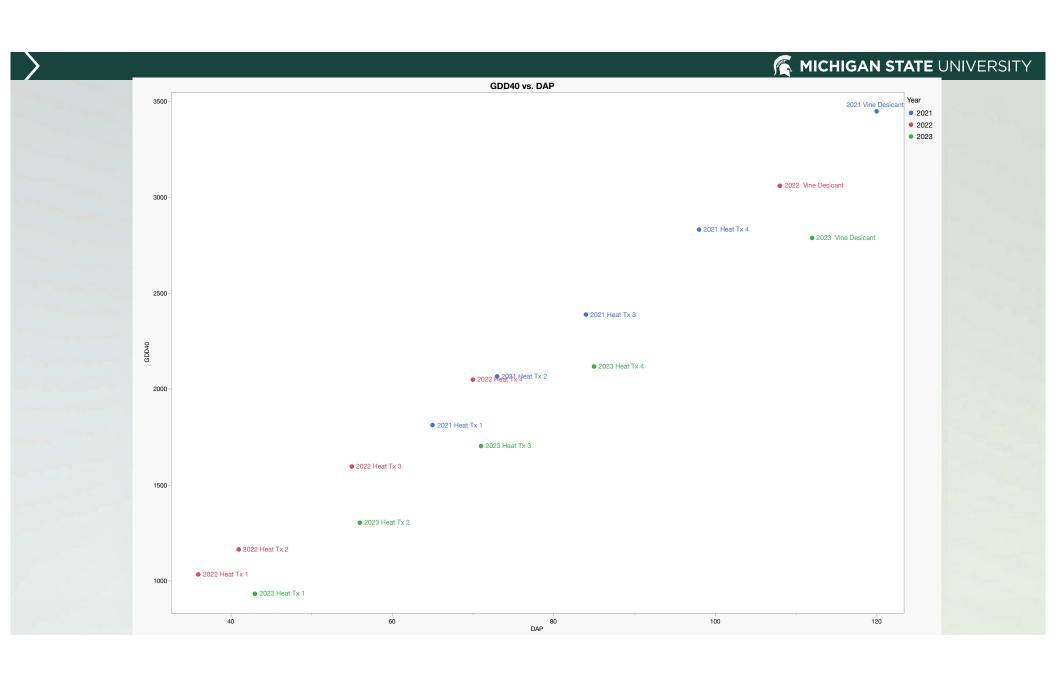
- RCBD, 3 replications of 3-row blocks, 20 ft plots
- **2021, 2022, 2023**



Potato Heat Stress Greenhouse Structure







Agronomic Yield and Grading Data

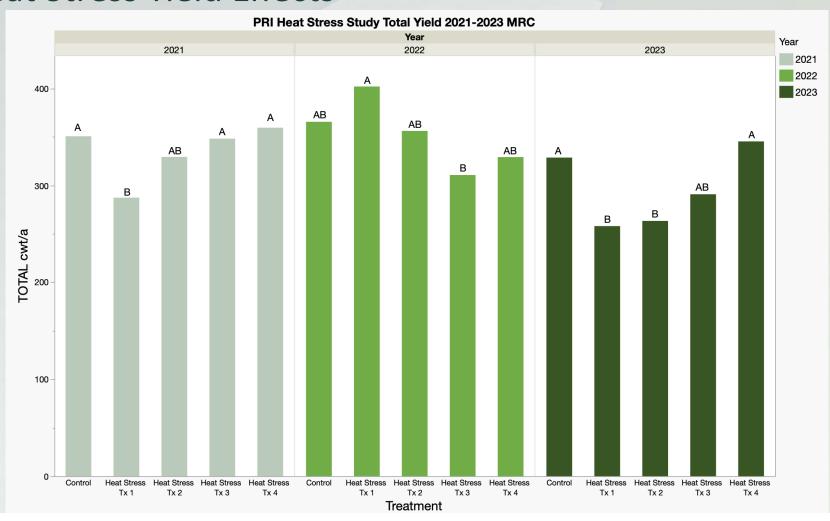
ANOVA p-values

				Prob > F			Percent by Weight (%)						Internal Quality (%)				
Year	Trial	Source	DF	TOTAL cwt/a	US#1 cwt/a	Specific Gravity	US#1 %	В%	A %	A1 %	A2 %	OV %	PO %	HH %	VD %	IBS %	BC %
2021	Heat Stress	Treatment	4	0.008	0.049	0.000	0.922	0.895	0.922	0.384	0.397	NA	0.626	0.023	0.408	NA	0.539
2021	Heat Stress	Line	1	0.558	0.700	0.002	0.849	0.656	0.849	0.437	0.439	NA	0.459	0.010	0.003	NA	0.195
2021	Heat Stress	Line*Treatment	4	0.745	0.595	0.505	0.152	0.182	0.152	0.374	0.575	NA	0.278	0.023	0.579	NA	0.539
2022	Heat Stress	Treatment	4	0.040	0.015	0.002	0.132	0.123	0.120	0.028	0.000	0.431	0.169	0.906	0.001	0.783	0.539
2022	Heat Stress	Line	1	0.052	0.000	<.0001	<.0001	<.0001	<.0001	0.004	<.0001	0.329	0.092	0.059	0.147	0.052	0.195
2022	Heat Stress	Line*Treatment	4	0.924	0.765	0.781	0.492	0.463	0.578	0.051	0.001	0.431	0.505	0.906	0.613	0.783	0.539
2023	Heat Stress	Treatment	4	0.000	0.000	<.0001	0.018	0.015	0.020	0.038	0.114	0.462	0.405	0.405	0.888	0.462	NA
2023	Heat Stress	Line	1	<.0001	0.004	<.0001	<.0001	<.0001	<.0001	<.0001	0.000	0.354	0.286	1.000	0.872	0.354	NA
2023	Heat Stress	Line*Treatment	4	0.687	0.855	0.333	0.242	0.273	0.222	0.343	0.271	0.462	0.129	0.089	0.621	0.462	NA



Heat Stress Yield Effects

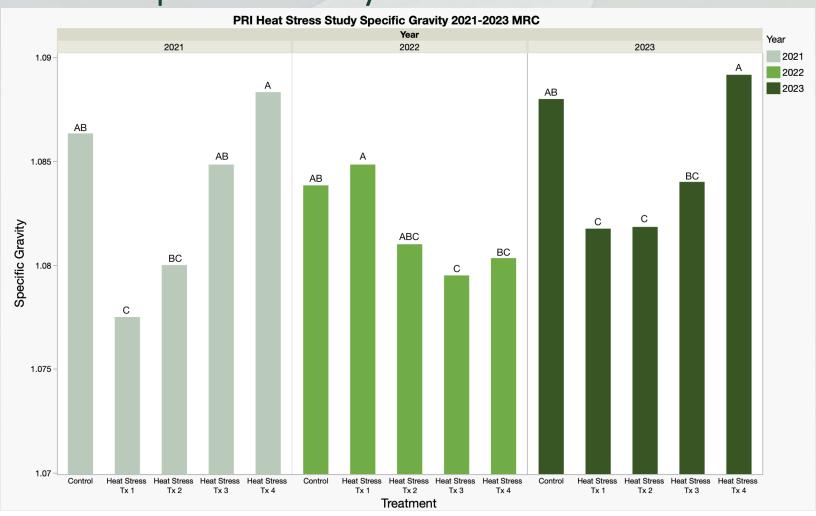
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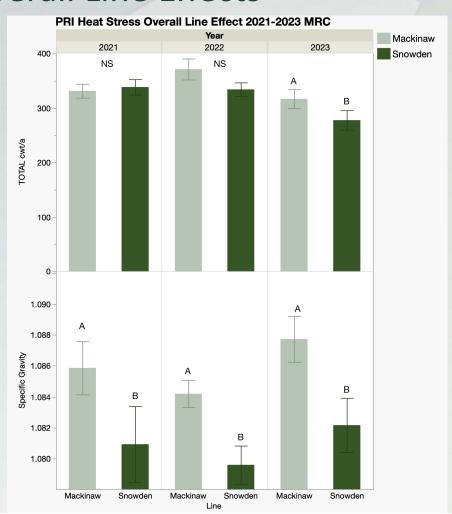
Heat Stress Specific Gravity Effects





Means within each effect with the same letter are not significantly different as determined by Tukey's HSD (alpha = 0.05).

Heat Stress Overall Line Effects





Storage Chip Quality

- **2021-2022**
- **2022-2023**
- 2023-2024 (in progress)
- Techmark Lab Data
 - Chip color score
 - Glucose
 - Total Defects

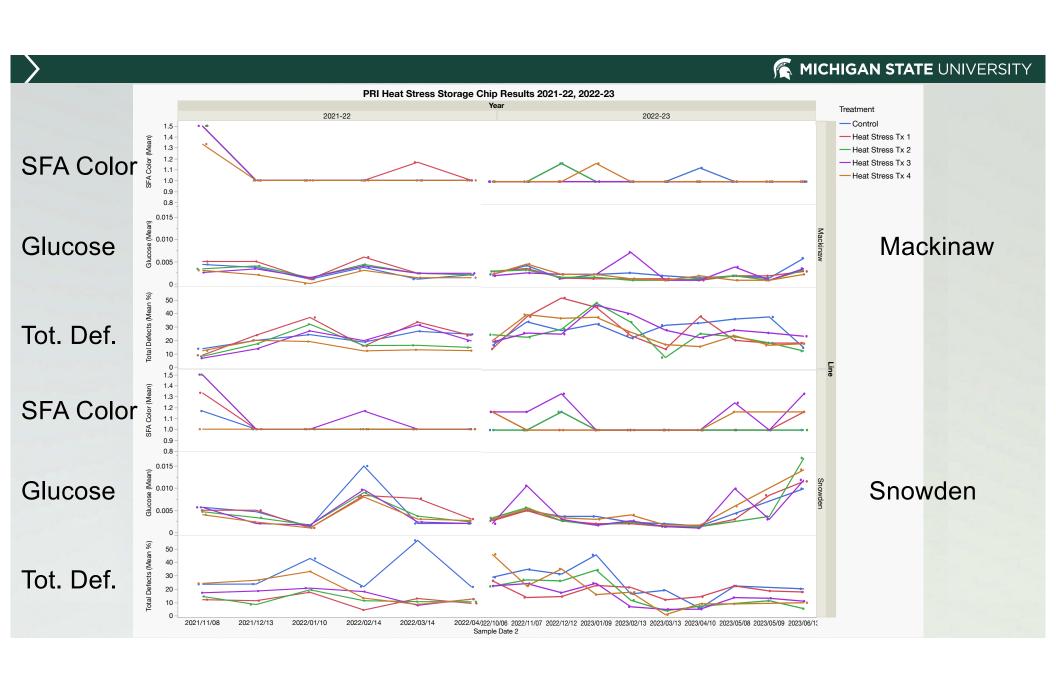
Mackinaw, 9 months storage



Control



Heat 1 - Early tuber bulking

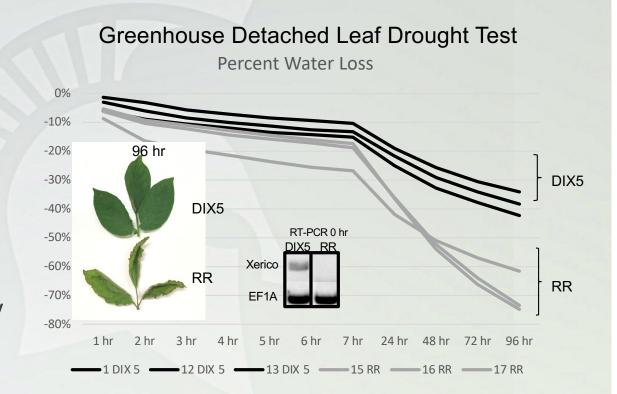




XERICO Drought Tolerance Technology for Potato

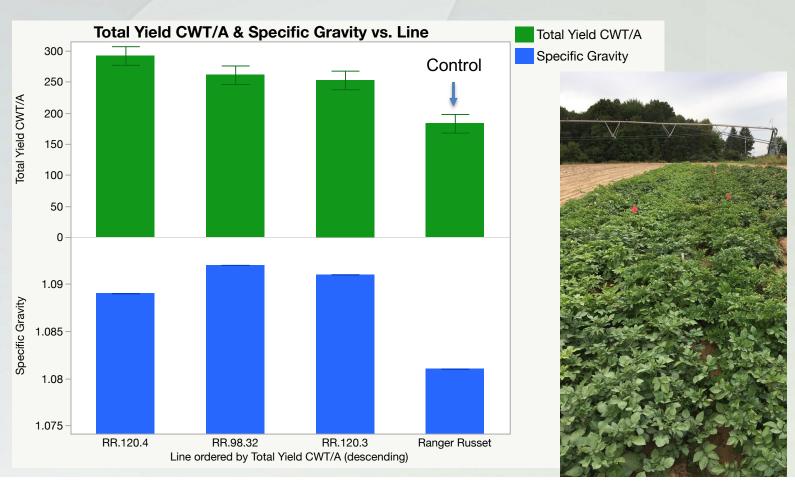
A trait for climate change

- XERICO, RING-H2 zinc-finger increases ABA (Han, MSU)
- Transformations using the XERICO gene coupled with drought inducible promoter in a commercially important potato varieties
- Greenhouse studies to verify function
- Field trials to assess agronomic traits



2019-23 XERICO Field Trials at MSU

- Test trait in potato in the field
- No yield penalty
- Increase in starch content



USDA Animal and Plant Health Inspection Service U.S. DEPARTMENT OF AGRICULTURE



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WASHINGTON, January 31, 2024 – The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) recently reviewed four plants modified using genetic engineering to determine whether they posed an increased plant pest risk relative to non-modified comparators:

- GDM Seeds, modified soybean for drought tolerance.
- · BioHeuris, modified soybean for herbicide resistance.
- Michigan State University, modified potato for lowered glucose and fructose in tubers.
- ZeaKal, modified soybean for increased seed oil and protein.

APHIS found these modified plants were unlikely to pose an increased plant pest risk compared to other cultivated plants. As a result, they are not subject to regulation under 7 CFR part 340. From a plant pest risk perspective, these modified plants may be safely grown and bred in the United States.

Heat Stress Study Conclusions

- Heat stress can significantly reduce yield
- Heat stress can significantly reduce specific gravity
- Impact on storage chip quality nonconclusive
- Mackinaw demonstrates heat stress tolerance for yield and specific gravity



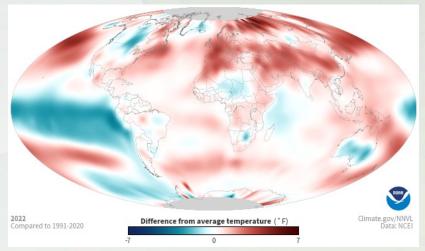
Breeding Climate Resilient Potatoes

- Understanding Climate Stress effects on potato production
- Genetic modification for drought stress tolerance

Breeding and Selection in stressed environments and with

reduced inputs

- Selection Environments
- Reduced Nutrients
- Reduced Irrigation



Temperature - Global Yearly, Difference from Average

