

NDSU Potato Breeding Program

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Potato Improvement

Potato is a significant horticultural crop in North Dakota, Minnesota, and the Northern Plains. Potatoes in ND and the northern plains are produced primarily on irrigated, sandy soils; however, a significant number of acres are non-irrigated. The Northern Plains Potato Growers Association website (nppga.org) details the market breakdown as 62% French fry/frozen processing, 16% fresh market (primarily red and yellow skinned cultivars for tablestock; ND is the largest producer of red potatoes in the US), 12% chip processing, and 10% certified seed production (ND ranks second in the US). Potato research at NDSU has been conducted since the late 1800s. The potato breeding program was initiated in 1930 by the North Dakota Agricultural Experiment Station (NDAES). The potato improvement team, via conventional breeding methods, focusses on incorporation of durable and long-term pest and stress resistance, environmental and economic sustainability, enhanced quality and nutritional attributes across market types, and high yield potential. Twenty-six cultivars have been released since its inception. NDSU cultivar releases have been widely adapted, impacting potato production in North Dakota, Minnesota, and across North America.

In order to address the shortcomings of commercial industry standard cultivars and the needs of the Northern Plains and Minnesota Area II potato producers and industry, the following research objectives were established for 2020:

1. Develop improved germplasm and superior potato cultivars adapted to the North Dakota, Minnesota and beyond, via traditional hybridization, emphasizing early maturity and introgressing resistance genes for biotic pests and abiotic stresses, improved quality attributes, and environmental and economic resource sustainability.
2. Identify, evaluate, and apply innovative technologies and genetics and genomics tools to increase efficiency, gain knowledge and modernize breeding efforts, including early generation selection technologies, marker assisted selection, SNP genotyping, extraction of dihaploids and development of inbred diploid lines, data mining, participatory plant breeding, and others as appropriate.
3. Conduct disease, pest and stress evaluations and agronomic production related evaluations for promising advancing selections and newly released cultivars, for development of and inclusion in cultivar specific management profiles.

Field research – 2020

In 2020, irrigated potato breeding trial sites include Oakes, Larimore and Inkster, ND, and Park Rapids, MN. Nine new and advancing red and yellow skinned genotypes compared to five standards are included in a small fresh market trial at the Oakes Research Extension Center. A

second trial is evaluating 13 dual-purpose russet/long white selections compared to seven processing industry standards. We are assisted with these trials by Kelly Cooper, Heidi Eslinger, and Seth Nelson. The Larimore site is hosted by Carl, Michael and Casey Hoverson at Hoverson Farms. They built a new mini pivot just outside of Larimore in 2020 for potato research efforts. Our trials include the processing trial with 14 advancing russet and long white selections compared to industry standards including Bannock, Ranger, Umatilla, Shepody, Dakota Russet and Russet Burbank. The National French Fry Processing trial (NFPT), supported by Potatoes USA, is grown at this site, with the goal of identifying processing selections with superior French Fry processing potential and low acrylamide levels; there are 50 entries in 2020, including 33 Tier 1, 14 Tier 2, and 1 Tier selections from US breeding programs, compared to industry standards Russet Burbank and Ranger Russet. NDSU NFPT entries include ND13213B-1Russ, ND1412Y-5Russ, ND14110B-1Russ, and ND14110B-3Russ, all in Tier 1; we did not have enough seed of ND12241YB-2Russ, a promising processing selection, to include in Tier 3 (it was a Tier 2 entry in 2019), so we are increasing for inclusion in 2021. The preliminary processing trial includes 84 russet and long white-skinned genotypes with processing potential, compared to 12 industry standards; this is an unreplicated trial, providing information about processing ability and guiding selection and movement forward in the breeding pipeline. The North Central Regional Trial has 30 entries focused on the fresh market. In 2020, NDSU entries include six promising red skinned selections with white or yellow flesh (ND102663B-3R, ND102990B-2R, ND113091B-2RY, ND113338C-4R, ND1232B-1RY, ND1232B-2RY), and one yellow, ND1241-1Y. This site is also the location for a trial evaluating AgZyme and ZyDrive versus grower standard practice. Three cultivars are included in the replicated trial: Bannock Russet, Russet Burbank, and Umatilla Russet. In 2020, two trials are planted at Inkster, the vine kill study conducted in collaboration with Drs. Gary Secor and Andy Robinson, a project funded by a North Dakota Specialty Crop Block Grant (SCBG) in response to a problem identified by ND certified seed potato growers using crop oils for deterring aphid probing, and a second site of the AgZyme/ZyDrive trial. Trials at Park Rapids, MN, are hosted by the RD Offutt Farm, and include a processing trial with 15 entries, a common scab screening trial with 68 entries across market types, and a replicated *Verticillium* wilt resistance screening trial (25 genotypes across market types) conducted in collaboration with Dr. Pasche's program.

Non-irrigated research sites in 2020 include locations at Crystal, Hoople, and Fargo, ND. The fresh market trials are conducted on the farm of Dave and Andy Moquist (O.C. Schultz), north and east of Crystal. The fresh market trial has 30 entries, 24 advancing red, yellow and purple skinned selections compared to six fresh market standards. The preliminary fresh market trial includes 90 entries, 76 selections compared to 14 fresh market cultivars. These new promising selections include red-skinned white-fleshed or yellow-fleshed, yellows, and specialty types; many possess potential disease resistance traits. Chip processing trials are located just north of Hoople, and are hosted by Lloyd, Steve and Jamie Oberg. The chip processing trial includes 14 advancing chip selections compared to seven chip processing standards. The National Chip Processing Trial (NCPT), supported by Potatoes USA, with a primary goal of rapidly identifying superior alternatives for Snowden (long-term chip processing potential) and Atlantic (susceptibility to internal heat necrosis) includes 121 unreplicated selections (Tier 1) and 27 replicated entries (Tier 2) from US potato breeding programs, compared to four industry chip selections. The preliminary chip processing trial includes 16 selections compared to eight chip industry standards.

We look forward to sharing our research and results with all and wish to thank our trial hosts and those who supply certified seed, the NPPGA, MN Area II Potato Research and Promotion

Council, Cavendish Farms, Simplot, Potatoes USA, NIFA, the ND SCBG program and others for research funding in support of this work, Valley Tissue Culture, the North Dakota State Seed Department, Minnesota Department of Agriculture, and to the potato improvement team for collaboration in conducting these trials. The potato breeding team includes Dick (Richard) Nilles (research specialist), and graduate students Felicity Merritt, Edoardo Poletti, Hashim Andidi, Tannis Anderson and James Bjerke.

Seed production

The NDSU potato breeding program seedling nursery, seed maintenance plots, and increase lots are planted south of Baker, MN, on the James F. Thompson Farm. All lots are entered for certification with the Minnesota Department of Agriculture. The seedling nursery includes single hills from 90 families, and following success in 2019, also includes out-of-state seedlings from Idaho, Maine and Texas; single hill selection will begin in early September. New in 2020 is the genomic selection study being conducted by the north central breeding team (Drs. Douches, Endelman, Shannon, and Thompson) as part of our NIFA project; it is focused on rapid selection and is focused on PVY resistance and chip processing quality. Maintenance and increase lot production is used to maintain the genotypes via phenotypic recurrent selection and is the seed source for research trials conducted by our program, collaborators at NDSU, and research and industry collaborators in ND, MN, and beyond. As in previous years, about two dozen Chilean selections from the INIA program at Osorno, Chile, are being evaluated and/or increased in collaboration with Drs. Gary Secor and Julio Kalazich.

Graduate student research

Graduate students are an integral part of potato research. Felicity Merritt is completing her Master's thesis on sugar end resistance. Edoardo Poletti is a PhD. candidate working with Dr. Secor and myself on soft rot resistance, particularly to *Dickeya dianthicola*. He has developed foliar and tuber screening protocols and via screening identified resistant genotypes moving through our breeding program pipeline. Hashim Andidi is continuing work on metribuzin sensitivity developing a high throughput phenotyping method with Drs. Hatterman-Valenti, Flores, Stenger and myself; he is a Masters student. Tannis Anderson joined the project in May and is a Masters student working on diploid breeding. James Bjerke is completing his Master's thesis on late blight resistance.

North Dakota State University Fresh Market Trial, Crystal – 2020

Entry	Parentage		Maturity	Yield Potential	Utilization	Comments
	Female	Male				
AND00272-1R	Minn. 17922	A92653-6R	Medium	Medium to high	Tablestock	
ND6002-1R	NorDonna	Bison	Medium	Medium	Tablestock	
ND7132-1R	ND5002-3R	ND5438-1R	Medium	Medium to high	Tablestock	
ND102663B-3R	Dakota Ruby	Patagonia	Medium	Medium to high	Tablestock	Late blight resistance breeding
ND102990B-2R	ND071007B-2R	Dakota Ruby	Medium early	Medium to high	Tablestock	High set
ND113091B-2RY	Romanze	Dakota Ruby	Medium early	High	Specialty	LB, GN, & PVY resistance breeding
ND113207-1R	T10-12	Dakota Ruby	Medium	High	Tablestock	
ND113338C-4R	Dakota Ruby	ND7779C-3R	Medium early	Medium to high	Tablestock	
ND1232B-1RY	Romanze	Dakota Ruby	Medium early	Medium to high	Specialty	LB, GN, & PVY resistance breeding
ND1232B-2RY	Romanze	Dakota Ruby	Medium early	High	Specialty	LB, GN, & PVY resistance breeding
ND14215C-4R	ND4659-5R	ND7779C-3R	Medium early	Medium to high	Tablestock	
ND1241-1Y	AND07358-1Y	Ivory Crisp	Medium	High	Multi-purpose	Yellow flesh
ND1243-1PY	AND07358-1Y	ND7132-1R	Medium	Medium to high	Specialty	Pale yellow flesh
ND13106-1R	ATND99331-2PintoY	ND7834-2P	Medium early	Medium to high	Tablestock	
ND13109-2Y	C322	Yukon Gold	Medium to late	High	Specialty	Yellow flesh
ND13193B-1R	Dakota Ruby	Patagonia	Late	Medium to high	Tablestock	
ND13236-2R	ND050132C-6R	AND07135-1R	Late	Medium to high	Tablestock	
ND13241-6R	N050132C-6R	ND081745C-1P	Medium	Medium to high	Tablestock	
ND13296Y-6R	ND081783-1R	95043.11	Medium	High	Tablestock	PVY resistance breeding
ND1455Y-1R	Dakota Jewel	95043.11	Medium early	Medium	Tablestock	PVY resistance breeding
ND1465-1R	Dakota Ruby	Norland	Medium	Medium to high	Tablestock	
ND14151-24R	AND07135-2R	Dakota Ruby	Late	Medium to high	Tablestock	
ND14151-25R	AND07135-2R	Dakota Ruby	Medium early	Medium to high	Tablestock	
ND14151-26R	AND07135-2R	Dakota Ruby	Medium early	Medium to high	Tablestock	High set
Dakota Ruby	ND7188-4R	ND5256-7R	Medium	Medium to high	Tablestock	
Gala			Medium early	Medium to high	Specialty	Common scab, GN & wart resistance
Red LaSoda	Sport of LaSoda		Medium to late	High	Tablestock	Industry standard, widely adapted
Red Norland	Sport of Norland		Early	Medium to high	Tablestock	Industry standard, widely adapted
Sangre	Viking	A6356-9	Medium	Medium to high	Tablestock	Check, widely adapted
Yukon Gold	W5279-4	Norglean	Medium	Medium to high	Specialty	Industry standard, widely adapted

Planted: May 18, 2020 Replicates: 4 Row Spacing: 36 inches Within-Row Spacing: 12 inches Thank you to Dave and Andy Moquist and others

North Dakota State University Chip Processing Trial, Hoople -- 2020

Entry	Parentage			Maturity	Yield Potential	Utilization	Comments
	Female	Male					
ND7519-1	ND3828-15	W1353	Medium	Medium	Chip processing	Cold chips	
ND7799c-1	Dakota Pearl	NY115	Medium	Medium to high	Chip processing	Cold chips	
ND092018C-2	ND2858-1	King Harry	Medium early	Medium	Chip processing	CPB resistance breeding	
ND113307C-3	ND7799c-1	ND7519-1	Medium	High	Chip processing	CPB resistance breeding	
ND113394CAB-7	ND04932CAB-3	Dakota Pearl	Medium early	Medium to high	Chip processing	Insect and LB resistance breeding	
ND113508C-4	ND060835C-4	M3	Medium	High	Chip processing	CPB resistance breeding	
ND122C-1	Dakota Diamond	M2	Medium	Medium	Chip processing	CPB resistance breeding	
ND12107CB-1	ND5873-21	ND7379-6	Medium late	High	Chip processing	CPB and LB resistance breeding	
ND13219C-3	ND028799C-3	ND7519-1	Medium	Medium to high	Chip processing	CPB resistance breeding	
ND13219C-4	ND028799C-3	ND7519-1	Medium	Medium to high	Chip processing	CPB resistance breeding	
ND1441-1	Dakota Crisp	Waneta	Medium	Medium to high	Chip processing		
ND1450CAB-3	Dakota Diamond	ND102800ABC-1	Medium	Medium to high	Chip processing	Insect and LB resistance breeding	
ND1451CAB-3	Dakota Diamond	ND102809AB-2	Medium early	High	Chip processing	Insect and LB resistance breeding	
ND1452CB-1	Dakota Diamond	ND102857CB-1	Late	Medium to high	Chip processing	CPB and LB resistance breeding	
Atlantic	Lenape	Wauseon	Medium	High	Chip processing	Industry standard	
Dakota Crisp	Yankee Chipper	Norchip	Medium	High	Chip processing	Uniform tubers	
Dakota Pearl	ND1118-1	ND944-6	Medium	Medium	Chip processing	Consistent cold chipper, industry standard	
Lamoka	NY120	NY115	Medium to late	High	Chip processing	Tested as NY139; common scab resistance	
Pike	Allegany	Atlantic	Medium	High	Chip processing	Common scab resistance	
Snowden	Lenape	Wischip	Medium	High	Chip processing	Industry standard, long-term storage	
Waneta	Marcy	NY115	Late	High	Chip processing	Tested as NY 138; suitable for fresh market	

Planting Date: May 16, 2020

Hills/Plot: 20

Seed Piece Treatment: NuBark MZ

Seed Piece Spacing: 12"

Row Spacing: 36"

Thanks to: Lloyd, Steve and Jamie Oberg, Andy Gullikson, NPPGA, MN Area II, USDA-NIFA, and Jorde Certified Seed, John Miller Farms Inc., Black Gold, Nilsons, and Dagens for seed potatoes.

North Dakota State University Processing Trial, Larimore – 2020

		Parentage								
Entry	Female	Male	Maturity	Yield Potential	Use	Comments				
MN13142										
ND8068-5Russ	ND2667-9Russ	ND4233-1Russ	Very early	Medium to high	Dual-purpose	UMN selection, strong dormancy				
ND050032-4Russ	Dakota Russet	Russet Norkotah	Medium	Medium to high	Dual-purpose					
ND113100-1Russ	Russet Norkotah	M7	Medium	Medium to high	Dual-purpose					
ND12162AB-1Russ	ND039194AB-1Russ	Dakota Trailblazer	Medium-late	Medium to high	Dual-purpose					
ND13217C-1	ND028799C-3	ND7192-1	Medium	Medium to high	Processing					
ND13221C-3	ND028799C-3	ND092003C-1	Medium	Medium to high	Processing					
ND14252B-4	ND028888cB-1	ND860-2	Medium	Medium to high	Processing					
ND14261B-2Russ	ND028984B-1	ND049546b-10Russ	Medium	Medium to high	Dual-purpose					
ND14265AB-3Russ	ND039194AB-1RussY	Dakota Trailblazer	Medium	Medium	Dual-purpose					
ND14266AB-1Russ	ND039194AB-1RussY	Russet Norkotah	Medium	Medium	Dual-purpose					
ND14286BC-2Russ	ND050219B-82Russ	Q115-6	Medium	Medium to high	Dual-purpose					
ND14286BC-11Russ	ND050219B-82Russ	Q115-6	Medium	Medium to high	Dual-purpose					
ND14318CAB-4	ND102643CAB-2	Waneta	Medium	Medium to high	Processing					
Alturas	A77182-1	A75188-3	Late	High	Processing	Verticillium wilt resistance, low input				
Bannock Russet	A75175-1	A75188-3	Late	High	Dual-purpose	Resistant to early dying				
CalWhite	Pioneer	BC8370-4	Early	High	Fresh					
Dakota Russet	Marcy	AH66-4	Medium to late	Medium to high	Dual-purpose	Sugar end resistance				
Ivory Russet			Early	Medium to high	Dual-purpose	Proprietary				
Ranger Russet	Butte	A6595-3	Medium to late	Medium to high	Dual-purpose	Resistant to internal & external defects				
Russet Burbank	Sport of Burbank		Late	Medium to high	Dual-purpose	Industry standard (two seed sources)				
Russet Norkotah	ND9526-4Russ	ND9787-5Russ	Early	High	Tablestock	Industry standard (fresh)				
Shepody	Bake-King	F58050	Medium	Medium to high	Processing	Industry standard				
Umatilla Russet	Butte	A77268-4	Late	High	Dual-purpose	Resistant to early dying, sugar ends				

Planting Date: May 27, 2020

Within-Row Spacing: 12 inches

Hills/Plot: 20

Row Spacing: 36 inches

Seed Piece Treatment: NuBark MZ

Agronomic Practices: Preplant, hilling, and herbicide applied by Hoversons. In-season fungicide applications by NDSU Plant Pathology.

Thanks to: Carl, Michael, and Casey Hoverson and all at Hoverson Farms, Northern Plains Potato Growers Association, MN Area II Potato Research & Promotion Council, Simplot, Cavendish Farms, and RD Offutt Company, Nilsons, and the Forest River Colony for seed potatoes.