Potato Breeding and Cultivar Development for the Northern Plains
North Dakota State University
2011 Summary

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Potato is the most important vegetable and horticultural crop grown in North Dakota. Potatoes were planted on about 84,000 acres (33,994 ha) in 2011 (NASS 2011); total acreage harvested was approximately 77,000 (31,161 ha). The average yield was reported 235 cwt./acre (138.8 t per ha). Production was reduced by approximately 16% from 2010. Lost production was primarily due to wet conditions at planting and in June. In 2011, 49% of acres eligible for certification by the North Dakota State Seed Department were planted to cultivars developed by the NDSU potato breeding program. The NDSU potato breeding program conducted research trials and seed maintenance/increase at eleven locations in ND and MN in 2011. In 2012, ND8229-3, a dual-purpose russet selection, may be considered for release; it offers producers sugar end and Verticillium wilt resistance, in addition to outstanding French fry/frozen processing and tablestock properties. ND4659-5R, ND5002-3R and ND8555-8R are beautiful red-skinned selections for the tablestock market should also be considered for release. Large scale evaluation of three advancing chip processing selections, ND7519-1, ND8304-2, and ND8305-1, are planned for 2012.

NDSU potato cultivar releases have traditionally been widely adapted and adopted, significantly impacting production in North Dakota and Minnesota, the Northern Plains, but also throughout North America. As a leader in potato breeding, selection, and cultivar development, the aim of the NDSU potato breeding program is to identify and release superior, multi-purpose cultivars that are high yielding, possess multiple resistances to diseases, insect and other pests and stresses, have excellent processing and/or culinary quality, and that are adapted to production in North Dakota, Minnesota, and the Northern Plains. The potato improvement team emphasizes disease, insect pest and stress resistance, including late blight, cold-sweetening, Colorado potato beetle, Verticillium wilt, pink rot and Pythium leak, silver scurf, sugar end, Fusarium dry rot, and aphid resistance breeding. In order to develop durable long-term resistance to these pests and stresses, breeding efforts include germplasm enhancement, incorporating resistance and improved quality attributes through the use of wild species, wild species hybrids, and the use of released cultivars and advanced germplasm from breeding programs around the globe. Our breeding, evaluation, and screening efforts are successful because of the cooperative and interdisciplinary efforts amongst the NDSU potato improvement team, the North Dakota State Seed Department (NDSSD) and Minnesota Department of Agriculture, and with potato producers, research and industry personnel in ND, MN, the Northern Plains, and across North America.
In order to address the needs of potato producers and the potato industry, we have established the following research objectives:

1) Develop potato (*Solanum tuberosum* Group Tuberosum L.) cultivars for North Dakota and Minnesota, the Northern Plains, and beyond, using traditional hybridization that are genetically superior for yield, market-limiting traits, and processing quality.

2) Identify and introgress into adapted potato germplasm, genetic resistance to major disease, insect, and nematode pests causing economic losses in potato production in North Dakota, Minnesota, and the Northern Plains.

3) Identify and develop enhanced germplasm with resistance to environmental stresses and improved quality characteristics for adoption by consumers and the potato industry.

The NDSU potato improvement team conducts breeding, selection, and cultivar development efforts, focusing on traits important to our industry, including high yield, durable disease and insect pest resistance, and improved quality attributes, such as cold processing ability (both chip and frozen products), and sugar end resistance. Germplasm enhancement and dedicated crossing blocks are used in hybridizing efforts to develop resistance to pests and stresses, and in improving quality attributes. In 2011, 544 families were created using 154 parental genotypes. Of these families, 321 (59%) included late blight resistance breeding, 256 (47%) Colorado potato beetle (CPB) resistance breeding, and 199 (37%) chip processing and 99 (18%) frozen processing with cold sweetening resistance breeding. Two hundred forty families from botanical seed (TPS) were grown in the summer greenhouse crop. Of these families, 174 (73%) included late blight resistance breeding, 55 (23%) CPB resistance breeding, 57 (24%) aphid resistance breeding, 5 (2%) *Verticillium* wilt resistance breeding. Harvest of the summer crop is finished, and nearly complete for the fall crop; with the summer and fall crops combined more than 102,000 individual seedlings were planted in the greenhouse. The new greenhouse facility is allowing a crop in just over two months, with larger seedling tubers produced and more set per individual genotype.

In 2011, in the field at Langdon, ND, 84,680 seedlings, representing 518 families, were evaluated; 804 selections were retained, accounting for just under one percent. Unselected seedling tubers from cooperating programs in Idaho, Texas and Maine were grown at Larimore, ND. Unselected seedling tubers, totaling 45,702 tubers, were shared with the breeding programs in ID (21, 243), ME (7,826), CO (10,023), and TX (20,558). In 2011, 851 second, 167 third year, and 381 fourth year and older selections, were produced in maintenance and increase lots at Absaraka, ND, and Baker, MN.

Yield and evaluation trials were grown at nine locations in North Dakota and Minnesota, seven irrigated (Larimore, Oakes, Inkster, Williston, Perham (2) and Sebeka) and three non-irrigated locations (Hoople, Crystal and Valley City). Thirty-two entries were grown in the chip trial at Hoople, including 22 advancing selections from the NDSU program, four lines from Frito-Lay, and six standard chipping cultivars. In the preliminary chip trial 92 entries were grown; chip and quality evaluations will be used to more efficiently determine what to maintain and promote, and what genotypes to drop. A new trial in 2010 was the National Chip Breeders Trial (NCBT) with the goals to rapidly identify and develop clones to replace Atlantic for southern production areas,
and Snowden from storage, initiated by the USPB and regional chip processors. In 2011, 167 entries were included in the unreplicated NCBT and 36 in the replicated trial. At Crystal, 38 entries were grown in the fresh market trial, including 29 advancing selections and nine named cultivars. In the preliminary fresh market trial 30 entries were evaluated, including 25 advanced selections and five industry standards. The Crystal site was badly compromised by the wet June, thus making it difficult to accurately assess yield and quality attributes. Twenty selections and commercially acceptable cultivars were grown in the Oakes processing trial, 20 in the Larimore processing trial, and 22 in the Williston processing trial. Several selections early in the evaluation process demonstrate good yield and frozen processing potential. The preliminary processing trial at Larimor had 80 entries, including six check genotypes. Similar to the preliminary chip processing trial, this trial will be used to more efficiently determine selections to proceed with and those to drop from further consideration based upon frozen processing quality attributes. A new trial in 2011 is the NFPT. Similar to the NCBT, this is an industry driven trial directed by the USPB and processing companies, with evaluations in WA, ID, ND and also WI. There were 81 clones evaluated at all four locations, and sugar, asparagine and acrylamide levels are analyzed following various storage regimen. One hundred fifty-four clones selected from out-of-state seedlings in 2010 and prior were grown in maintenance plots; about a dozen processing and specialty genotypes were retained, including the exceptionally high yielding selection with processing potential and widely publicized AFND4405-1Russ. Additionally at Larimore, the NDSU potato breeding program cooperated with Simplot Plant Sciences in conducting three trials evaluating improved lines of Ranger Russet, Russet Burbank and Atlantic. Trials at Inkster ranged from the chip processing yield trial with 30 entries (including six industry standards and four FritoLay clones), evaluation of genotypes for resistance to Verticillium wilt in collaboration with Dr. Neil Gudmestad and Julie Pasche (21 clones across market types, rather than frozen processing focus), and cultural management trials including work with a foliarly applied nutritional product, and the acrylamide trial (a sister trial to Dr. Carl Rosén’s in Minnesota, but supported by a North Dakota Specialty Crop Block Grant). A processing trial was grown at Perham, a collaboration with RDO/Lamb-Weston. A second trial at Perham evaluated a nutritional supplement applied as a seed piece treatment and foliarly; this was a collaboration with Tobkins. Two additional new trials in 2011 were organic trials at Sebeka and Valley City, with 24 and 22 entries, respectively. The focus was specialty types, and also included genotypes with late blight and/or Colorado potato beetle resistance. Four entries from NDSU were evaluated in the North Central Regional Potato Variety Trial (NCRPVT), including ND8555-8R and AND00272-1R, bright red skinned selections suitable for the fresh market, and ND8068-5Russ and ND8229-3, both dual-purpose russets. NCRPVT locations are Crystal (fresh market), Hoople (chip processing), Larimore (frozen processing), and Inkster (fresh market, chip and frozen processing). Our efforts continue to identify processing (both chip and frozen) germplasm that will reliably and consistently process from long term cold storage. As we grade, chip processing selections are sampled, ‘field chipped’, stored at 42F and 38F (5.5C and 3.3C) for eight weeks, while a fourth set is evaluated the following June from 42F storage. Frozen processing selections are evaluated after grading and from 45F (7.2C) storage for eight weeks and again the following June. All trial entries are evaluated for blackspot and shatter bruise potential.

In 2011, Dr. Gary Secor’s program evaluated seedling families using a detached leaf assay in the greenhouse. Resistant selections are retained for field evaluations in 2012. Collaborative field
trials for late blight foliar and tuber evaluations with Dr. Secor were lost due to wet planting conditions at Prosper. Similarly, the bacterial ring rot trial with Dr. Neil Gudmestad’s program at Prosper was also lost. Two Colorado potato beetle resistance screening trials at Glyndon conducted in collaboration with Dr. Deirdre Prischmann-Voldseth also succumbed to seed piece decay after planting due to saturated soils. Sucrose rating, invertase/ugpase analysis, and serial chipping of chip and frozen processing selections is conducted by Marty Glynn (USDA-ARS) at the USDA-ARS Potato Worksite in East Grand Forks, MN. We also submitted entries in many cooperative trials with various producers, industry, and research groups across North America. As in 2011, trial results will be reported in articles in the Valley Potato Grower magazine.

The most promising advancing red fresh market selections include ND4659-5R, ND8555-8R, AND00272-1R, ND6002-1R and ND7132-1R. Dual-purpose russet selections, ND8229-3, ND8068-5Russ and several hybrids between Dakota Trialblazer and ND8229-3 possess excellent appearance, yield, and processing qualities. ND7519-1, ND8304-2, and ND8305-1, advancing chip processing selections, possess excellent appearance and cold sweetening resistance. These selections are summarized in the graphics below.

Goals for 2012 include developing improved germplasm with the goal of potato cultivar releases for ND, MN, the Northern Plains and beyond, using traditional hybridization, and utilizing early generation selection techniques such as marker assisted selection and greenhouse screening procedures when possible in order to more rapidly identify genetically superior genotypes. Our efforts will focus on the needs of our producer and potato industry stakeholders, including incorporation of resistance to major insect, disease and nematode pests, and to environmental stresses, with an emphasis on improved quality attributes. Working with the NDSSD and MN Department of Agriculture, we will strive to improve our seed increase efforts in order to produce high quality certified seed. We are grateful for the opportunity to conduct cooperative and interdisciplinary research with members of the NDSU potato improvement team, the USDA-ARS programs in Fargo and East Grand Forks, and the North Central and other potato research programs across the globe. Our heartfelt thanks to our grower, industry, and research cooperators in North Dakota, Minnesota, and beyond. We are grateful for the support and cooperation in providing resources of land, certified seed, research funds, and equipment.
ND8229-3

- Marcy x AH66-4
- Medium maturity
- Medium vine size
- High yield potential
- Good storability and excellent fry color from 45F storage. Suitable for the fresh market too.
- High specific gravity
- Resistance to sugar ends and Verticillium wilt
- Tolerant of metribuzin applications

ND8068-5Russ

- ND2667-9Russ x ND4233-1Russ
- Medium vine size
- Very early vine maturity
- Medium to high yield potential
- Dual-purpose
- High specific gravity
- Good storability with low sugar accumulation and excellent frozen processing quality after 7 months storage
**ND4659-5R**

- NorDonna x ND2842-3R
- Suited for the fresh market
- Medium vine with red-purple flowers
- Medium maturity
- Medium yield potential
- Bright red, round, smooth tubers with white flesh and shallow eyes
- Medium specific gravity
- No outstanding disease or pest susceptibilities
- Stores well

**ND8555-8R**

- ND7188-4R x ND5256-7R
- Suited for the fresh market
- Medium maturity
- Medium-large vine size
- High yield potential
- Bright red, round, smooth tubers with white flesh and shallow eyes
- Very uniform tuber size profile
- Medium specific gravity
- Stores well
AND00272-1R

- MN17922 x A92653-6R
- Suited for the fresh market
- Medium vine with red-purple flowers
- Medium-late maturity
- Medium yield potential
- Bright red, round to oval, tubers with white flesh, shallow eyes and smooth tuber type
- Low to medium specific gravity
- No outstanding disease or pest susceptibilities
- Stores well

ND6002-1R

- NorDonna x Bison
- Medium sized vine
- Medium-late vine maturity
- Medium yield potential
- Round, smooth, bright red tubers with smooth eyes and bright white flesh
- Low to medium specific gravity
- Early in evaluation process
**ND7132-1R**

- ND5002-3R x ND5438-1R
- Medium maturity
- Medium yield potential
- Bright red skinned, oval to oblong tubers with white flesh
- Early in evaluation process

**ND7519-1**

- ND3828-15 x W1353
- Medium sized vine
- Medium-late maturity
- High yield potential
- High specific gravity (+1.090 average in ND)
- Chips from 42F storage
ND8304-2

- ND860-2 x ND7083-1
- Medium early maturity
- Small to medium sized vine
- Medium yield potential
  - Nice tuber type, smaller size profile
- High specific gravity
- Chips from 42F storage
  - Excellent cold chipping selection

ND8305-1

- ND2471-8 x White Pearl
- Medium maturity
- Medium sized vine
- Medium yield potential
  - Nice tuber type, smaller size profile
- High specific gravity
- Chips from 42F storage
  - Excellent cold chipping selection
ND7799c-1

- Dakota Pearl x Dakota Diamond
- Medium vine size
- Medium-late maturity
- High yield potential
  - Nice tuber type and tuber size profile
- Medium to high specific gravity (1.086 average)
- Chips from 42F storage

ATND98459-1RY

- ATD252-5R x T4845
- Medium to large vine size
- Medium maturity
- High yield potential
- Round, smooth, red tubers with shallow eyes and yellow flesh
- Medium to high specific gravity
**ND7834-2P**

- NorDonna x ND5554-1R
- Medium vine size
- Medium maturity
- Medium to high yield potential
- Oval and blocky tubers, smooth, dark purple (blue) color, with very shallow eyes and marbled flesh
- Medium to high specific gravity

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**ND7818-1Y**

- Morene x Marcy
- Medium vine size
- Medium maturity
- Medium to high yield potential
- Oval, smooth, yellow skinned tubers with yellow flesh
- Medium to high specific gravity
- Excellent cold chipping selection
- ‘European’ type
ATND99331-2 PintoY

- Inca Gold x COA94019-5R
- Large and vigorous vine
- Medium maturity
- High yield potential
- Specific gravity is low (avg. 1.070 across ND locations)
- Suited for the specialty tablestock market with bright yellow flesh. Excellent steamed, boiled, mashed, in soups, stews and potato salad. Makes light yellow colored lefse.