

Development of Chip Processing Potato Cultivars with Long-Term Storage Capabilities and Cold Sweetening Resistance Hoople - 2015

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A primary objective of the North Dakota State University (NDSU) potato breeding program is the breeding, selection, evaluation, development, and release of chipping potato cultivars possessing cold-sweetening resistance, improved chip processing quality, with high yield potential and multiple resistance to important diseases, insect pests, and environmental stresses. Our efforts provide opportunities to enhance economic and environmental sustainability for potato producers and the chip industry, and the potential for superior quality products for consumers.

This report summarizes the NDSU Chip Processing Trial, hosted by Lloyd, Steve and Jamie Oberg, north of Hoople, ND, in 2015. The replicated (4) trial was planted on May 21 using an assist-feed planter. Cultivar specific management practices typical of chip processing production fields in the northern Red River Valley were used; the Hoople trial is non-irrigated (an irrigated chip trial was grown at Hoverson Farms in 2015). Vines were flailed on September 11 and the trial was harvested on October 13 with a single-row Grimme harvester. Days to flailing were 113, while days to harvest were 145. Agronomic characteristics, yield and grade, and chip processing quality traits are summarized in Tables 1-3. Long-term storage evaluation of this material will be processed in mid to late June. Our most advanced chipping genotypes are pictured and described at the end of the article. We hope this summary will serve as a reference for potato producers, research and extension personnel, industry representatives, and consumers.

Fourteen advancing selections were compared to nine commercially acceptable chip processing cultivars. The selections represent a diverse set of germplasm with several wild *Solanum* species including *S. phureja*, *chacoense*, *etubersum*, *berthaultii*, represented in the pedigree of many. In addition to attributes such as cold sweetening resistance, high specific gravity, Colorado potato beetle and insect resistance, resistance to viruses, late blight and water rots, this diverse material may result in selections with a decrease in the tuber size profile, often tuber set is increased, and some tubers may be flat, have deeper eyes or ends (both stolon and apical), and generally be a bit rougher or lower yielding. Percentage stand ranged from 91 to 99; ND7818-1Y and Snowden both average 91% (Table 1). Vine sized ranged from small (2.0 for ND113060-1) to large (4.5-4.8 for Snowden, ND102822CAB-1ND113307C-3, Lamoka, Pike and Dakota Diamond to name a few). The mean vine maturity was 2.3 (a reflection of the breeding programs effort to identify high yielding early maturing genotypes suited for our short growing seasons). The range was 1.0 (very early) for ND7818-1Y to 3.5 for Dakota Diamond. Stems per plant ranged from 1.4 to 2.5

with a mean of 2.0. Tuber numbers per plant averaged 8.0, with a range of 6.1 for ND102858CB-2 to 11.8 for ND8305-1.

Yield and grade for all entries is summarized in Table 2. Mean yield was 275 cwt./acre, with a range of 203 cwt./acre for ND113289C-1 to 345 cwt./acre for NDJL21C-1. The mean percentage A-sized tubers (4-10 ounce) was 54, with a range of 17 for ND113060-1 to 70 for Dakota Diamond. Percentage undersized tubers (0-4 ounces) ranged from 16 for NDJL21C-1 to 83 for ND113060-1, with a mean of 36. NDJL21C-1, Dakota Crisp, Dakota Diamond, Dakota Pearl and Snowden exceeded 15% oversized (>10 oz.) tubers. There were few US No. 2s or culls; tubers were culled or dropped in grade primarily due to growth cracks, misshapen tubers, or greening. At grading, little scab (common) was noted; ND8304-2, ND092018C-3 and Ivory Crisp had a trace. Tuber shaped ranged from 1.6 to 2.3 (data not shown), where 1 is round, 3 is oblong, and 5 indicates long tuber shape. Most selections had round tuber shape (1-1.5), however NDJL21C-1 rated a 3.8 so may be more suited for enhancing French fry processing genotypes due to the more elongate shape. Skin color (data not presented) ranged from white to flaky (slight netting) for Atlantic, Snowden and ND102822CAB-1; ND7818-1Y is yellow. Flesh colors when cut for internal disorders were white, creamy and ND7818-1Y has medium yellow flesh. Mean hollow heart/brown center was 0%, thus not reported.

Mean specific gravity, an important attribute and indirect measure of tuber dry matter, was 1.0971, with a range of 1.0881 for ND102822CAB-1 to 1.1076 for ND8305-1 (Table 3). Specific gravity in the Northern Plains tends to be quite high across market types. Our focus continues to be identification of chip processing germplasm that will reliably and consistently process from long-term cold storage. As we grade, chip processing selections are sampled, and stored at 42F and 38F (5.5C and 3.3C) for eight weeks (Table 3); a second set is evaluated the following June (materials from this trial will be chipped during the third week of June). In response to industry needs and consumer demands, potato producers and industry personnel are seeking potato cultivars which process (chip, French fry and other frozen products) reliably from long-term storage. Current commercially acceptable cultivars tend to perform well through February or March (for most northern production areas), but quality (chip fry color and defects) generally declines thereafter. The chip industry would like to have the option of storing potatoes for nearly 12 months and then have them fry light and with few defects. Several factors affect storability, including sugar accumulation in storage, dry matter, bruise susceptibility, pathogen susceptibility, and respiration. Chip scores from the field varied from 1 to 9 using the USDA chip color chart (HunterLab instrument values of 43.4 to 66.9). All clones rated as unacceptable from 38F storage, although ND8331Cb-2 did rate a 7 on the color chart. ND8331Cb-1 has had mixed reviews in the past eight years of evaluation; while chip color is always excellent, yield, grade and tuber shape have been inconsistent and it has pronounced PVY susceptibility, thus it was determined last fall to maintain it for parental germplasm, but it will no longer be considered for cultivar release. Following eight weeks storage at 42F (5.5C), chip color chart ratings ranged from 2 for ND7519-1, ND7799c-1 and ND113289C-1, to a 10 for NDJL23C-1. HunterLab instrument scores were an average of 53.9; ND7799c-1, ND113289C-1, Dakota Pearl, ND7519-1, ND8305-1, ND8331Cb-2 and Lamoka had the brightest chip colors, exceeding a reading of 60. All trial entries are evaluated for blackspot and shatter bruise potential (Table 1). Blackspot bruise is evaluated using the method of Pavék and Corsini where tubers from 45F storage are peeled using an abrasive peeler and held overnight at room temperature; discoloration resulting from a mixing of cell components (polyphenol oxidase and tyrosine) due to cell damage elicited by the peeling is rated on the stem end, providing an assessment of bruise potential. For the 23

genotypes reported here, the range was 1.5 (little) to 4.8 (severe), with a mean of 3.0. Shatter bruise potential is evaluated for tubers from 45F storage using a bruising chamber made with digger chain baffles. The range was 1.6 (ND8331Cb-1) to 3.4 (Ivory Crisp) and a range of 2.4, indicating low to manageable potential for all. Finally, a general rating score of 1 (poor) to 5 (perfect) is given based on assessment of all traits. The mean general rating was 3.5, with a range of 2.6 to 4.0. Many commercially acceptable cultivars including Dakota Pearl, Dakota Crisp, Ivory Crisp and Lamoka rated as a 4.0; similarly, ND7799c-1 and ND7519-1 our two most promising chip processing selections rated at 4.0 and 3.9, respectively. Figures 1 and 2 summarizing these selections are provided at the end of the article. Release consideration is planned prior to the Northern Plains Potato Growers Association Research and Reporting Conference in February. Many of you will remember that we have reported the parentage of ND7799c-1 in previous years as Dakota Pearl by Dakota Diamond. Our collaborative research with Dr. Jeff Endelman at the University of Wisconsin, using genome wide association studies, found that the male parent of this clone is really NY115. Apparently at time of selection in our seedling nursery at Langdon a break between families was missed (very easy to do and now thankfully we have a tool for verification) and the clone was believed to have been of this parentage. This information was reported at the NPPGA Research Reporting Conference and International Crops Expo in February 2015, along with many other venues. None-the-less, ND7799c-1 is an exceptional clone that warrants release consideration.

The potato breeding program, as part of the potato improvement team, collaborates closely with projects in Plant Sciences, Plant Pathology, and Entomology at NDSU and the University of Minnesota (Crookston and St. Paul). This team effort permits evaluation and screening for resistance to diseases, insect pests, and environmental stresses, in addition to development of cultivar specific management information. We also cooperate closely with the USDA-ARS programs at East Grand Forks, MN and Fargo, ND, in addition to potato research programs in Idaho, Texas, Colorado, Maine, Florida, New Jersey and New York, and particularly with members of the North Central regional group including Michigan State University, and the Universities of Minnesota and Wisconsin.

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Table 1. Agronomic and bruise evaluations for advanced chip processing selections and cultivars, Hoople, 2015.

Clone	Stand %	Vine Size ¹	Vine Maturity ²	Stems per Plant	Tuber No. per Plant	Shatter Bruise ³	Black-spot Bruise ⁴	General Rating ⁵
1. ND7519-1	99	4.3	2.1	2.1	6.9	2.3	2.8	3.9
2. ND7818-1Y	91	3.5	1.0	2.3	10.5	2.5	3.2	3.3
3. ND7799c-1	98	3.0	2.5	1.6	6.6	2.5	1.5	4.0
4. ND8304-2	95	2.5	1.3	2.2	6.5	2.0	3.9	3.1
5. ND8305-1	95	4.0	3.3	2.2	11.8	2.6	2.3	3.0
6. ND8331Cb-2	95	3.8	2.0	1.9	7.9	1.6	2.5	2.6
7. ND092018C-3	95	4.5	2.1	1.4	7.0	2.7	4.7	3.0
8. ND102822CAB-1	94	4.8	2.5	2.2	11.5	1.8	4.2	3.4
9. ND102858CB-2	98	2.8	2.0	2.2	6.1	2.4	2.6	3.5
10. ND113060-1	96	2.0	1.6	2.4	11.0	2.2	4.4	3.4
11. ND113289C-1	93	2.3	1.5	1.7	7.3	2.5	3.3	3.4
12. ND113307C-3	99	4.8	2.0	2.0	8.9	3.0	2.7	3.8
13. NDJL21C-1	99	3.9	2.3	1.5	6.7	2.3	3.1	3.4
14. NDJL23C-1	99	3.0	1.6	1.8	7.9	2.3	4.8	3.1
15. Atlantic	96	4.0	2.8	2.2	7.6	1.7	2.4	3.5
16. Dakota Crisp	98	4.3	3.3	1.9	7.2	2.3	2.7	4.0
17. Dakota Diamond	99	4.5	3.5	1.9	7.6	2.5	2.6	4.0
18. Dakota Pearl	98	3.5	2.3	2.0	6.7	2.4	1.7	4.0
19. Ivory Crisp	95	4.0	2.8	2.5	7.5	3.4	1.7	4.0
20. Lamoka	96	4.5	2.5	2.2	6.4	2.8	3.5	4.0
21. NorValley	96	4.5	2.8	1.8	9.8	3.0	3.4	3.4
22. Pike	99	4.5	2.3	2.0	7.5	2.4	2.4	3.6
23. Snowden	91	4.8	2.9	2.3	7.3	2.2	3.6	3.3
Mean	96	3.8	2.3	2.0	8.0	2.4	3.0	3.5
LSD ($\alpha=0.05$)	6	0.8	0.7	0.5	1.3	0.5	0.7	0.4

¹ Vine size – scale 1-5, 1 = small, 5 = large.

² Vine maturity – scale 1-5, 1 = early, 5 = late.

³ Shatter bruise – scale 1-5, 1= none; 5 = severe.

⁴ Blackspot bruise determined by the abrasive peel method, scale 1-5, 1=none, 5=severe.

⁵ General rating based on scale of 1 to 5; 1 = poor, 5 = excellent (perfect).

Table 2. Yield and grade for advanced chip processing selections and cultivars, Hoople, 2015.

Clone	Total Yield cwt./a	Yield A Size cwt/a	A Size %	0-4 oz. %	4-6 oz. %	6-10 oz. %	>10 oz. %	US 2s %	Culls %
1. ND7519-1	268	162	60	29	42	18	6	0	5
2. ND7818-1Y	262	119	46	52	36	9	1	2	0
3. ND7799c-1	256	170	66	28	46	20	6	0	0
4. ND8304-2	236	144	61	31	47	14	6	2	0
5. ND8305-1	269	78	28	69	25	3	0	2	0
6. ND8331Cb-2	208	98	47	51	37	10	1	1	1
7. ND092018C-3	210	104	50	47	43	8	1	2	0
8. ND102822CAB-1	321	159	49	42	36	13	5	1	3
9. ND102858CB-2	246	158	64	28	49	15	7	0	1
10. ND113060-1	216	37	17	83	15	2	0	0	0
11. ND113289C-1	203	94	45	53	37	8	1	0	0
12. ND113307C-3	296	185	62	36	49	13	2	0	0
13. NDJL21C-1	345	192	55	16	36	19	20	0	9
14. NDJL23C-1	305	189	62	27	43	19	6	4	1
15. Atlantic	328	224	68	25	49	19	6	0	2
16. Dakota Crisp	341	204	60	18	42	18	21	0	2
17. Dakota Diamond	329	229	70	20	51	19	9	1	0
18. Dakota Pearl	307	197	64	20	46	19	15	1	0
19. Ivory Crisp	271	131	48	35	36	13	14	1	3
20. Lamoka	265	166	63	25	44	19	12	0	1
21. NorValley	308	142	46	42	35	11	9	1	2
22. Pike	255	152	59	38	45	14	3	0	0
23. Snowden	286	166	58	26	42	16	15	1	1
Mean	275	152	54	36	40	14	7	1	1
LSD ($\alpha=0.05$)	41	39	10	10	7	4	7	2	2

Table 3. Specific gravity, chip color (chip chart and HunterLab value) prior to storage and following 8 weeks at 38F (3.3C) and 42F (5.5C) storage, Hoople, 2015.

Clone	Specific Gravity ¹	Field Chip		3.3C Storage		5.5C Storage	
		Chart ²	Hunter ³	Chart	Hunter	Chart	Hunter
1. ND7519-1	1.1053	1	65.6	9	45.0	2	62.5
2. ND7818-1Y	1.0879	4	64.5	10	33.9	7	55.9
3. ND7799c-1	1.0885	3	65.1	8	46.2	2	64.4
4. ND8304-2	1.0906	1	66.6	8	43.3	7	52.6
5. ND8305-1	1.1076	2	64.4	9	48.7	2	62.5
6. ND8331Cb-2	1.0999	3	64.5	7	42.2	4	62.0
7. ND092018C-3	1.1039	8	50.1	10	29.9	9	40.9
8. ND102822CAB-1	1.0985	6	57.1	10	28.8	8	45.4
9. ND102858CB-2	1.0881	5	61.3	10	26.9	9	42.9
10. ND113060-1	1.1002	2	66.9	9	39.3	5	58.9
11. ND113289C-1	1.1078	2	65.7	8	45.7	2	63.1
12. ND113307C-3	1.0981	2	66.5	9	35.6	6	54.9
13. NDJL21C-1	1.0923	8	50.9	10	26.5	9	41.4
14. NDJL23C-1	1.0928	9	43.4	10	22.5	10	36.0
15. Atlantic	1.1003	5	61.7	10	36.0	8	51.3
16. Dakota Crisp	1.0918	3	64.9	9	41.0	7	54.6
17. Dakota Diamond	1.0962	4	62.1	10	36.2	8	49.2
18. Dakota Pearl	1.0985	3	63.9	8	44.4	4	63.1
19. Ivory Crisp	1.1035	4	64.2	10	35.3	7	54.4
20. Lamoka	1.0934	2	65.4	9	38.5	6	60.3
21. NorValley	1.0889	3	65.2	10	37.1	5	58.2
22. Pike	1.0989	4	63.9	10	29.9	7	50.4
23. Snowden	1.1007	4	63.6	10	33.0	7	54.0
Mean	1.0971	4	62.0	9	36.8	6	53.9
LSD ($\alpha = 0.05$)	0.0078	2	3.4	1	4.2	2	5.0

¹ Specific gravity determined by weight-in-air, weight-in-water method.

² Potato Chip Color Reference Standard, Courtesy of B.L. Thomas, B.L. Thomas and Associates, Cincinnati, Ohio, Potato Chip Institute International. 1 = white, 10 = very dark; 4 and below acceptable.

³ HunterLab value – 60 minimum, 70 preferred.

Figures 1 and 2. The most advanced chip processing selections with release potential.

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



ND7799c-1

- Dakota Pearl x NY115
- 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

