

**Progress Report to the Maine Potato Board Research Subcommittee  
January 31, 2018**

**Project Title:**

Breeding New Varieties to Provide Marketing Opportunities and Improved Pest Resistance (2017 Growing Season)

**Investigators:**

Gregory A. Porter, Paul Ocaya, and Tammy Mills; School of Food & Agriculture, University of Maine, Orono.

**Executive Summary:**

The University of Maine Potato Breeding Program uses traditional plant breeding to create, select, and develop new potato varieties for Maine and beyond. The objective is to develop and select new potato varieties which will provide marketing opportunities to the Maine Potato Industry and/or solve disease management problems. During 2017, our research effort by market category was: 50% russets and long-whites for processing and/or fresh market; 40% whites/yellows for chipping and/or fresh market; and 10% reds and specialty varieties. The Maine breeding program is the only eastern U.S. program with an emphasis on russets and long-whites with processing and fresh market potential. This report provides a summary of the 2017 activities.

Caribou Russet (AF3362-1) was named and released during 2015. It has shown commercial promise as a dual-purpose russet with outstanding yields, bruise resistance, relatively low hollow heart incidence, moderate scab resistance, and reasonably good appearance for fresh market. Adoption of Caribou Russet continued at a brisk pace during 2017. Sebec (AF0338-17) and Easton (AF3001-6) were named and released during 2014. Sebec is primarily an alternative to Atlantic for chipping out of the field in the mid-Atlantic and S.E. states. Easton, a long-tuber-type clone with netted to lightly russet skin, has outstanding fry color and yields, good tuber type, relatively little hollow heart, and very good verticillium wilt resistance. Sebec has many positives and still has commercial potential, but it has struggled to gain a foothold in the Eastern market. Easton struggled with seed quality and bruise susceptibility issues during its initial commercialization and has not been adopted by the industry.

We have many more promising clones in the development pipeline. Examples include: AF4124-7, AF4296-3, AF4872-2, AF5071-2, AF5091-8, AF5164-19, AF5179-4, AF5406-7, AAF07521-1, and WAF10073-3Rus (russets for fry processing; several of these have dual-purpose potential); AF5312-1 and AF5468-5 (promising fresh market russets); AF4157-6 (an early-maturing chipping clone); AF4648-2 (a mid-season chipper and fresh market clone with scab, PVY, and golden nematode resistance); AF5040-8 (a mid-season chipper with high yields and specific gravity); AF5429-3 (a mid-season chipper with high yields and specific gravity, as well as verticillium wilt, blackspot, and golden nematode resistance); AF4138-8, AF5280-5, AF5450-7, and NDAF102629C-4 (fresh market whites with scab resistance); AF4831-2 (a pretty red with oblong tubers, good quality, and moderate scab resistance); AF4659-12 (a yellow-fleshed “pinto-type”, fingerling/roaster, specialty variety with an interesting red and

yellow skin pattern and excellent cooking quality) and AF5245-1 (a medium-early, purple-skinned, white-fleshed clone with scab resistance). We have several other reds and specialty types (e.g. purple or pink blush, purple skin, yellow-fleshed, and/or purple- and red-fleshed clones) in the development pipeline.

Priorities in the area of disease resistance are: late blight, scab, and PVY. Because of increasing concerns about PVY in the U.S. potato industry, we have dramatically increased our crossing and selection program for PVY resistance since 2011. Although these diseases are our top priorities, our work on disease and pest resistance also included efforts to develop varieties with resistance to: PLRV, powdery scab, verticillium wilt, fusarium dry rot, pink rot, soft rot, nematodes, bruising, internal defects, insects, etc. Marker-assisted selection for potato virus Y (PVY) and golden nematode resistance is now an integral part of the breeding program. We are now developing marker-assisted selection procedures for late blight resistance. Advanced clones in our program typically have resistance to several important potato pests. As an example, AF4648-2, a promising dual-purpose chipping and fresh market white, combines excellent common scab and PVY resistance with moderate late blight, pink rot, and soft rot resistance. Progress in breeding for late blight and scab resistance has been dramatic. We currently have 64 late blight resistant clones moving through the selection process. This includes twenty-seven 3<sup>rd</sup>-year clones (27 of 176, 15.3%). Considering more advanced material, 37 of 78 (47.4%) 4<sup>th</sup>-year and older clones screened for late blight resistant clones showed moderate to good resistance. Fifty-eight of 142 selections (40.8%) had scab resistance in our 2017 screening trial. Thirty-three (19.6%) of 168 4<sup>th</sup> year and older clones tested showed evidence of PVY resistance when screened for the presence of DNA-based markers associated with PVY immunity associated with the Ry<sub>adg</sub> or Ry<sub>sto</sub> resistance genes. Twenty-nine (17.3%) of 168 4<sup>th</sup> year and older clones tested showed evidence of golden nematode resistance when screened for the presence of the DNA-based markers associated with resistance (H1 marker). Clones with late blight, scab, and/or PVY resistance are present at an increasing frequency in our program and several are advancing toward commercialization. These clones will be moved forward based on field performance and either be developed for commercial release or used as breeding material to produce future commercially valuable cultivars with field resistance to late blight, PVY, and/or scab.

### **Project Objectives:**

1. To breed, select, and develop new potato varieties for Maine which provide marketing opportunities and/or improved pest/disease resistance.

### **Grant Received:**

\$35,000

### **Accomplishments to Date:**

The University of Maine Potato Breeding Program uses traditional plant breeding to create, select, and develop new potato varieties for Maine and elsewhere. The objective of this research is to develop and select new potato varieties which will provide marketing opportunities to the Maine Potato Industry and/or solve disease management problems. Funding provided by the ME Potato Board and USDA-ARS has allowed us to incorporate marker-assisted selection for potato virus Y (PVY) resistance and golden nematode. We are now developing marker-

assisted selection procedures for late blight resistance. During 2017, our research effort by market category was as follows: 50% russets and long-whites for processing and/or fresh market; 40% whites/yellows for chipping and/or fresh market; and 10% reds and specialty varieties. The Maine breeding program is the only eastern U.S. program with an emphasis on russets and long-whites with processing and fresh market potential. Priorities in the area of disease resistance were: late blight, scab, and PVY. Because of increasing concerns about PVY in the U.S. potato industry, we have dramatically increased our crossing and selection program for PVY resistance since 2011. Although these diseases were our top priorities, our work on disease and pest resistance also included efforts to develop varieties with resistance to: PLRV, powdery scab, verticillium wilt, fusarium dry rot, pink rot, soft rot, nematodes, bruising, internal defects, insects, etc. This report provides a summary of the 2017 activities.

**Progress on Russets/Long Whites:** Caribou Russet (AF3362-1), a dual-purpose russet, was named and released during 2015. Plant Variety Protection (PVP) was obtained and it has been licensed by the Maine Potato Board. Adoption of Caribou Russet continued at a brisk pace during 2017. It has outstanding yields, bruise resistance, relatively low hollow heart incidence, moderate scab resistance and reasonably good appearance for fresh market. Baked quality has been good. It may also be a suitable alternative to Shepody for out-of-field and short-term storage fry processing. Management of PVY in seed stocks is expected to be challenging for this variety. It is susceptible to internal heat necrosis in southern areas. Easton (AF3001-6) was named and released during 2013/2014. PVP has been obtained and Easton has been licensed by the Maine Potato Board. Easton, a long-tuber-type clone with netted to lightly russet skin, has outstanding fry color and yields, good tuber type, relatively little hollow heart, and very good verticillium wilt resistance. It requires much less N fertilizer than Russet Burbank. Easton was a top performer in the National Fry Processing Trials (NFPT); however, potential weaknesses with rot, skinning, and bruise susceptibility have limited its commercial success.

AF5312-1 and AF5468-5 are promising fresh market russets. In addition, we currently have many other advanced russet/long-white clones in field and processing trials with McCain Foods and other processors. The most advanced and promising russets for fry processing are AF4124-7, AF4296-3, AF4872-2, AF5071-2, AF5091-8, AF5164-19, AF5179-4, AF5406-7, AAF07521-1, and WAF10073-3Rus. Several of these candidate varieties may also work as dual-purpose russets. Yield, tuber type, size profile, internal quality, bruise resistance, and fry processing characteristics are key selection criteria. Promising russet selections with processing potential have been entered into the industry-funded National Fry Processing Trials (NFPT) in ID, ME, MI, ND, OR, WA, and WI. Easton (AF3001-6) and AF4296-3 were among the top performers for yields, low acrylamide levels, and fry quality in the NFPT trials. Caribou Russet (AF3362-1) and AF4124-7 had good yield and quality in NFPT, but did not have exceptionally low acrylamide levels in fries compared to the standard varieties. Clones that were particularly good performers in NFPT during 2016 and 2017 were AF5071-2, AF5091-8, AF5179-4, AF5406-7, and AAF07521-1.

**Progress on Whites and Chippers:** Our program is an active participant in the National Chip Variety Trials (NCPT). The NCPT has 10 trial sites [CA, FL, MI, NC, ND, NY OR, TX, and WI(2)] representing major production areas of the U.S). The most promising clones from NCPT enter the Potatoes USA/Snack Food Association (SNAC) chipping trials in CA, FL, ID, ME, MI, MO, NC, ND, OR, PA, and WI, as well as the Potatoes USA NextGen/FastTrack chip evaluation program. Each year we submit ~15 promising chipping clones to NCPT for national

evaluation. AF5429-3 was the top performing clone in the 2017 NCPT trials. AF5040-8 is currently in the SNAC chipping trials and AF5429-3 will begin SNAC testing in 2018. AF5040-8 is in the FastTrack/NextGen chipping program, mostly as a possible high gravity alternative to Atlantic in the SE states. It has Atlantic's specific gravity, but has much better internal quality and chip color than Atlantic.

Sebec (AF0338-17) was named and released during 2013/2014. PVP has been obtained and Sebec was licensed by the Maine Potato Board. Sebec is primarily an alternative to Atlantic for chipping out of the field in the mid-Atlantic and S.E. states. It combines high yields, good out-of-field chip quality, verticillium resistance, and much less internal heat necrosis and hollow heart than Atlantic. Growers need to reduce fertility levels and harvest it slightly later than Atlantic to obtain adequate specific gravity for out-of-field chipping. Sebec can also be used for fresh market, though it greens quickly under fluorescent lights and is moderately susceptible to scab. Sebec has many positives and still has commercial potential, but it has struggled to gain a foothold in the Eastern market.

AF4648-2 combines excellent common scab and PVY resistance with good tuber appearance, yields, specific gravity, internal quality, bruise resistance, fresh market quality, and chip quality. It also has moderate late blight, pink rot, and soft rot resistance. It has potential for fresh market and as a chipper for conditions when common scab limits other varieties. Long-term chip color can be quite good as long as it is harvested before chilling conditions occur and then is stored at 50 to 55F. It does not chip well from cool storage and it is quite susceptible to powdery scab. AF4157-6 is a promising chipping clone that combines early maturity and good out-of-field chipping in the southern states with excellent storage chip color, including low sugars and the ability to chip from cool storage. It has relatively small tuber size, inconsistent yields, and is scab susceptible, but has moderate resistance to pink rot. AF5040-8 has been a top performer in the national chip trials (NCPT) due to its high yields, high specific gravity, and good internal quality. It has consistently out produced Atlantic and Snowden in Southern trials, while providing specific gravity equal to or exceeding Atlantic. I am currently thinking that its best market fit is for out-of-field chipping in the south. It has attractive tubers, high specific gravity, and very pale yellow flesh. It is moderately susceptible to common scab. AF5040-8 is currently in the Potatoes USA FAST-TRACK program due to its potential as a chipper for southern areas. AF5429-3 is another promising advanced chipping clone in the program. It has high specific gravity, excellent chip color, and resistance to golden nematode, verticillium wilt, and blackspot bruise. Seven new promising chipping clones are being promoted to our 2017 advanced chipping trials.

AF4648-2 (described above) is a promising candidate for both chipping and fresh market use. AF4138-8, AF5225-1, AF5280-5, AF5450-7, and NDAF102629C-4 are attractive fresh market whites with high yields and good quality for fresh market. Most of our fresh market candidates have good common scab resistance. These clones are advancing through the program and are being extensively trialed to determine which will merit entry into commercial trials and seed production. The top priority for fresh market selection is an early, scab-resistant white for fresh market use throughout the East as a better quality replacement for Superior. Of the group listed above, I currently favor AF4648-2 and AF5280-5 for their combinations of yield, quality, and disease resistance.

**Progress on Reds and Specialty Types.** Growers have expressed a strong interest in new red varieties that have smooth skin, attractive appearance when grown on our soils, and ability to hold their skin color in storage. Reds are a critical component of the seed potato market and new, well-adapted reds will provide opportunities for our seed growers, especially in VA, NC, FL, and other southern states. This is a new component of the program which was established based on grower input. In addition to our own crosses, red seedling tubers are brought in from WI, ND, CO, and ID and are selected for appearance and yield under northern ME conditions. After two years of selection in northern ME, seed is sent to FL, NC, and central ME trials for additional selection under diverse soil and environmental conditions. This process should result in the development of new, widely adapted, red-skinned varieties. Several are showing good potential though it has been difficult to find the ideal combination of skin quality, yields, bruise/skinning resistance, and PVY tolerance. AF4831-2 is currently our most advanced red. It has pretty skin, relatively small oval tubers, moderate scab resistance, verticillium resistance, and good internal quality. Seed stocks of AF4831-2 and several other promising reds are being expanded for larger-scale testing in 2018 and beyond.

We currently have six promising specialty clones that should be of interest to small-scale growers. AF4659-12, a yellow-fleshed “pinto-type” specialty variety with an interesting red and yellow skin pattern. It produces small, fingerling-type tubers that are excellent roasted, boiled, or fried. AF5245-1 is purple skinned with white flesh and moderate scab resistance. It is very attractive and has good yields, tuber size, and internal quality. It has much better purple skin color than Caribe, Purple Viking, and other standard purples. AF5412-3 has purple skin and flesh along with resistance to late blight, verticillium wilt, and net necrosis. AF5414-1 has red skin and flesh along with resistance to common scab, late blight, and net necrosis. AF5633-2 has round tubers, purple skin and flesh along resistance to blackspot bruise and net necrosis. NDAF113458-2 is very high yielding and has white flesh and purple-spashed, buff colored skin. It has resistance to blackspot bruise.

**Progress of Disease Resistance:** Advanced clones in our program typically have resistance to several important potato pests and/or physiological disorders. As examples, Caribou Russet has resistance to common and powdery scab as well as excellent bruise resistance; Caribou Russet, Easton and AF4296-3 have good verticillium resistance; AF4296-3 has good fusarium resistance, AF4648-2, a promising chipper and tablestock clone, combines excellent scab and PVY resistance with moderate late blight, soft rot, and pink rot resistance. Priorities in the area of disease resistance are: late blight, scab, and PVY. Because of increasing concerns about PVY in the U.S. potato industry, we have dramatically increased our crossing and selection program for PVY resistance since 2011. Although these diseases are our top priorities, our work on disease and pest resistance also included efforts to develop varieties with resistance to: PLRV, powdery scab, verticillium wilt, fusarium dry rot, pink rot, soft rot, nematodes, bruising, internal defects, insects, etc. Marker-assisted selection for potato virus Y (PVY) and golden nematode resistance is now an integral part of the breeding program. We are now developing marker-assisted selection procedures for late blight resistance. Progress in breeding for late blight and scab resistance has been dramatic. We currently have 64 late blight resistant clones moving through the selection process. This includes twenty-seven 3<sup>rd</sup>-year clones (27 of 176, 15.3%). Considering more advanced material, 37 of 78 (47.4%) 4<sup>th</sup>-year and older clones screened for late blight resistant clones showed moderate to good resistance. Fifty-eight of 142 selections (40.8%) had scab resistance in our 2017 screening trial. Thirty-three (19.6%) of 168 4<sup>th</sup> year and older clones tested showed evidence of PVY resistance when

screened for the presence of DNA-based markers associated with PVY immunity associated with the  $Ry_{adg}$  or  $Ry_{sto}$  resistance genes. Twenty-nine (17.3%) of 168 4<sup>th</sup> year and older clones tested showed evidence of golden nematode resistance when screened for the presence of the DNA-based markers associated with resistance (H1 marker). Clones with late blight, scab, and/or PVY resistance are present at an increasing frequency in our program and several are advancing toward commercialization. These clones will be moved forward based on field performance and either be developed for commercial release or used as breeding material to produce future commercially valuable cultivars with field resistance to late blight, PVY, and/or scab.

***Breeding and Selection Approach:*** Crossing takes place at Aroostook Research Farm using parents from our program, Cornell University, Michigan State, North Dakota State University, University Wisconsin, and the USDA-ARS, as well as named varieties from North American, South America, and Europe. We generate true potato seed from the crosses and use these seeds to produce greenhouse seedling tubers. Excess greenhouse tubers are exchanged with the USDA-ARS Idaho, Colorado, North Dakota, and Wisconsin breeding programs to gain access to russets, reds, and chippers from their programs that will strengthen our program's ability to provide new varieties for the Maine industry. This type of exchange program improves the efficiency of potato breeding and variety development throughout North America.

The University of Maine Potato Breeding Program plants ~50,000 single-hills at Aroostook Research Farm during each season (this represents ~50% of the initial screening of potato clones conducted in the eastern U.S.). These single-hill plots were derived from greenhouse tubers grown during the previous year (by our program, the USDA-ARS Aberdeen, North Dakota State University, Colorado State University, and the University of Wisconsin) and represent the first year of field selection to produce new potato varieties. Each single hill is a candidate new potato variety developed from crossing two parents with desirable characteristics (e.g. PVY resistance, market quality, etc). At harvest, clones from the single hills (~1200, typically 2-3%) are selected for further evaluation based on their yield and appearance. The ~1200 clones selected from the single hills are evaluated in year#2 in our 8- and 12-hill plots. Those that are selected during the 2<sup>nd</sup> field year (~300 clones) are screened again during year #3 in ME (northeast conditions) and NC (southeast climatic conditions). The whites and reds are also screened in FL (southeast climatic conditions). Late blight susceptibility is determined by screening this 3<sup>rd</sup>-year material in PA. Only the clones with outstanding yields, market quality, and/or pest resistance are kept at each stage. Seed is multiplied in year #3 so that the top performers can enter 4<sup>th</sup> year replicated yield trials (ME) and regional performance trials (FL, NC, VA, MD, PA, and OH); also the National Chip Variety Trials, NCPT which has 10 trial sites [CA, FL, MI, NC, ND, NY OR, TX, and WI(2)] representing major production areas of the U.S.). The most promising of these enter the Potatoes USA/Snack Food Association (SNAC) chipping trials in CA, FL, ID, ME, MI, MO, NC, ND, OR, PA, and WI. Promising russet selections with processing potential enter the National Fry Processing Trials (NFPT in ID, ME, MI, ND, OR, WA, and WI). Over the course of six years of field selection the clones are evaluated for yield, quality, disease resistance, bruise susceptibility, processing characteristics,

## Potato Breeding and Variety Development Project

Cross Desirable Parents in Greenhouse (FY minus 2)	Market classes (50% russets, 40% whites, 10% reds/specialties) Disease resistance priorities (scab, late blight, PVY, others) Crossing at Orono and Presque Isle (ARF)
Produce Seedling Tubers in Greenhouse (FY minus 1)	Seedling Tuber Production in Two ARF Greenhouses
1 <sup>st</sup> -year Selection Plots in Presque Isle, single hills (FY1)	~50,000 new candidate varieties each year (~1200 saved each year for future study)
2 <sup>nd</sup> -year Selection Plots in Presque Isle, 8 or 12 hills (FY2)	Fry color evaluations begin (~1200 candidate varieties/year)
3 <sup>rd</sup> -year Selection Plots in FL, NC, and ME (Presque Isle and Exeter), 20 hills (FY3)	Selection in four different environments (FL, NC, ME1, ME2) improves ability to detect widely-adapted, reliable candidate varieties (~300/year) Processing quality evaluations continue Late blight resistance screening begins DNA-based markers used to test for PVY and GN resistance
Replicated Yield & Quality Trials, ME; screening trials in other states (FY4)	Yield and quality trials expand to multiple sites in ME (ARF, St. Agatha, Exeter) and beyond (~100/year) Screening begins in National Chip Processing Trials (NCPT) Introduction to fry processing companies
Replicated Yield & Quality Trials, ME and other states (FY5)	DNA-based marker testing continues Disease screening: late and early blight, VW, scab, PVY, PLRV/NN, fusarium, pink rot, and soft rot) Screening begins in National Fry Processing Trials (NFPT) Virus removal and clean seed multiplication may begin
Advanced Replicated Yield & Quality Trials, ME; Eastern Regional Trials; Trials in Other Areas; Commercialization Trials; Seed Production (FY6 and beyond)	Extensive yield and quality trials continue in ME (ARF, St. Agatha, Exeter) and beyond (~20/year) Snack Food Association Chip Variety Trials (SFA/USPB) NCPT and NFPT trials continue Grower, chip and fry processing company trials Continued disease screening and DNA-based marker screening Virus removal and clean seed multiplication may begin

and other attributes. It takes six to eight field seasons of selection and evaluation of the advanced materials at multiple trials sites to identify potato clones that show enough promise to warrant seed production for commercial-scale evaluation. Because each step of the process from crossing through initial field selection to multi-site testing of advanced materials takes

place during each growing season, our program generates a steady stream of promising candidate potato varieties than have the potential to benefit the potato industry. It can be thought of as a conveyor belt with many (~50,000 per year) potential varieties entering the front end and a handful of new candidate varieties with commercial potential coming out the end each year. The progression on clones and selections by field selection year is presented in Table 1. We work with growers and processors to commercially test the most promising clones and determine which merit commercial release.

Crosses conducted in the Aroostook Research Farm greenhouse and at Orono during spring 2017 resulted in 341 families and ~224,800 true potato seed (TPS). The top priorities represented in the 2017 crosses were improved russet, processing, and chipping clones, especially with late blight, scab, and/or virus resistance. Seedling tubers (49,509) from prior ME crosses and from germplasm exchanges with other breeding programs (WI, CO, USDA-ARS, and ND) were planted in the field and selected for performance under ME growing conditions. We selected 1538 (3.1%) for continued evaluation in 2018. By category the selections were as follows: 781 (51%) round to oblong white- or yellow-skinned potatoes for fresh and/or chipping markets; 119 (8%) red- or purple-skinned potatoes for fresh market; and 638 (42%) long-tuber-type whites and russets for fresh and/or processing markets. The selection of red- or purple-skinned potatoes (5 to 14% since 2013) is a marked change for the program and reflects grower interest in developing red-skinned varieties with excellent appearance under ME and Eastern conditions.

A total of 338 second-year clones were selected during 2017 (338 out of 1575, 21.5%). Of these selections, 125 (37%) were russets or long whites. There were 151 (45%) round-white or yellow-fleshed selections and 62 (18%) were red-skinned or specialty clones. Many of these clones were derived from parents with late blight, PVY, and/or other key disease resistance traits. The 338 selected second-year clones will be advanced to 3<sup>rd</sup> year testing during 2018 in ME, FL, NC and PA.

Thirty-eight of 52 (73%) advanced selections (6<sup>th</sup> year or older clones) were retained for further evaluation in ME and elsewhere. The advanced clones that have been selected are distributed as follows: 19 russets and long whites (50%), 13 chippers, fresh market, yellows, or dual-purpose whites (34%), and 6 reds, purples, and specialty types (16%). Five have late blight resistance, 20 have scab resistance, and two are PVY immune.

Twenty-nine of 38 (76%) intermediate selections (5<sup>th</sup> year clones) were retained for further evaluation next year. These were distributed as follows: 18 russets and long whites (62%), 8 round-whites or yellow-fleshed (28%), and 3 red-skinned or specialty clones (10%). Two have late blight resistance, seven have scab resistance, and none are PVY immune.

Fifty-four of 90 (60%) 4<sup>th</sup> year clones were retained for further evaluation next year. These were distributed as follows: 25 russets and long whites (46%), 24 round-whites, yellows, and chippers (44%), and 5 colored-skinned or specialty clones (9%). Seventeen (32%) have late blight resistance, 19 (35%) have scab resistance, and fourteen (26%) are PVY immune based on DNA-based marker data.

Ninety-eight of 323 (30%) 3<sup>rd</sup> year clones were retained for further evaluation next year. These were distributed as follows: 43 russets and long whites (44%), 44 round-whites and



yellows (45%), and 11 colored skinned or specialty clones (11%). Fifteen (15%) have late blight resistance and 39 (40%) are from crosses with PVY resistant or immune parents. Scab resistance has not been formally tested at this stage though susceptibility has been used as a discard criteria to this point.

Tissue culture, minitubers, N1 or N2 seed of the following advanced clones are available from the Maine Seed Potato Board or will become available after the 2018 harvest: Sebec (AF0338-17), Easton (AF3001-6), Caribou Russet (AF3362-1), AF4138-8, AF4124-7, AF4157-6, AF4172-2, AF4296-3, AF4648-2, AF4659-12, AF4872-2, and AF5040-8. So far this year, three clones have been submitted to the University of Wisconsin for virus removal and entry into tissue culture: AF5312-1 (fresh market russet), AF5071-2 (fry processing russet), and AF5429-3 (high yielding chipper). Sebec, AF4157-6, AF4296-3, AF4648-2, and AF5040-8 are or have been part of the Fast-Track seed production program of the US Potato Board and/or the US Potato Board/SCRI acrylamide project. This program produces minitubers and start-up seed production for processing trials.

**Table 1 Selected clones by field year, market type, and known resistances to late blight, scab, or PVY.**

Field Selection	Year	# of Clones	Market Type (#, %)	Clones with Known Disease Resist.		
				Late Blight	Scab	PVY Immune
1 <sup>st</sup>	single hills	1538	781 (50%) whites, yellows 119 (8%) reds, specialties 638 (42%) russets, longs			
2 <sup>nd</sup>	8- or 12-hills	338	151 (45%) whites, yellows 62 (18%) reds, specialties 125 (37%) russets, longs			
3 <sup>rd</sup>	60-hills	98	44 (45%) whites, yellows 11 (11%) reds, specialties 43 (44%) russets, longs			
				15		
4 <sup>th</sup>	Prelim. YT	54	24 (44%) whites, yellows 5 (9%) reds, specialties 25 (46%) russets, longs			
				17	19	14
5 <sup>th</sup>	Intermed. YT	29	8 (28%) whites, yellows 3 (10%) reds, specialties 18 (62%) russets, longs			
				2	7	0
≥6	Advanced YT	38	13 (34%) whites, yellows 6 (16%) reds, specialties 19 (50%) russets, longs			
				5	20	2

**Licensing/Royalties/Commercialization.** Until recently, most releases have been public releases (the exception was Reeves Kingpin, licensed initially to McCain Foods). Policies of U.S. Breeding Programs have changed dramatically with Plant Variety Protection and most are now protected and require licensing and royalties. Most future releases from the Maine Breeding Program are likely to be via licensing with favorable terms for Maine growers and/or companies. The Maine Potato Board, University, and stakeholders have worked together to develop a release plan for our varieties. We have named and released Sebec (AF0338-17), Easton (AF3001-6), and Caribou Russet (AF3362-1) since 2013/2014. Plant variety protection (PVP) was obtained for these varieties and all three varieties were licensed from the University by the Maine Potato Board. More varieties will be released in the coming years as long as they show commercial potential. Most are expected to involve PVP; however, depending on the market class and/or expected scale of production public releases may also be used.

**Example Recent Maine Releases and Promising Selections.** Selections that have performed particularly well in the 2017 ME Breeding Program and Maine regional and advanced trials were:

### Chipping

- |          |  |
|----------|--|
| Sebec    | Tested as AF0338-17. It has yields similar to Atlantic in the S.E. with very little internal heat necrosis or hollow heart. It is not a storage chipper, but chips very well from the field and could have market potential as an alternative to Atlantic in the mid-Atlantic and Southeastern U.S. Chip growers need to reduce fertility levels and harvest it slightly later than Atlantic (when Atlantic has gone off grade due to internal defects) to obtain adequate specific gravity.                                       |
| AF4157-6 | Early maturing with moderate to good yields, excellent chip color, good gravity, bruise resistance. It may work well from the field in the South and from storage in the north. Small tuber size and scab susceptibility are weaknesses. It can have good yields for an early, but has been inconsistent.  |
| AF4648-2 | Mid-season maturity with good yields, chip color, gravity, and bruise resistance. This clone is common scab and PVY resistant with moderate resistance to late blight, pink rot, and soft rot. It has potential for fresh market and as a chipper for conditions when common scab limits other varieties. Long-term chip color can be quite good as long as it is harvested before chilling conditions occur and then is stored at 50 to 55F. It does not chip well from cool storage and it is quite susceptible to powdery scab. |
| AF5040-8 | Mid-season, high yields, high gravity, good internal quality and chip color. Susceptible to scab. AF5040-8 is a possible alternative to Atlantic in the South and mid-Atlantic states. It will be in the Potatoes USA FastTrack/NextGen commercial-scale chip trials as soon as seed is available. It chips well from 50F storage, but not from cool storage.  |
| AF5429-3 | Medium-late maturity, high yields, medium-high gravity, good chip color, large tubers. Verticillium, golden nematode, and blackspot resistance, but susceptible to scab. It is entering the Potatoes USA/SFA national chip trials (SNAC) in 2018 and was the top performer nationally in the 2017 National Chip Processing Trials (NCPT).  |

Other Promising chipping candidates that will be tested again in 2018: AF5563-2 (good yields, chip, and gravity; moderate scab, bruise, and verticillium resistance); AF5563-5 (good yields, appearance, and chip; moderate gravity; moderate scab and bruise resistance; WAF10664-3 (high yields, moderate scab resistance, good gravity and chip color).

#### Fresh market whites

Sebec Tested as AF0338-17. Widely adapted, medium to medium late, round to oblong tubers, slight net, fair to good appearance, low internal and external defects, moderately susceptible to scab, susceptible to greening under fluorescent lights.

AF4138-8 Bright appearance with slightly netted, round to oblong tubers, excellent boiled quality, early to mid-season maturity, moderate scab resistance, and higher yields than Superior. Size profile can be smaller than Superior.

AF4648-2 Described above, smooth skin, bright appearance, round to oblong tubers, mid-season, good internal quality, very good common scab resistance plus PVY, late blight, pink rot, and soft rot resistance.

AF5280-5 Medium early, bright, moderate scab resistance, large tubers, good internal quality. Scab, pink rot, bruise, and golden nematode resistance.

Other Promising fresh market whites that will be tested again in 2018: AF5225-1 (high yields, cream flesh, verticillium and bruise resistance, scab susceptible); AF5450-7 (late maturity, high yields, verticillium, bruise, golden nematode, and scab resistance). AF5563-5 (good yields, appearance, and chip; moderate gravity; moderate scab and bruise resistance).

#### Russets or Long Whites

Caribou Russet Tested as AF3362-1. A medium-late maturing, dual-purpose russet with fair to good appearance, long to oblong tubers, low external defects, moderate specific gravity, and good fry color. It has high yields, moderate to large tuber size, and good internal quality (except for internal heat necrosis in southern areas). It has moderate scab resistance and is resistant to golden nematode and bruise.

AF4124-7 A mid-season russet with large tuber size and good processing quality. Yield, gravity, and internal quality have been good. It is moderately resistant to common scab, blackspot bruise, and fusarium, but is moderately susceptible to verticillium wilt.

AF4296-3 A late maturing, russet with good fry quality, fair tuber appearance, and high yields. Specific gravity is moderate (average of 1.079 in ME trials) and fry color from storage has been good. Fry color uniformity is very good. It is moderately susceptible to scab, but has moderate verticillium resistance and good bruise resistance.

AF5312-1 A mid-season russet with good appearance, flavor, and fresh market potential. Yield, gravity, and internal quality have been good. It has resistance to scab, blackspot, shatter, and fusarium.

Other Promising russet and long-white candidates that will be tested again in 2018: AF4872-2 (russet, good yields and excellent processing quality, some oblongs); AF5071-2 (russet, good yields and fry quality, processing, some hollow heart and off shapes, resistant to verticillium and shatter); AF5091-8 (russet, good yields, fry processing, externals, resistant to blackspot, pink rot, fusarium); AF5164-19 (russet, good yields, possible dual purpose, externals, resistant to

verticillium and fusarium); AF5179-4 (russet, good yields, processing, resistant to verticillium and fusarium); AF5406-7 (russet, good yields, processing, resistant to late blight, scab, blackspot, shatter, verticillium, fusarium, and pink rot); AF5468-5 (russet, good yields, fresh market, resistant to scab, fusarium, and verticillium); AAF07521-1 (russet, large tubers, good yields, processing, resistant to late blight, blackspot, fusarium, pink rot); WAF10073-3Rus (russet, good yields, processing, resistant to scab, blackspot, shatter, fusarium).

### Reds and Specialty

- AF4659-12 A yellow-fleshed “pinto-type” specialty variety with a interesting red and yellow skin pattern. It produces small, fingerling-type tubers that are excellent roasted, boiled, or fried.
- AF4831-2 Bright red skin, oval tubers, relatively small size profile, white flesh, medium to medium-late vine maturity.
- AF5245-1 Purple skin, white flesh, mid-season maturity, high yields, moderate scab resistance.
- Other Promising red and specialty candidates that will be tested again in 2018: AF5412-3 (purple flesh, late blight, verticillium, and net necrosis resistance); AF5414-1 (red flesh, scab, late blight, and net necrosis resistance); NDAF102696C-5 (red skin, pretty, small tubers for baby red market, moderate resistance to verticillium wilt and blackspot); NDAF113484B-1 (red skin, pretty, small tubers for baby red market, blackspot resistance); NDAF113458-2 (buff skin with a purple blush, high yields, bruise resistance).