Potato Breeding and Selection for Colorado

SUMMARY RESEARCH PROGRESS REPORT FOR 2013
AND RESEARCH PROPOSAL FOR 2014

Submitted to:

Colorado Potato Administrative Committee (Area II) - Research Committee

Title:

Potato Breeding and Selection for Colorado

Funding Source: CPAC, Area II

Project Leaders:

David G. Holm and Caroline Gray, Department of Horticulture and Landscape Architecture, Colorado State University, San Luis Valley Research Center

Collaborators:

- Robert D. Davidson (retired) and Andrew J. Houser - Disease Screening and Evaluation
- Samuel Y. C. Essah - Cultivar Specific Production Management
- Sastry S. Jayanty - Cultivar Specific Postharvest Management and Physiology
- Henry J. Thompson - Nutritional Characteristics and Health Attributes
- Jorge M. Vivanco and Dayakar Badri - Nematode and Pink Rot Resistance
- Kent P. Sather and Richard W. Haslar (retired) - Potato Certification Service
- Colorado Potato Growers
- Other cooperating research/extension programs - several cooperators throughout the United States and Canada provide breeding material and opportunities to screen our germplasm under various growing conditions and disease pressures.

Nature, Scope, and Objectives of the Proposed Research:

Potato cultivar development is a four-step process, encompassing first, the generation of segregating populations and evaluation for visual agronomic traits. Second, superior progenies are identified and these selections undergo additional evaluation for economically important characteristics. Third, a profile of cultivar specific management criteria - production and postharvest - are developed, which a grower, shipper, processor, and/or marketer may fine tune for his/her operation. Finally, the new cultivar must be introduced to the intended market. These steps provide a base for a successful cultivar release. Without all components, fruition is difficult to attain.

The major objectives of the Colorado Potato Breeding and Selection Program are: (1) to develop new potato cultivars with increased yield, improved quality, improved nutritional and health characteristics, resistance to diseases and pests, and tolerance to environmental stresses; (2) to collaborate with growers, shippers, processors, and research/extension personnel to assess the production, adaptability,

marketability, and other characteristics of advanced selections from the Colorado program; (3) to provide a basic seed source of selections to growers for seed increase and commercial testing; (4) to evaluate promising selections for possible export (interstate and international).

The primary emphasis is placed on the development of russet cultivars. The balance of the breeding effort is devoted to developing red, specialty, and chipping cultivars. This broad approach is important because it recognizes the diverse markets accessed by potato growers throughout Colorado.

Besides the major objectives outlined previously, specific breeding emphasis is being placed on identifying germplasm and developing cultivars that have: (1) early vine maturity and early tuber bulking; (2) immunity to PVY; resistance to (3) late blight (foliar and tuber); (4) storage rots [dry rot (*Fusarium* and early blight) and bacterial soft rot]; (5) pink rot; (6) nematodes; (7) powdery scab; (8) corky ringspot, and (9) that have improved nutritional quality, health attributes, and other "consumer" characteristics such as improved red skin color retention and improved shelf life.

Enhancement of the Competiveness of Colorado Potato Growers:

Many challenges and opportunities are confronting the Colorado potato industry. These challenges/ opportunities include new disease pressures, food safety, water quality/supply, current market constraints, new market development (processing, exporting, etc.), changing consumer expectations, and increasing costs with highly variable potato prices. To help meet these challenges, continued emphasis needs to be placed on developing new potato cultivars with economically important characteristics. Also emphasis will be placed on developing sustainable cultivars by selecting for "low input" cultivars, primarily for reduced nitrogen and fungicide inputs and with improved postharvest qualities. Cultivars with these characteristics will help assure that the potato industry in Colorado remains productive and in a competitive position.

Methods:

Table 1 presents a description of the steps involved in developing new potato cultivars. It takes 14+ years to develop a new potato cultivar. Year 1 and 2 are the potato breeding phase of the development process. Parents are selected and crossed to produce true potato seed. Seedling tubers are then produced from the true seed in year 2. Subsequent years (3+) represent the selection phase of the development process. Each year represents another cycle of field selection. As each cycle is completed, fewer and fewer clones remain and the amount of seed per selection is increased. Clones remaining after eight cycles of field selection are released to growers for evaluations prior to official release as a named cultivar.

We will continue to identify opportunities to utilize marker assisted selection based on expanding and developing new collaborations with appropriate faculty.

Facilities, Equipment, Personnel Support:

Facilities/Equipment. The Colorado Potato Breeding and Selection Program is based at the San Luis Valley Research Center. Current facilities and equipment usage are consistent with previous years' needs by this program. However **the goal still remains to acquire improved grading equipment to facilitate more detailed size profiling of selections under evaluation.**

Support Personnel. The partial financial support of a Research Associate by the SLV potato industry for the Colorado Potato Breeding and Selection Program has been very valuable. We also rely on the current SLV Research Center staff to prepare fields for planting and to assist in other activities including seed preparation, planting, and harvest activities. The collective support activities of Stan Price, Ron Price, Sharon Yust, and Michelle Leckler are greatly appreciated. **There is a need of one additional full-time field support person to facilitate the overall activities at the SLV Research Center. This need can likely be taken care of via hiring of a manager in the near future.**

Outreach Plan for Reporting Information to Growers and Other Stakeholders:

The Colorado Potato Breeding and Selection Program provides for many outreach activities. Included are:

- Field Days - all growers invited
- Annual Open House - all growers invited
- Annual Advanced Selection Evaluation Meeting - all growers invited
- Presentations in various venues including the Southern Rocky Mountain Agricultural Conference and professional meetings
- When requested, articles for SpudItems
- Advanced selections are provided to growers to evaluate for potential release as named cultivars. Our goal is to visit participating growers during late summer and at harvest.
- Tours for individuals and groups
- Website - the website will focus on the various programs located at the SLV Research Center, including potato breeding and selection, postharvest physiology, field physiology, potato pathology, and potato certification. Expected deployment of the new website is anticipated for late March. The url will be http://potatoes.colostate.edu.

Potential for Leverage of Outside Funding:

Ongoing support by the potato industry is fundamental to maintaining external funding received for the potato breeding from NIFA (National Institute of Food and Agriculture) and other potential sources. Also, these funds are vital to maintaining collaborative relationships with other research projects supporting the overall potato research efforts in Colorado.

Project Timeline:

This project is ongoing. Potato cultivar development is a process encompassing a minimum time-period of 12 to 14+ years from hybridization to release of a new cultivar. Based on this timeline, advanced selections from crosses made in 2013 will be available for grower evaluation in 2023. This illustrates the long term nature of potato breeding programs. It also underscores the importance of collaborative efforts in cultivar development, the impact of inadequate funding, and the significance of other research management decisions. These factors impact the characteristics that future cultivars will possess as we strive to meet the needs of the Colorado potato industry.

Because the timeline for cultivar development is lengthy, improved methods to speed up the breeding and selection process are continually evaluated. We will continue to identify opportunities to utilize technologies such as marker assisted selection (MAS) based on expanding and developing new collaborations with appropriate faculty.

Significant Accomplishments for 2013:

The following is a brief summary of research conducted in 2013.

The Colorado Potato Breeding and Selection Program intercrossed 98 parental clones in 2013 in two separate crossing blocks. The emphasis of the first crossing block was russet and yellow flesh cultivar development and PVY resistance. The second crossing block emphasized russet and specialty cultivar development and disease resistance, mostly PVY resistance. Seed from 431 combinations was obtained.

Approximately 33,903 first-size seedling tubers representing 154 families were produced from 2012 greenhouse crosses for initial field selection in 2014, there are still 52 families yet to be harvested. These seedlings represent crosses segregating primarily for russets, reds, specialty types, and resistance to late blight, PVY, corky ringspot, and nematodes. Second through fourth size seedling tubers will be distributed to Idaho (USDA-ARS), Maine, North Dakota, Oregon, Texas, Wisconsin, and Alberta, Canada (Agriculture Canada).

Colorado grew 88,037 first-year seedlings representing 362 families in 2013, with 536 selected for subsequent planting, evaluation, and increase in future years. A portion of these seedlings were obtained from the USDA-ARS (Aberdeen, Idaho), Agriculture Canada, Texas A&M University, and University of Maine. Another 973 clones were in 12-hill, preliminary, and intermediate stages of selection. At harvest, 196 were saved for further increase and evaluation. Eighty-seven advanced selections were saved and will be increased in 2014 pending further evaluation. Another 290 selections and cultivars were maintained for germplasm development, breeding, and other experimental purposes including seed increase/maintenance.

Field trials conducted in 2013 included: Preliminary Trial, Intermediate Yield Trial, Intermediate Specialty Yield Trial, Advanced Yield Trial, Southwestern Regional Russet Trial, Southwestern Regional Red Trial, Southwestern Regional Chip Trial, Southwestern Specialty Trial, Western Regional Russet/Processing Trial, Western Regional Red Trial, Western Regional Specialty Trial, San Luis Valley Chipping Trial, and Western Regional Chipping Trial. All trials are grown under "low input" conditions, primarily for reduced nitrogen and fungicide.

A total of 159 samples were evaluated for two or more of the following postharvest characteristics: blackspot susceptibility, storage weight loss, dormancy, enzymatic browning, specific gravity, french fry color, french fry texture, and chip color.

Advanced selections evaluated in the Southwest Regional Trials, Western Regional Trials, or by potato growers in 2013, included 13 russets (AC99375-1RU, AC00395-2RU, CO03276-5RU, CO05024-11RU, CO05040-1RU, CO05068-1RU, CO05110-6RU, CO05132-2RU, CO05149-3RU, CO05152-5RU, CO05175-1RU, CO05189-2RU, and CO05189-3RU), 3 reds (CO04159-1R, CO05211-4R, and CO05228-4R), 10 chippers (AC01151-5W, AC00206-2W, AC03433-1W, AC03452-2W, AC05153-1W, CO02024-9W, CO02033-1W, CO02321-4W, CO03243-3W, and CO05061-6W) and 13 specialties (AC99330-1P/Y, AC05175-3P/Y, ATTX01180-1R/Y, CO97222-1R/R, CO97226-2R/R, CO97232-2R/Y, CO97233-3R/Y, CO04067-8R/Y, CO04056-3P/PW, CO04063-4R/R, CO04099-3W/Y, CO05037-2R/Y, and CO05037-3W/Y).

Several selections are being considered for exclusive release. Included are russets - AC96052-1RU, CO97087-2RU, CO98067-7RU, CO99053-4RU, and CO03276-5RU; reds - CO98012-5R, CO99076-6R,

CO99256-2R, CO00277-2R, and CO00291-5R; chippers - CO95051-7W, CO00188-4W, CO00197-3W, and CO00270-7W; and specialties (including yellows) - AC97521-1R/Y, ATC00293-1W/Y, CO97215-2P/P, CO97222-1R/R, CO97226-2R/R, CO97227-2P/PW, CO97232-1R/Y, CO97232-2R/Y, CO99045-1W/Y, CO00405-1RF, CO00412-5W/Y, CO00415-1RF, VC0967-2R/Y, VC1002-3W/Y, and VC1009-1W/Y.

PVP applications were submitted for Masquerade (AC99329-7PW/Y), Crestone Russet (CO99053-3RU), and Mercury Russet (CO99100-1RU). Plant Variety Protection was granted for Mesa Russet in 2013. AC99330-1P/Y and CO97233-3R/Y will be named Midnight Moon and Red Luna.

Table 2 compares the more advanced selections and named cultivars for yield, grade, maturity, specific gravity, and grade defects.

Collaborative Studies:

The following collaborative studies were conducted in 2013. These programs have their own funding for these projects and funding is not requested in our budget to support these efforts.

- Several advanced selections were evaluated for disease symptom expression trials in Colorado. These trials were conducted in cooperation with Rob Davidson (retired), Andrew Houser, Kent Sather, and Rick Haslar (retired). Disease evaluations included bacterial ring rot, potato leafroll virus, PVY, and powdery scab.

- Several advanced selections were distributed to state/USDA-ARS collaborators in Idaho, Michigan, Oregon, Texas, Washington, and Wisconsin for additional disease evaluations. These selections were screened for one or more of the following diseases: late blight, early blight, scab (common and powdery), PVY, *Verticillim* wilt, and zebra chip. In addition, selections were provided to the National Trials for late blight and scab (powdery and common) screening trials.

- Several selections were entered in the National Fry Processing Trials conducted in Washington, Idaho, Maine, and North Dakota. A focus of these trials is to identify selections with low acrylamide potential. Several chippers were entered in the National Chip Processing Trials. These trials were planted in 9 locations in northern and southern areas.
- Germplasm is continually being acquired with late blight resistance, virus resistance (PXY, PVY, corky ringspot and leafroll), and nematode resistance from various sources. Primary sources of new germplasm are the USDA-ARS in Aberdeen, Idaho; Prosser, Washington; Madison, Wisconsin; and Oregon State University in addition to resistant selections identified in our program. These materials are being selectively introgressed into the breeding program.

- Health attributes and nutritional characteristics of advanced selections were evaluated by Sastry Jayanty and Henry Thompson, Jairam Vanamala (moved), and Lavanya Reddivari (moved).

- Advanced selections were evaluated in cultural management trials in collaboration with Samuel Essah.

- Efforts continue to find outside funding to support nematode resistance studies with Jorge M. Vivanco and Dayakar Badri.

- Marketing and associated branding studies were initiated with Rob Davidson, Sastry Jayanty, Samuel Essah, and Jennifer Bond with funding provided by a Specialty Crop Block Grant from the Colorado Department of Agriculture. Unfortunately the project was not completed to the satisfaction of all involved because a key investigator on the project left CSU for other employment.

Graduate Students

Katie Larson. *Color, Carotenoid Content and Sensory Perceptions in Potato Germplasm from the Colorado Potato Breeding and Selection Program*. Co-advised by David Holm and Sastry Jayanty.

The major objectives of this research project were: (1) to evaluate and compare the tuber-flesh color of 138 genotypes in the Colorado Potato Breeding and Selection Program; (2) to measure select genotypes for total and individual carotenoid content; (3) to evaluate 12 select genotypes for volatile flavor compounds present using both steamed and microwaved cooking methods; and (4) to perform a sensory analysis for 5 select genotypes using both steamed and microwaved cooking methods.

Tuber flesh color was measured using a reflectance colorimeter to determine the chroma and hue of each genotype. Chroma indicates the intensity or saturation of a color and hue measures true color. A subset of 100 genotypes, 65 tetraploids and 35 diploids, were then analyzed for total carotenoid content. Carotenoids are phytonutrients produced in the tuber flesh of potatoes that contain various health benefits such as reduction of cardiovascular diseases, some cancers, and macular degeneration. Eight select genotypes were analyzed for carotenoid composition. The specific carotenoids detected were antheraxanthin, cryptoxanthin, lutein, neoxanthin, violaxanthin, and zeaxanthin. Volatile flavor compounds were analyzed in 12 select genotypes, including two diploid genotypes with high carotenoid levels, using both microwaved and steamed cooking methods. A sensory evaluation was done on a subset of 5 genotypes that were analyzed for volatile compounds. The sensory evaluation used both microwaved and steamed cooking methods and included 98 untrained panelists. This research project provided insight into the tuber flesh color, carotenoid content, volatile profiles, and sensory assessment of various genotypes from the Colorado Potato Breeding and Selection Program

Sara Kammlade. *The Influence of Agromanagement on Soil Health and Potato Mineral Nutrients.* Co-advised by David Holm and Samuel Essah.

Previous studies have observed differences in the mineral nutrient concentrations of food crops when grown in conventional versus organic systems. However, they have not accounted for inherent dissimilarities in the agroecosystems as a result of differing agromanagement, which may explain how and why such differences are observed. Agromanagement (rotation, fertilizer, pesticide inputs etc.) shapes soil health – the biological, chemical, and physical properties of soil. Soil organisms – bacteria, fungi, protozoa, and nematodes – are essential in regulating biogeochemical cycling and are therefore critical in crop mineral nutrient acquisition. By studying a spectrum of management practices from a conventional "feed the plant" paradigm to a biological "feed the soil" paradigm we can see how these management systems alter soil health and how, in turn, this influences potato mineral nutrients.

The objectives of this research are to:

1. Characterize how a spectrum of agromanagement practices, alter soil health;
2. Determine if and what certain soil health metrics correspond to higher potato mineral nutrients;

3. Determine the heritability of potato mineral nutrients to determine if high mineral nutrient concentration can be selectively bred for; and
4. Determine the stability of potato mineral nutrient uptake to identify clones that exhibit a stable response across many agroecosystems.

Raven Bough. *Screening Potato Germplasm for Flavor Utilizing HS-SPME/GC-MS and Sensory Panel Analyses*. Co-advised by David Holm and Sastry Jayanty.

The development of potato cultivars with improved flavor in the San Luis Valley has the potential to expand the region's fresh potato market by focusing on consumer appeal. Through analysis of existing cultivars, the objective of this project is to establish a flavor rating methodology for potato selections based on correlation of HS-SPME/GC-MS quantification of major flavor compounds and sensory panel tests. Flavor ratings will guide germplasm screening in the breeding process, which will enable the development of new cultivars with improved flavor.

Objectives for 2014: (Note - some of objectives listed are collaborative projects and thus will be funded through other sources and are presented here for information only).

1. The potato breeding and selection program will be continued. This aspect of the program is primarily oriented to developing new potato cultivars. Emphasis will continue to be placed on developing russet cultivars that have early vine maturity and early tuber bulking.

   Advanced clones will be tested in yield trials, Southwestern Regional Trials, Western Regional Trials, out-of-state trials, and by growers.

2. Adjunct breeding initiatives have been started over the last few years and will continue. These initiatives are focused on increasing disease resistance and the nutritional and health attributes of potatoes in collaboration with other CSU faculty.

   a. Disease resistance breeding has focused on introgressing parental material with identified resistance to late blight, immunity to PVY, tuber resistance to dry rot (*Fusarium* and early blight), and bacterial soft rot. Additional emphasis is being placed on identifying and incorporating germplasm demonstrating resistance/immunity to pink rot, powdery scab, corky ringspot, and nematodes. These studies are in collaboration with Andrew Houser.

   b. Parental material with improved nutritional and health characteristics will be incorporated in the breeding and selection program. We currently are increasing our emphasis on flavor and the identification of novel material that may be useful to incorporate into our breeding program. This has been facilitated by the CDA Specialty Crop Block Grant "Screening of Potato Germplasm for Flavor as a Potato Breeding Selection Tool". As part of this project new efforts will be directed to sensory evaluations of advanced selections both via taste panels and alternative screening techniques. Additionally we will continue our efforts to screen for mineral nutrient density in potato tubers as influenced by agromanagement system. The above projects are in collaboration with Sastry Jayanty, Samuel Essah, and graduate students.

3. Clones in the 7th cycle of field selection will be evaluated in cultural management trials and for postharvest disease reaction. Disease evaluations will be conducted primarily on bacterial soft rot, dry rot (*Fusarium* and early blight) and corky ringspot. These studies will be conducted in cooperation with Andrew Houser and Samuel Essah.

4. Collaborative efforts will continue to focus on an "accelerated" breeding approach for high priority characteristics. This would employ greenhouse and field evaluations, where appropriate, to characterize breeding material earlier in the selection program. Primary focus will include PVY, powdery scab, corky ringspot, and pink rot.

5. Continue the use of on-farm trials to: (1) assist in the development of management guidelines; (2) detect unforeseen problems; (3) determine predictability of performance; and (4) screen for disease reaction [foliar and tuber (pink rot and powdery scab)]. This will be a collaborative effort with Andrew Houser and Samuel Essah. Please refer to the research reports of Rob Davidson and Samuel Essah for 2013 results.

6. Evaluate preliminary, intermediate, and advanced selections from the breeding project, Southwestern Regional Trials, and Western Regional Trials for: blackspot susceptibility, storage weight loss, dormancy, enzymatic browning, specific gravity, chip color, french fry color, and french fry texture.

2014 Proposed Budget
(2013 - Proposed $64,000, Funded $62,500)

Budget Item	Amount	Notes
Research Associate	35,500	Salary plus fringe benefits (partial support)
Temporary Labor	15,950	Hourly support personnel
Supplies	6,600	Miscellaneous greenhouse and field supplies
Travel	700	Travel within Colorado
Equipment & Maintenance	2,200	Greenhouse and assistance to SLVRC
Chemicals	3,050	Greenhouse and some field chemicals
Total Budget	**$64,000**	

Table 1. Generalized potato breeding and selection scheme used at the SLV Research Center.

Year	Comments
1	Select parents for crossing and true seed production in the greenhouse.
2	Produce seedling tubers from true seed in the greenhouse.
3	70,000-80,000 seedling tubers planted in the field as single hills. Several thousand tubers are obtained from other breeding programs. Initial selection of this material takes place at harvest. First cycle of field selection.
4	Twelve-hills of each single-hill selection are planted. Second cycle of field selection.
5	Preliminary Selections Tier 1 (PT1). Third cycle of field selection (48 plant tuber-unit seed increase). Initial evaluations for chipping qualities (chip color after various storage regimes and specific gravity) are conducted this year and subsequently.
6	Preliminary Selections Tier 2 (PT2). Fourth cycle of field selection (96 plant tuber-unit seed increase). Initial evaluations to characterize selections for blackspot bruise potential, storage weight loss, dormancy, and enzymatic browning. Initial evaluations for french fry potential (french fry color and specific gravity) are conducted this year and subsequently. Evaluations for chipping qualities are continued.
7	Intermediate Selections. Fifth cycle of field selection. Initial data collected on yield, grade, and growth characteristics. Plant a 144 plant tuber-unit seed increase and a 2 rep x 25 plants intermediate yield trial (IYT).
8-9, 14+	Advanced Selections: Includes selections that have advanced from the IYT. Additionally selections are included that have graduated from the Southwest Regional and Western Regional Trials. The advanced yield trials for reds, specialty types, and chippers are planted with entries in the Western Regional Red, Specialty and Chip Trials. Selections are in the 6th-7th and 12+ cycles of field selection. All advanced yield trials (AYT) have 4 reps x 25 plants. Sixth- and seventh- year field selections respectively have a 400/1,600 plant tuber-unit seed increase. Selections in the sixth cycle of selection are indexed for viruses and cleanup/micropropagation is initiated. Testing for ring rot and PLRV reaction is also initiated at this stage and continues as needed. Selections in the 7th cycle of field selection are entered into cultural management trials and postharvest disease reaction (dry rot and soft rot) evaluations.
10	All 8th year selections have a 1/2 acre tuber-unit seed increase planted. These selections are entered in the Southwestern Regional Trials (4 locations - CO, TX, CA). Cultural management trials and postharvest disease reaction evaluations continue as needed.
11-13	All 9th year or older selections generally have a 1 acre or greater seed increase. These selections are entered in the Western Regional Trials (4 trials): main (russets and long whites), red, specialty , and chip. The Western Coordinating Committee (WERA027) directs these trials at 10+ locations in the Western United States each year. Cultural management trials and postharvest disease reaction evaluations continue as needed.
11+	Grower/industry evaluations. The Colorado Potato Breeding and Selection Project relies on the cooperation of several growers, shippers, and processors to evaluate advanced selections for adaptability and marketability.
14+	Release as a named cultivar.

Table 2. Summary comparison of advanced selections and named cultivars for yield, grade, maturity, specific gravity, and grade defects.

Clone	Usage[1]	# Trials	Total Yield (Cwt/A)	% US #1	Vine Maturity[2]	Specific Gravity	% External Defects[3]	% Hollow Heart[4]
Russets								
AC99375-1RU	Dual	7	500	83	3.1	1.099	1.7	0.0
AC00395-2RU	Dual	6	478	87	3.9	1.101	1.5	0.6
Canela Russet	FM	27	352	90	3.2	1.096	1.1	0.1
Centennial Russet	FM	35	294	77	3.0	1.079	0.8	0.3
Crestone Russet	Dual	7	501	89	3.3	1.089	3.6	0.7
Mercury Russet	Dual	7	358	85	1.4	1.084	3.9	0.2
Mesa Russet	Dual	10	419	86	2.9	1.082	1.8	2.5
Rio Grande Russet	FM	22	533	80	3.0	1.086	2.8	0.4
Russet Norkotah	FM	94	371	84	1.8	1.079	2.2	0.4
Specialties								
AC99330-1P/Y	Spec	7	495	58	2.9	1.082	0.0	0.2
CO97233-3R/Y	Spec	7	477	73	3.3	1.082	4.0	2.3
CO04056-3P/PW	Spec	4	330	27	2.8	1.086	0.1	0.0
CO04063-4R/R	Spec	4	262	19	2.4	1.071	0.2	0.0
CO04067-8R/Y	Spec	4	426	64	2.8	1.083	2.3	0.0
CO04099-3W/Y	Spec	4	379	50	2.7	1.091	0.6	0.3
Mountain Rose	Spec	8	383	68	2.2	1.081	1.1	0.0
Purple Majesty	Spec	23	467	52	2.2	1.085	0.6	0.9
Yukon Gold	Spec	37	402	89	1.9	1.087	1.8	0.5

Table 1 continued on next page

Table 1 (cont'd). Summary comparison of advanced selections and named cultivars for yield, grade, maturity, specific gravity, and grade defects.

Clone	Usage[1]	# Trials	Total Yield (Cwt/A)	% US #1	Vine Maturity[2]	Specific Gravity	% External Defects[3]	% Hollow Heart[4]
Chippers								
AC01151-5W	Chip	6	465	79	3.1	1.090	2.6	0.2
CO02024-9W	Chip	6	416	79	3.0	1.088	1.5	0.2
CO02033-1W	Chip	6	426	85	2.7	1.098	0.8	1.6
CO02321-4W	Chip	6	423	80	2.8	1.101	3.6	0.0
AC03433-1W	Chip	5	414	80	3.5	1.086	6.8	0.2
CO03243-3W	Chip	5	464	86	3.3	1.089	2.0	0.5
AC00206-2W	Chip	4	324	79	2.8	1.086	2.3	1.7
AC03452-2W	Chip	4	446	85	3.1	1.078	1.4	0.6
Atlantic	Chip	45	459	86	3.2	1.098	2.7	5.1
Chipeta	Chip	42	536	85	3.3	1.090	5.3	0.6

[1]FM=fresh market; Dual= fresh market and processing potential; SPEC=specialty.

[2]Vine maturity: 1=very early; 2=early; 3=medium; 4=late; 5=very late.

[3]Includes defects such as second growth, growth crack, misshapen, and green.

[4]Based on tubers greater than 10 ounces.

Clones discontinued from further grower evaluations are available for exclusive release through CSU. Data summaries for all clones are available on request. Please contact David Holm for further information.

Russets: AC96052-1RU, CO97087-2RU, CO98067-7RU, CO99053-4RU, and CO03276-5RU.

Reds: CO98012-5R, CO99076-6R, CO99256-2R, CO00277-2R, and CO00291-5R.

Chippers: CO95051-7W, CO00188-4W, CO00197-3W, and CO00270-7W.

Specialties (including yellows): AC97521-1R/Y, ATC00293-1W/Y, CO97215-2P/P, CO97222-1R/R, CO97226-2R/R, CO97227-2P/PW, CO97232-1R/Y, CO97232-2R/Y, CO99045-1W/Y, CO00405-1RF, CO00412-5W/Y, CO00415-1RF, VC0967-2R/Y, VC1002-3W/Y, and VC1009-1W/Y.