## PROGRESS REPORT

**Title of Project: Potato Breeding and Cultivar Development in the Southwest**

**Primary Research Personnel: Asunta (Susie) Thompson-Johns, David G. Holm, J. Creighton Miller, Jr., and Ronald E. Voss**

Justification and Objective:

Potato production in the Southwest encompasses a varied set of environmental conditions, pest problems and market niches. These diversities require the development of cultivars that are widely adapted to the region, or are suited for specific production areas and/or markets. This project was designed with the overall objective to develop and evaluate improved potato cultivars to meet the production, marketing, and consumer needs of the Southwest United States.

Summary of Work and Accomplishments for 1997:

Several sub-objectives were outlined in the original proposal in 1997. These are aimed at the development of a long-term collaborative effort to address the needs of potato producers and industry personnel primarily in the Southwest, but all producing regions of the country when applicable. This was the first year of a formalized program, and progress toward the overall objective is highlighted in the following narrative.

- The uniform Southwest Region Potato Trial is currently under development. Timing of funding precluded a trial in 1997. Final plans will be developed at a Southwest Group meeting on January 18, 1998, for the upcoming production year.
- Development of cultivars for fresh and processed use, was accentuated in 1997. The Colorado based breeding program intercrossed 51 parental clones in 1997. Botanical seed from 193 combinations were obtained. Primary emphasis was on fresh and processing russets, chippers and reds. Seedling tubers from selected families will be produced in 1998 for field selection in 1999. Approximately 40,000 seedling tubers were produced from 1996 crosses for initial field selection in 1998. Second through fourth size tubers will be distributed to Idaho, Minnesota, Oregon, Texas and Alberta, Canada. Currently, additional seedling tubers are being produced from 14 specialty crosses made in 1994 for field selection in 1998. Approximately 72,000 first-year seedlings were grown in 1997, with 820 being selected for subsequent planting and evaluation in future years. A portion of these seedlings were obtained from Idaho, Texas and Canada. The Texas based program increased first year seedlings from 40,000 to 65,000 in 1997. From 327 crosses, 328 first year selections were made. Seedling tubers were shared with the USDA-ARS program at Aberdeen, Idaho, Oregon State University, North Dakota State University and Colorado State University breeding programs.
- Grower evaluations were conducted on eight russets (AC78069-17, AC83064-1, AC83064-6, AC87084-3, CO80011-5, CO81082-1, CO85026-4 and CO87009-4),

one chipping selection (BCO894-2) and two reds (CO86218-2 and DT6063-1R). Several of these intermediate and advanced clones from the Colorado program were evaluated in Arizona and California by grower cooperators, as well as the Texas A&M and University of California cooperators. Western Regional Trial entries from Colorado included AC87084-3, AC88357-3, CO86218-2, CO87009-4, DT6063-1R and Russet Norkotah Selections 3 and 8. Texas initiated a new Winter variety evaluation trial for red skin and yellow flesh cultivars in the Rio Grande Valley of Texas; 23 clones were evaluated. The 1998 trial will be planted the first week of December and will consist of 10 red and 14 yellow-fleshed clones. An additional 32 advanced red selections will be planted in an observation trial at the same location. A unique feature of these trials are that they are produced using drip irrigation. This is an important innovative production system for future potato production in the US and is especially important for minimizing foliage diseases such as late blight. Additionally in 1997, eleven different trials were conducted at Springlake, Texas.

- Non-tissue culture based seed stocks of all selections are being increased. Tissue culture based stocks are being developed of all selections in at least the sixth year of field selection, including many Texas and California selections. A cooperative advanced selection nursery was produced at the San Luis Valley Research Center. Both Texas and Colorado personnel were involved in the evaluation of this material.
- Two Colorado Russet Norkotah clonal selections (line selections, strains, sub clones) continue to show commercial value in several areas of the US. Seed stocks are rapidly being increased to meet commercial demand. The Texas Russet Norkotah Strains (TXNS112, TXNS223 and TXNS278) continue to show great promise with yield increase of 20-30% over the standard. All were included in the WRCC trials in 1997. Several other Texas R. Norkotah strains are also being evaluated. It is anticipated that more than 15,000 acres of the strains will be planted in 1998, due to high grower demand for a replacement of the standard R. Norkotah.
- A concerted effort was initiated this fall to evaluate all advanced selections for postharvest disease reaction to dry rot (*Alternaria solani* and *Fusarium* sp.) and soft rot (predominately *Erwinia* sp.).
- Thirteen advanced selections are being evaluated by a cooperator in the CSU Department of Food Science and Human Nutrition for improved culinary, dietary and other human health benefits. While the anti-oxidant and skin set work is progressing, the reduced funding level has inhibited significant progress on this work.
- Cultivar specific management profiles are an integral part of cultivar development if success of the new release is desired. Advanced selections from Colorado are entered into trials for nutrient management, herbicide tolerance, spacing and growth analysis at least one year prior to growers trying the material. This gives the producer and development project the opportunity to fine tune the management of the clone together. In 1997, approximately 20 advanced selections were evaluated in various cultural trials. Two advanced clones were found to be extremely sensitive to metribuzin, CO87009-4 and AC87084-3. The Russet Norkotah line selections from Colorado, Selections 3 and 8, appear to have substantially less requirement for nitrogen, while producing a very high quality and high yielding crop. Under San Luis Valley conditions producers typically use about 225 pounds of nitrogen to produce a

crop of 400 cwt/acre. The line selections perform equally as well, or better (some producers in excess of 500 cwt/acre) at 160-180 pounds of nitrogen. The cultivar specific management profile for DT6063-1R was released to producers in 1997. This clone should be named and released in 1998 by Dr. Holm.

- Other items of interest include development of a home page for the Texas Potato Variety Development Program called AGGIE SPUDS. The URL is http://potato.tamu.edu. The San Luis Valley Research Center has also developed a home page (URL http//www.colostate.edu/depts/slvrc). A considerable amount of information is available through this source regarding potato breeding and cultivar development in Colorado.
- Four publications have been published or are in press from work completed through the reporting period by the Texas group. Colorado has also had several articles and publications out or in review during this interval.
- Texas held its Annual Field Day on June 25 at Springlake. Susie Thompson-Johns was in attendance, along with several Colorado certified seed growers. The Kern County, California Field day was held the same day at Bakersfield. David Holm attended that event.

Outlook for 1998:

- A meeting of the Southwest Group will take place January 18, 1998 in Pocatello, Idaho, in conjunction with the WRCC-27 meeting and the Idaho Potato Conference. The coordination and planning of activities for the coming year are the principal objectives of this meeting.
- Currently, 32 parental clones have been planted for intercrossing in early 1998. Primary emphasis of this Colorado crossing block is specialty types.
- Texas material has been incorporated into the cultivar specific management trials for 1998, including precutting investigations. Texas does not currently have a person responsible for such activity, so the material will be in trials in Colorado, and perhaps in some concurrent trials in Texas with a joint effort between the two programs.

## OBJECTIVES

The overall objective is to develop and evaluate improved potato cultivars to meet the production, marketing, and consumer needs of the Southwest U.S. This will be achieved by realization of the following goals:

a. Establish a uniform Southwest Regional Potato Trial for evaluation of advanced clones (breeding lines) in varying environments and production areas.

b. Develop russets, reds, chippers, and specialty cultivars for fresh and processed use.

c. Develop cultivars that compliment production and breeding programs in the rest of the U.S., particularly the Western and North Central Regions.

d. Provide a quality uniform seed source for cooperators, including scientists and growers of advanced selections, through disease-free, tissue culture based, seed stocks.

e. Develop superior sub-clones (i.e. strains or line selections) from important cultivars, as appropriate.

f. Evaluate germplasm, advanced clonal selections, and cultivars under diverse environmental conditions.

g. Screen a wide range of genetic material for resistance to disease and insect pests of economic importance to potato production in the Southwest and incorporate the resistant material into the breeding programs.

h. Evaluate cultivars and advanced clonal selections for improved culinary, dietary and other human health benefits.

i. Determine the best cultural practices for successful sustainable and economical production of advanced clonal selections and newly released cultivars, which optimize their genetic potential.

## PROCEDURES

Parents with desired characteristics will be hybridized at Colorado State University (CSU) and Texas A&M University (TAMU).

Approximately 100,00 seedlings will be produced for initial selection in Colorado and Texas. Subsequent generations of selected clones will be tested at an increasing number of locations in Colorado, Texas and California, and ultimately in the uniform Southwest Regional Trial (SWRT).

**Development of Multipurpose Potato Cultivars with Disease and Insect Resistance**

**Agreement No. 97-34141-4122**

**Principal Investigators: N.C. Gudmestad, R.Novy, J.H. Lorenzen, G.A. Secor**

**Period Covered: 7/1/97 to 11/30/97**

Progress Report. During the summer of 1997, 123,414 seedlings were grown for minituber production in the NDSU potato breeding program, representing a 33% increase since 1996. This increase in seedling numbers reflects the breeding program's efforts to develop potato cultivars resistant to late blight and early blight. Twenty-two percent of the potato families planted for seedling tuber production in 1997 had one or more parents that were identified as having late blight resistance. This past summer, approximately 7,000 potato seedlings from the previously mentioned families were screened for late blight resistance using a detached leaf assay developed by our research group. Briefly, this technique involves preparing inoculum of *Phytophthora infestans (PI)*, US-8 genotype, A2 mating type, from our culture collection at North Dakota State University. The isolate or isolates chosen are selected to insure that all possible R-virulence genes are represented during challenge inoculations to make sure that we do not inadvertantly select for major gene resistance rather than durable resistance. Inocula is diluted to $2.0x10^4$ zoospores/ml, and then used to challenge inoculate leaves collected from each family. One fully expanded leaf from each plant in a family is randomly collected. Leaves are placed into a mist room (>90% RH), and inoculated with a mist of *Pi* inoculum. The *Pi* suspension is uniformly sprayed to wetness onto the upperside of the leaves. The number of infected leaves was counted at 4, 5, 6, and 7 days after inoculation (DAI) and recorded as a percent of the total leaves inoculated. Each seedling population is screening at least twice. These evaluations provide the breeding program with valuable data concerning the frequency and degree of late blight resistance within a family at a very early stage of the breeding program.

The resistance of more advanced North Dakota selections to foliar blight also was evaluated in field plots at Prosper, ND in 1997. Whereas susceptible clones had 90 - 100% necrotic tissue by the end of August, several resistant clones with a range of 0 - 40% necrotic tissue were identified. At harvest, these resistant clones were evaluated for agronomic traits and tubers of the more acceptable clones saved. Tubers of the selected individuals also were screened for tuber blight resistance this fall. Individuals have now been identified with both foliar and tuber resistance to late blight, and these individuals will be used as parents in our crossing block this winter.

The breeding program is also incorporating genetic resistance to *Verticillium* wilt, early blight, silver scurf, PLRV, PVY, green peach aphid and Colorado potato beetle into commercially-acceptable clones. ND5822C-7 is an example of our efforts in this area. Identified as resistant to Colorado potato beetle in preliminary screenings, ND5822C-7 is also notable for its yield and tuber-type under the water-saturated growing conditions of the Grand Forks site in 1997.

The breeding program also has identified several advanced selections with the potential for release as cultivars. ND2676-10 is a bright, white chipper that may be suitable for

chipping from long-term storage from 40F without the need for reconditioning. It was entered in the North Central Regional Potato Variety Trial (NCRPVT) for the second year in 1997. In the 1996 NCRPVT, (6 trial sites) its average U.S. No. 1 yield was 248 cwt/A compared to *Snowden* at 282 cwt/A, *Norchip* at 234 cwt/A, and *Atlantic* at 317 cwt/A.

One of the highest yielding chippers in the North Dakota irrigated trials in 1996, ND2470-27 again was outstanding in 1997. It was the highest-yielding white chipper at both the irrigated Oakes and McCanna, ND sites. Average U.S. No. 1 yield across the two irrigated sites and a dryland site in 1997 was 350 cwt/A, as compared to *Snowden* at 268 cwt/A, and *Atlantic* at 322 cwt/A. It also has cold chipping properties and could be used as tablestock with high sensory ratings for boiling, baking, and microwaving in 1995 - 1997.

Among the North Dakota red selections, ND3574-5R and ND5084-3R were the top yielders in 1997. Both have a deeper red color than *Red Norland* from the field. U.S. No. 1 yields of ND5084-3R, ND3574-5R, and *Red Pontiac* averaged across the Oakes, McCanna, and Park River sites were 343, 300, and 368 cwt/A, respectively. With yields similar to *Red Pontiac*, ND5084-3R and ND3574-5R surpass *Red Pontiac* in that they produce a smaller percentage of tubers in the oversize (>3" in diameter).

Promising russet selections are ND4093-4Russ and ND4027-4Russ. These russet selections compare favorably with *Russet Burbank*. ND4093-4Russ has a nice tuber type with excellent russeting. In sensory evaluations it compared favorably with *Russet Burbank* for fry color, taste, and texture. However, its lower specific gravity may limit its use for processing. ND4027-4Russ, with favorable sensory ratings for boiling, baking, and microwaving, has a higher specific gravity than ND4093-4Russ and could be used as a dual-purpose russet

Progress has also continued in our germplasm enhancement program as a result of this funding. Foliar glycoalkaloids were determined for a population of 105 individuals segregating for resistance to Colorado potato beetle. The same population was screened for beetle resistance and phenotypic characters at three locations. AFLP markers were screened against resistant and susceptible bulks, and primer combinations were selected for population mapping, which is in progress. Additional crosses (65) were made for enhanced insect resistance (leptine + glandular trichomes) and multiple resistance (late blight, virus, nematode, verticillium).

Publications:

Balbyshev NF, Lorenzen JH. 1997. Hypersensitivity and egg drop, a novel mechanism of host- plant resistance to Colorado potato beetle (Coleoptera: Chrysomelidae). J. Econ. Entomol. 90:652-657

Lorenzen JH, Balbyshev NF. 1997. ND2858-1: a new tetraploid source of resistance to the Colorado potato beetle. Amer. Potato J. 74: 331-335

Novy RG, Johansen RH, Secor GA, Farnsworth BL, Lorenzen JH, Gudmestad NC, Holm ET. 1997. Nordonna: a red-skinned potato cultivar with wide adaptability. Amer. Potato J. 74:31-37

**Title of Project:**

Development of Multipurpose Potato Cultivars with Disease and Insect Resistance

**Project Summary:**

Potato is a food crop of major importance in the United States. Annual production is in excess of 23 million tons with a farm-gate value of nearly $2.5 billion and important value-added uses. Approximately 60% of the U.S. potato crop is utilized for processing with the balance of the acreage planted to tablestock, certified seed and other purposes.

Potato cultivars developed for both processing and fresh market/tablestock must possess agronomic characteristics such as high yield potential, acceptable dry matter content, resistance to mechanical damage during harvest and storage operations, and resistance to physiological defects such as hollow heart, black spot and internal brown center. Additionally, fresh market cultivars must have culinary characteristics that make them suitable for multiple uses such as boiling, baking and microwave cooking. Most processed potatoes are held in environmentally controlled facilities (6-10 C, 90+% RH) for up to 10 months. Thus, long-term storage properties of potatoes destined for this market, such as resistance to the accumulation of undesirable reducing sugars and freedom from disease and defects, represent a major determinant of tuber quality that must be addressed by breeding programs.

Major constraints to potato production in the U.S. include a number of disease and insect pests such as late blight and early blight foliar disease, silver scurf, *Verticillium* wilt, aphid species and the Colorado Potato Beetle (CPB). Late blight and early blight occur in nearly every production area and the fungicides used in their control contribute to the relatively high amount of pesticides that are applied to the crop on a yearly basis. Late blight can destroy the growing crop as well as cause significant tuber decay in storage. Early blight can cause yield reductions of up to 50% if left uncontrolled. Foliar fungicides are currently the most effective management tool since no resistance exists in commercially acceptable cultivars. Silver scurf is a seed-borne disease that affects the periderm of the potato tuber. It is the major reason for raw product rejection of potatoes destined for chip production and a major source of price discounts for fresh market (washed, bagged, and count-carton) potatoes. Control measures are few and no resistance exists in potato cultivars grown anywhere in the world. *Verticillium* is one of the main components of the early dying complex and also causes a disfiguring vascular discoloration that destroys the commercial value of affected potatoes. The CPB is the most important defoliating insect pest of potato in the U.S. and most other temperate production regions of the northern hemisphere. Aphids reduce yield potential through feeding activities, but also transmit potato virus Y and potato leaf roll virus which cause additional yield and quality reductions.

North Dakota State University (NDSU) has one of the leading potato breeding and germplasm enhancement programs in the nation, specializing in the development of cultivars with wide adaptability. Eighteen potato varieties have been developed and released since the late 1950's. The potato breeding program evaluates nearly 100,000 seedlings a year, making it one of the largest breeding programs in the U.S. Selections from these crosses are made in four states. For example, in recent years there have been selections in advanced regional or national

trials with prefixes such as NDA, NDO, NDTX, etc., indicating these clones were NDSU seedlings that were provided to other states where they were selected. In addition, NDSU sends advanced selections for evaluation in the regional North Central Potato Variety and the national Snack Food Association Trials consisting of eight states and seven states, respectively. North Dakota selections are also placed in eight state/provincial trials. Therefore, NDSU's breeding program is one of national importance.

Progress continues to be made in the development of widely-adapted potato cultivars that have improved horticultural and agronomic traits. Emphasis has also been placed on resistance to cold-sweetening in germplasm developed for use in potential processing potato cultivars. This resistance is currently being used by our group via traditional breeding techniques and through genetic engineering. Resistance to disease and insect pests has also become a priority. Resistance to late blight and early blight has been utilized from a number of sources. Silver scurf resistance was recently identified in *Solanum demissum* and immunity to bacterial ring rot in *Solanum acaule* by this research group. Genetic resistance to these diseases will not only improve disease management, but will also be more environmentally sound as well.

Heritable resistance sources to *Verticillium* and to CPB, derived from wild *Solanum* species, have been identified and segregating populations are being characterized. The *Verticillium*-resistant material also segregates for resistance to cold-sweetening. Wild potato species contain many negative agronomic traits, and introgression of useful resistance traits should be enhanced by utilization of molecular markers to advance resistant germplasm while eliminating negative traits.

**Objectives:**

1) Develop potato *(Solanum tuberosum* Group Tuberosum L.) cultivars for North Dakota and the United States that are genetically superior for yield, marketing, and processing quality through traditional breeding and molecular biology techniques.

2) Identify and incorporate into adapted potato cultivars genetic resistance to (a) Colorado potato beetle and (b) green peach aphid and viruses PVY and PLRV.

3) Develop germplasm resistant to late blight, early blight, silver scurf and *Verticillium* and assess introgression of resistance genes into selections with acceptable horticultural and agronomic traits.

**Progress Report:**

Although funding for potato varietal development research is now competitive, this program has previously funded a number of studies involving germplasm enhancement. Initial progress was made in determining the relationships among cold-chipping (low reducing sugar accumulators) and respiration rate and invertase activity as well as the inheritance of this trait (Ehlenfeldt et al., 1990). For example, clone ND860-2, which is a source of cold-sweetening resistance developed and used extensively in our program, as well as in other programs, was found

**CSREES Special Grants Progress Report**
**Improved Production and Utilization Technology Through Variety Development**
**From**
**David S. Douches**
**Cooperators: W. Kirk, R. Hammerschmidt, E. Grafius, G. Bird and M. Whalon**
**Michigan State University**
**East Lansing, MI 48824**

**December 4, 1997**

The Michigan State University potato breeding program produced 35,000 new seedlings for evaluation and selection in 1997 at the Lake City Experiment Station. Traits segregating in these seedling populations include yield, specific gravity, chip-processing quality, and resistances to scab, late blight, erwinia soft rot, verticillium wilt, viruses and insect pests. In addition, 1,700 8-hill plots, 300 20-hill plots and 80 30-hill plots were evaluated in the field. As a result, 1,800 single hills, 250 8-hill plots, 80 20-hill plots and 40 40-hill plots were advanced for postharvest evaluation (specific gravity, chip-processing and dormancy) and further evaluation in larger plots in 1998. Approximately 50 of the best performing lines will be advanced to replicated agronomic trials in 1998 at the Montcalm Research Farm.

At the Montcalm Research Farm agronomic trials were conducted to evaluate performance, marketable maturity and adaptability. Approximately 180 advanced breeding lines or cultivars were evaluated. Some of the best performing lines were NY101, MSB107-1, MSE018-1, MSE228-11, Umatilla Russet, MSE202-3Rus, MSB076-2, MSE222-5Y and MSE149-5Y. The strong performance of MSE018-1, MSE228-11, MSB107-1 and MSB076-2 was also observed in a series of on-farm trials. Some other promising clones that will be further studied include MSE228-1, MSF373-8, MSE250-2, MSE230-6, MSE263-10, MSF014-9, MSG104-6, MSF313-3, MSG227-2 and MSG274-3 which have scab resistance, late blight resistance and/or cold-chipping potential.

Replicated scab and late blight trials were conducted which included all the material tested in the agronomic trials. Disease infection was high in each trial. NY101, Onaway, MSNT-1, MSE221-1, Umatilla Russet, MSE202-3Rus, MSE192-8Rus, MSF014-9, Q8-2, MSE263-10, P32-3, MSG119-1RD, MSE033-1RD, and MSG227-2 were highly resistant to scab. In the late blight variety trial, the line MSG274-3 was the only line that survived the US8 genotype. Other lines with strong resistance include B0718-3, AWN86514-2, Bzura, B0767-2 and B0692-4. Lines with moderate resistance were MSE230-6, MSE246-5, MSG139-1, Nordonna, Matilda and Zarevo.

Research was conducted to identify the morphological, physiological and anatomical factors that predispose the foliar organs of some potato varieties to be susceptible to the novel biotypes of late blight caused by *Phytophthora infestans*. Also, some varieties and advanced breeding lines evaluated by Douches et al. (1996) appeared to be less susceptible to the novel biotypes of late blight. Histological investigations have revealed a) significant differences mainly in laminar topography and stomatal frequency differences between late blight susceptible and resistant advanced breeding lines and varieties, and b) major differences between late blight biotypes in their infection and foliar penetration behaviors. It appears that the degree of susceptibility of

varieties to late blight is directly proportional to the frequency of stomates on the upper epidermal surface of laminar tissue. Also, the less susceptible cultivars may have less pronounced venation, although this feature has to be investigated more fully. The novel (US8) biotype of late blight rapidly infects susceptible varieties by exploiting an unique and highly effective infection process. The zoospores of US8 biotypes directly penetrate (swim) into the stomatal cavities of susceptible varieties, encyst as normal, then produce multiple haustoria-like infection pegs and begin penetration through the mesophyll cells and into the parenchyma. Simultaneously these zoospores are producing hyphae that re-emerge from the stomatal cavity and seek out stomates for further penetrations. The infection process is very fast and an explosive infection occurs only four days after initial inoculation. The US1 biotype, appears to penetrate via stomatal guard cells and permeates through mesophyll and palisade cells relying on secondary sporulation for further spread of the infection. On resistant varieties, US8 modifies its infection mechanism to one similar to the US1 biotype and appears to be less infective. Further research is being initiated to combine "partial resistance" qualities of some potato varieties with appropriate dose fungicide management programs designed to reduce both the amount of fungicides applied and the cost of crop protection. Initial results indicate that such an approach is feasible.

Replicated detached leaf feeding studies were conducted using Colorado potato beetles collected from the Montcalm Research Farm. Potato lines tested included unmodified cultivars as well as those with glandular trichomes, high foliar leptines, and transgenic lines expressing CryIII and CryV insecticidal Bt proteins. CryIII-Bt transgenic lines showed almost no defoliation by the beetle larvae. The second most effective group of potato lines to reduce feeding was USDA 8380-1 and its CryV-Bt transformed lines. These lines showed a reduction in defoliation corresponding to 10-18% of that in the unmodified Russet Burbank control. Presence of the CryV-Bt gene did not significantly add to the effect of leptines alone. A CryV-Bt transgenic line of Spunta had 25% defoliation. This line differed from all but one of the other CryV-Bt lines tested by its lack of the b-glucuronidase reporter gene in the transformation construct. Lemhi Russet and two of its CryV-Bt lines exhibited a modest reduction in defoliation. Reduction relative to the Russet Burbank control ranged from 50-70%. Whether this was a result of the CryV-Bt gene was not clear because untransformed Lemhi Russet also showed the same reduction in defoliation even though two other Lemhi Russet CryV-Bt isolines showed as much defoliation as the Russet Burbank control. No other CryV-Bt line was effective in reducing defoliation by the beetle larvae. Glandular trichomes also did not reduce defoliation in this no-choice feeding study.

A large selection of named and numbered potato varieties are being screened for resistance to Fusarium sambucinum. Although no immunity has been found, some varieties are much less susceptible based on rate of development of the pathogen into the tuber over a four-week incubation period (MSG236-1 looks the best). Post harvest treatment of wounded tissues with chemical or biological inducers of resistance have provided good protection against infection. The mechanisms of action and tests on practical applications of this type of control are currently being investigated.

This was the first year of a formal program designed to evaluate the susceptibility of potato germplasm to plant-parasitic nematodes and soil-borne fungi: with the overall subproject consisting of five objectives. Development of the interactive database of potato germplasm with known resistance, tolerance and susceptibility to *Pratylenchus* spp., *Meloidogyne* spp., *Verticillium* spp., *Ditylenchus destructor*, *Globodera rostochiensis* and *G. pallida* has been initiated and will be completed and available on the MSU Department of Entomology website by June 1, 1998. The site for the permanent *P. penetrans-V. dahliae* nursery was selected at the Montcalm Potato Research Farm in Entrican,

Michigan, and planted to potato in 1997, for development of population densities of these organisms suitable for use in the 1998 potato germplasm evaluation program. It was determined in 1997 that most of the breeding lines reported in the literature as having tolerance or resistance to *P. penetrans* and other *Pratylenchus* spp. are not being propagated for further evaluation in relation to future potato cultivars. Seven existing cultivars (Atlantic, Chieftain, Onaway, Russet Burbank, Russet Norkotah, Shepody and Snowden) were evaluated in relation to their susceptibility to *P. penetrans* and *V. dahliae* under field conditions at the MSU Montcalm Potato Research Farm.

In the first test, mid-season population densities of *P. penetrans* recovered from soil and root tissue associated with Shepody were 65.2% less than the mean density recovered from the other six cultivars, and at-harvest stem colonization by *V. dahliae* was 53.3% lower, compared to the other cultivars. The results were the same for Shepody in the second test in relation to *V. dahliae* (49.2% less). Twelve of the breeding lines evaluated at MSU in 1997 exhibited less severe early-die symptoms than the other lines. These lines, including MSE018-1, will be field tested in 1998 in relation to their susceptibility to *P. penetrans* and *V. dahliae*. The glucose-oxidase gene, which can provide broad spectrum disease resistance, has been incorporated into 21 potato lines. Tissue culture plantlets of one or more of these will be evaluated in 1998, in relation to susceptibility to *P. penetrans* and *V. dahliae* under both tissue culture and field conditions.

# IMPROVED PRODUCTION AND UTILIZATION FOR POTATOES THROUGH VARIETY DEVELOPMENT

## SPECIFIC OBJECTIVES

1. Use conventional crossing and plant transformation techniques to genetically improve advanced cultivated germplasm and exotic *Solanum* spp. germplasm for the purposes of variety development.

2. Evaluate the agronomic performance, marketable maturity and adaptability of advanced selections and new releases from Michigan and other public and private breeding programs with emphasis on general appearance, dry matter, and external and internal defects which affect specific markets.

3. Develop and utilize disease screening procedures to evaluate advanced breeding lines, varieties, and *Solanum* spp. germplasm introductions for scab, Fusarium dry rot, Erwinia soft rot and late blight diseases.

4. Evaluate potato breeding lines and varieties for resistance to Colorado potato beetle and green peach aphid.

5. Examine the nature of resistance of late blight at the histological level.

6. Determine the nature of resistance for the control of Fusarium dry rot.

7. Identify and evaluate potato germplasm, lines and cultivars for resistance, tolerance and susceptibility to *Pratylenchus penetrans, Meloidogyne hapla* and *Verticillium dahliae*.

8. Study the market quality of potatoes for chip-processing during long-term storage as affected by variety.

Progress Report for CSREES Potato Research Project 97-34141-4189
December 1997

# Potato Variety Development & Evaluation in Maine & the Northeast
University of Maine

Bushway, Lambert, Olanya, Porter, Reeves, Sewell, Storch, Work

**Objective 1. Develop high-yielding, high-quality, disease-resistant new potato varieties of three types.**

Fifty-seven parents (19 russet, 14 white table, 9 chip selections, and 16 late blight resistant) were used in 140 crosses to produce 112,150 seeds. Greenhouse plantings consisted of 60,500 seeds from 101 families (32 russet, 20 chip, 10 round white, 30 late blight resistant, and 9 multiple disease resistant), which produced 15,542 first tubers and 4,143 seconds. The following field selection were made in 1997: from 27,791 single hills, 613 (2.2%) were saved fo planting in 1998. This planting included 3,396 greenhouse tubers fro the enhancement project of Bob Hanneman. From 252 12-hill plots, 68 (27%) were selected for winter testing and potential planting in 1998 Of the 49 60-hill plots, 42 (86%) were harvested for further testing Fifty-two advanced selections were screened for hollow heart; 31 for shatter bruise; 47 for blackspot bruise; 71 for verticillium reaction 140 inoculated with leafroll virus; 105 common scab; 68 acid scab; 7 rhizoctonia; 144 late blight; 33 virus Y; 25 ring rot; 58 golden nematode (New York); 8 corky ring spot (Florida); 107 are being teste for glycoalkaloid content; 74 will be tested for greening under fluorescent lights and 11 for soft rot reaction in December. Two selections were added to the 15 already entered into the Maine Seed Potato Board tissue culture program and the NE-184 trials.

**a. Round white table varieties.** The description of Mainestay was published in the American Potato Journal; 452 acres of seed were certified in 1997. A description of Quaggy Joe is being prepared for publication; thirty-seven acres of seed were certified in 1997. Selection AF 1437-1 performed very well in 1997. Samples of 18 advanced selections will be baked and boiled for panel tests in January

**b. Chipping varieties.** AF 875-15 has been tested in the National Snack Food Association Trials. One Virginia grower is interested in this selection; Maine seed growers are preparing to produce seed. Cold chipping selections in the Maine program include AF 1433-4 (completed testing in the SFA trials), AF 1424-6 and -7 (tested in th NE-107 trials and available for 1998 SFA tests), AF 1668-60 (also available for 1998 SFA tests). Samples of 21 selections were stored at five different temperatures for chipping in December, February and April.

**c. Long russet varieties for french fry and table.** Selections showing promise in 1997: AF 1753-16, AF 1820-1, AF 1808-18, AF 1844-2, and AF 1811-6. Other selections with low gravity, but high yields and good appearance for fresh market: AF 1753-1, AF 1826-5, AF 1291-113, and AF 1753-12. A commercial factory is interested in AF 1156-1 for amber chips. In cooperation with Dan Ronis of McCain Foods, some western russet selections have been tested: AC 83064-6 appears to hav the best potential. Samples of 27 selections have been saved for french fry processing in December.

2. **Conduct multi-site field evaluations of advanced selections.** Advanced selections from the Maine, USDA (Beltsville), New York, North Dakota, and Wisconsin potato breeding programs were tested in replicated trials at three Maine locations. Data collected included foliage disease incidence, vine maturity, yield, tuber size, internal and external tuber defects, specific gravity, and fry color. Trials at Aroostook Research Farm in Presque Isle included breeding trials in which thirty-four of the 156 selections had higher yields than standards, and an NE-184 regional trial with 45 selections. A trial at a commercial site in St. Agatha, ME (approximately 40 miles north of Aroostook Research Farm) included an NE-184 regional trial with 31 round-white and russet lines and a breeding trial (38 round-white and russet lines. Another site in East Corinth (approximately 200 miles south of Aroostook Research Farm), included an NE-184 regional trial (18 chipping lines) and a breeding trial (8 chipping lines). Differences in weather patterns, soil conditions, and management practices were observed among the three sites. Yield, quality measures, and rankings showed evidence of genotype x environment interaction. Preliminary data are being made available to the potato breeding programs and private companies that submitted lines for evaluation. Collection of fry color data begins in December and final reports will be distributed during January. In addition to the data collected at all three trial sites, sprouting characteristics, cooking quality, storage weight loss, and tuber disease incidence data were collected at the Aroostook Farm site.

Supplementing the advanced selection trials, regional cooperators received 7,244 pounds of 57 advanced lines for evaluation. (Florida 64, 8; North Carolina 275, 15; Virginia 45, 3; New York 110, 10; Long Island 135, 9; New Jersey 185, 17; Pennsylvania 5765, 28; Ohio 160, 13; West Virginia 300, 3; Wisconsin 105, 3; Nebraska 100, 2.)

3. **Coordinate regional evaluation of new selections.** In addition to establishing regional potato variety trial sites at Aroostook Research Farm in Presque Isle (45 lines) and on commercial potato farms in St Agatha (31 lines) and East Corinth (18 lines), the University of Maine prepared and shipped seed of 60 lines to NE-184 cooperators in Delaware, New Brunswick, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Prince Edward Island, Quebec, and Virginia. Reports from these trial sites will be collected and published as in previous years. Trial reports were collected from the 16 1996 NE-184 sites, compiled, and are being prepared for publication. The 1995 Northeast regional trial report was completed during 1997 and published as a Maine Agriculture and Forestry Experiment Station Miscellaneous Publication.

**Management Experiments.** A nitrogen rate x harvest date study was conducted with AF 1565-12 to determine optimum N-rates for this early maturing table line and to determine if it offered advantages (yield quality, nitrogen use efficiency) over the current early-maturing standard, Superior. In another experiment, three russet lines (A81473-2, AO77224-3, and AF 1643-10) were compared to Russet Burbank to determine if plant spacing and stem density could be manipulated optimize yield and tuber length for french fry processing. Results will be available in January. If the lines are determined worthy of commercial trials, management profiles will be developed for use by growers as they begin commercial production.

**Assess the resistance/susceptibility of potato cultivars and ,eding lines to Maine's major potato diseases and pests.**

**a. Screen selections for reactions to the major potato diseases ,nd pests in Maine.** Two populations of 102 seedlings each resulting from crosses with Helgeson's late blight resistant J117 were screened for late blight reaction in the detached leaf test. Eighteen other populations were screened in field plots; 22 resistant clones were selected for further testing.

Selections were inoculated with potato leafroll virus (PLRV) or potato virus Y (PVY) via green peach aphids raised on appropriate source plants. The 140 selections inoculated with PLRV will be examined for net necrosis in January, and will be planted in the field 1998 to be observed for leafroll symptoms. Those not showing symptoms will be tested using ELISA methods. Thirty-three selections were inoculated with PVY; obvious symptomatic selections were discarded. Those not showing symptoms will be tested in the greenhouse using ELISA methods, and planted in the field in 1998 to be observed for PV symptoms. (See also Objective 1.)

5. **Evaluate table quality of potato selections.** A trained sensory descriptive panel has been established to evaluate the flavor and texture attributes of baked potato selections. Use of consumer preference mapping has been applied to establish probable relations between consumer preference and sensory attributes. Twelve selections and three released varieties were mapped. Use of these models will provide a more comprehensive screening method to predict the likely consumer acceptance of experimental varieties.

6. **Evaluate cultivars for suitability to pre-peeling.** Tubers of St.Johns, Atlantic, Mainestay and Kennebec were processed from cold storage (40F) at 2,4,6, and 8 months post-harvest; peeled; processed with anti-browning agents; and stored at 4-6 C for testing at 0,4,7, and 14 days. Significant differences in browning were seen by variety and by storage period. St.Johns, Atlantic, and Mainestay showed less browning than Kennebec. Chlorogenic acid content, free tyrosine levels, and polyphenoloxidase activity had predictive effects on browning as measured by delta L values.

7. **Assist industry during the initial stages of potato variety evaluation and commercialization.** Eighteen commercial growers that tested advanced lines in 1997 were interviewed. Information on the production systems, current procedures for gaining experience with n varieties, and technical information needs was obtained. In Septemb samples were collected from 19 potato lines and varieties on eight farms. Yield and quality data from these samples was reported to th growers and breeding programs and will be published in the Maine Potato News. The most promising advanced lines will be recommended for 1998 commercial trials and follow-up site visits will be made t assess performance of each line.

# POTATO VARIETY DEVELOPMENT AND EVALUATION IN MAINE AND THE NORTHEAST

Alfred Bushway, David Lambert, Modesto Olanya, Gregory Porter, Alvin Reeves, Gary Sewell, Richard Storch, Therese Work.

## OBJECTIVES

1. Develop high-yielding, high-quality, disease-resistant new potato varieties of three types:
   a. Round white table varieties.
   b. Chipping varieties.
   c. Long russet varieties for french fry and table.

2. Conduct multi-site, field evaluations of advanced selections from the Maine Potato Breeding program to enhance selection of potential materials for commercial trials and eventual release in Maine and elsewhere in North America.

3. Coordinate regional evaluation of new selections from the Maine Potato Breeding Program, other public North American potato breeding programs (New York, USDA-Beltsville, USDA-Aberdeen, Wisconsin, Michigan, North Dakota, Agriculture Canada, etc.), biotechnology laboratories, and private companies under the NE107 regional project.

4. Assess the resistance/susceptibility of potato cultivars and breeding lines to Maine's major potato diseases and pests.
   a. Screen selections for reactions to the major potato diseases and pests in Maine (PVY, PLRV, verticillium, scab, late blight, early blight, net necrosis, rhizoctonia, soft rot, ring rot, Colorado potato beetle, aphids).
   b. Determine the impact of these diseases on yield and quality for optimum management of field and storage diseases.

5. Evaluate table quality of potato selections.
   a. Apply preference mapping techniques and sensory descriptive analysis to develop a more comprehensive evaluation of potato selections in the breeding and development program.
   b. Test new potato selections for culinary qualities.

6. Evaluate cultivars for suitability to pre-peeling.
   a. Identify cultivars suitable for pre-peeled refrigerated products in terms of extended shelf-life and sensory characteristics.
   b. Evaluate cultivars at harvest and through nine months of storage relative to their performance in pre-peeled refrigerated products.
   c. Use the data generated to build a predictive model for assessing the suitability of new cultivars for use in pre-peeled products.

7. Assist industry during the initial stages of potato variety evaluation and commercialization by providing research-based performance data, developing management profiles, and collecting information from commercial trials.

## PROCEDURES

**1. Develop new high-yielding, high-quality, disease-resistant potato varieties.** Potato breeding at the University of Maine and within other potato breeding programs starts with controlled crosses of parent lines chosen for superior yield, quality, or pest resistance characteristics. In the Maine program, true seed from these crosses are planted in the greenhouse yielding approximately 30,000 to 50,000 tubers for subsequent evaluation. These tubers are planted in the field (field season #1) at the Aroostook Farm Research Center in Presque Isle, ME and selected at harvest for tuber type. Typically, about 2,000 lines remain after field season #1. These lines are field tested again (12-hill plots, field season #2) at Aroostook Farm and screened for tuber type, yield, and quality. The best of these lines (approximately 100) will be retained and grown in 60-hill plots at Aroostook Farm during field season #3. Additional 20-hill observation plots are also produced during year #3 and the lines are screened for glycoalkaloid levels (Dept. of Food Science and Human Nutrition), tuber greening, and pest resistance (golden nematode, common scab, late blight, early blight, acid scab, and verticillium wilt).

1.a. **Develop new round white table potato varieties.**

High-yielding, disease-resistant named and unnamed round white table selections in the Maine Potato Breeding Program (Sunrise, Portage, St.Johns, Mainestay, Quaggy Joe, AF 303-5, and others) will be intercrossed to provide populations in which to select superior tablestock varieties.

1.b. **Develop new chipping potato varieties.**

Tetraploid selections with the ability to produce chips of acceptable color following long-term storage will be intercrossed and their progeny evaluated for processing ability following storage for different lengths of time (3, 5, and 7 months) at five different temperatures (3.3C, 5C, 7C, 10C, 13C). MaineChip, its parents, Somerset, and other unnamed selections in the Maine Potato Breeding Program will be utilized as crossing parents.

1.c. **Develop new russet dual purpose potato varieties.**

The russet selections in the Maine Potato Breeding Program have been derived from intercrossing selections from Washington, USDA, Minnesota and North Dakota. Cooperative efforts with Dan Ronis of McCain Foods have made available to the Maine program russet selections from Idaho, Colorado, and Oregon. All of these russet selections will be intercrossed and crossed with disease resistant selections from the Maine program to produce populations of seedlings in which selection will be made for yield, french fry quality, tuber type, and disease reactions.

# OREGON VARIETAL DEVELOPMENT PROGRAM

## 1997 Activities and Accomplishments

Project Leaders: A. Mosley, Department of Crop and Soil Science, Corvallis (C&SS); D. Hane, Hermiston Agricultural Research and Extension Center (HAREC), Hermiston; S. James, Central Oregon Agricultural Research and Extension Center (COARC), Madras; K. Rykbost, Klamath Experiment Station (KES), Klamath Falls; and C. Shock, Malheur Experiment Station, Ontario

Overview: Oregon workers conducted all aspects of a 65,000 progeny potato breeding program in 1997 with the exception of actual crosses. By long-standing agreement, Oregon crosses were made and botanical seeds were provided by ARS breeders at Aberdeen, Idaho. Traditional seeding and transplanting methods were then used to produce greenhouse tuber families at Corvallis for 1998 single-hill selection trials at the Central Oregon and Malheur stations and elsewhere (see below).

Depending on level of advancement, survivors of 1996 and earlier cycles were evaluated at all four Oregon branch stations, at Corvallis, on grower farms, in Tristate and Western Regional trials, and in state/provincial trials throughout the U.S. and Canada. Two Oregon selections (COO83008-1--"Russet Legend"; AO82611-7--"Umatilla Russet"), scheduled for imminent joint release by cooperating states and the ARS/USDA, have performed well in regions as diverse as Australia and Europe. Both will be protected through PVP insofar as possible. Royalties will be charged, especially outside the U.S., depending on the development of guidelines acceptable to the ARS/USDA, the industry, and cooperating states.

Certified, disease-free prenuclear test tube plants, minitubers, and rooted cuttings of advanced selections were provided to cooperating scientists and seed producers by C&SS personnel for increase purposes. Approximately 185 lbs of minitubers of COO83008-1 and AO82611-7 were allocated to Oregon seed producers free of charge in order to build up industry stocks prior to release. Preliminary reports indicate that U.S. and Canadian seed growers produced almost 300 acres of certified seed of each in 1997. Project leaders at the Central Oregon station supplied seed stocks for all replicated field trials in the western U.S and portions of Canada and for large pilot trials by processing companies including Nestle, Lamb-Weston, Simplot, and McCains.

Two tubers were saved from each of the 60,000 or so potted seedlings which tuberized in Corvallis greenhouses in 1996. "A"-sized tubers were retained for 1997 Oregon selection trials; "B's" were distributed

to: the ARS program at Aberdeen, Idaho (20,000); NDSU (15,000); and Texas A&M (20,000). Oregon progeny were therefore field-tested in more than 100,000 single-hills in 1997. Between 1 and 2% were selected for further evaluation. Similar numbers are anticipated for 1998 and after.

Resistance Screening:Field screening for disease resistance is becoming ever more important in potato varietal development because of increasing societal resistance to the extensive use of pesticides and, more recently, the advent of aggressive new strains of late blight. All entries in 1997 Tristate and Western Regional trials were evaluated for field resistance to the early-dying complex (primarily Verticillium wilt), common viruses, and rootknot nematodes at Hermiston. Entries will be further evaluated for net necrosis caused by PLRV within the next two months.

Twenty-two advanced chipping and russet selections (potential parents for Aberdeen "late blight" crosses) and 5 cultivars were evaluated for resistance to foliar and tuber symptoms of late blight at Corvallis. An additional 8 red-skinned selections and cultivars were also included. Statistically significant differences in both foliar and tuber injury were evident in the former group. Tuber infection levels for chippers and russets ranged from 0 to more than 50%. Several selections including A8792-1, A88338-1, AO82611-7, COO83008-1, and Atlantic showed less than 10% tuber decay compared to 42% for Ranger Russet and 27% for Russet Norkotah. Russet Burbank was mildly resistant to decay with only 10% infection. Interestingly, A88388-1 showed no decay while AO82611-7 (Umatilla Russet) and COO83008-1 (Russet Legend) were rated at 2.5 and 5.0%, respectively. Red-skinned selections were relatively more susceptible to decay than chippers and russets, but no statistical differences were evident. These and similar data from 1996 Corvallis screenings suggest that useful levels of resistance to both foliar and tuber expressions of late blight are achievable through typical breeding methods.

Yield and Performance Trials: More than 20 replicated comparisons of preliminary and advanced selections and named cultivars were conducted in Oregon in 1997. Entries were selected primarily from preceding cycles of the Oregon program as described above. Yield and grade information are currently available upon request but results of processing and storage tests are still being compiled. All results will be published in-state by January 1, 1998 and included in the 1998 U.S. National Potato Germplasm Evaluation and Enhancement Report collated and distributed by the ARS/USDA.

Selected advanced Oregon selections were included in irrigation and fertility trials at the Malheur, Hermiston and Klamath Falls stations. These stations, as well as the COARC, also performed (and are performing) extensive fry tests from storage. Red-skinned selections were extensively evaluated for storability by the Klamath station. KES workers also conducted a single-hill red selection trial with 2,000 entries; 36 were kept for further evaluation.

Promising Selections: The Idaho selection A8495-1 continues to perform well in Oregon trials. Smooth, oblong, russeted tubers make this clone highly suitable for tablestock use as well as processing. The Oregon red-skinned selection NDO2686-6R has shown some resistance to late blight as well as excellent promise for table use. Pending data from 1997 Tristate and Western Regional Trials, it will be rapidly increased in preparation for naming and release. Several clones of Russet Norkotah provided by Texas and Colorado cooperators have shown good potential with higher yields than the parent clone. As noted, the Oregon selections COO83008-1 and AO82611-7 will be released as "Russet Legend" and "Umatilla Russet" prior to the 1998 planting season. Both are high-yielding, attractive russets with excellent frozen processing characteristics.

Funding: Project leaders shared CSREES ($165,000), ARS ($42,000) and state and industry funds commensurate with overall contributions to the program.

## OBJECTIVES

- To identify and develop agronomically efficient, high-yielding potato varieties with resistance to diseases, nematodes, insects and stress, for frozen processing, fresh market, and chipping uses.

- To develop integrated production recommendations for optimum use of new varieties under Pacific Northwest conditions.

- To produce and allocate healthy field-grown seed of Oregon selections to cooperators for further testing as needed.

- To produce and distribute to seed growers and other interested parties, disease-free *in vitro* and certified prenuclear greenhouse stocks of Oregon selections nearing release.

## PROGRESS REPORT, 1996 (Activities partially funded by prior USDA Award No. 92-34141-7229)

Oregon successfully completed another annual cycle of a traditional 65,000-clone variety development program in 1996. Single-hill plantings were established at the Central Oregon and Malheur experiment stations. Field comparisons of advanced selections were conducted on four stations, at OSU, and on four commercial farms. Single- and 4-hill selections were made in late September by a team of PNW scientists. Another 65,000 tuberlings were produced at Corvallis to support similar efforts in 1997. Seedstocks were increased and distributed as needed for trials in Oregon and throughout the western region.

Morphological data, including Royal Horticultural Society (RHS) Color Chart readings and PVP descriptors, were collected for the 1997 release and PVP of COO83008-1 as "RUSSET LEGEND." LEGEND will be released jointly by Oregon, Washington, Idaho, Colorado, and the ARS. Since Oregon researchers identified this new clone, it will take the lead release efforts.

LEGEND produces superior yields of oblong, russeted tubers with good processing potential in most situations and excellent fresh market potential in certain short-season areas of the PNW including eastern Idaho and central Oregon. It has shown very useful levels of resistance to late blight tuber decay in Oregon, Washington, and New York. A preliminary production guideline was distributed at the January, 1997 Oregon Potato Conference to familiarize growers with optimum cultural and pest control inputs.

AO82611-7 will also be released by Oregon in cooperation with the ARS, Washington, and Idaho late in 1997. Morphological descriptors and color readings based on the RHS

# Annual Progress Report to CSREES for Potato Development and Improvement in the Northwest - Washington

Robert E. Thornton
Washington State University

The Washington potato variety development efforts are carried out by a combination of resources from USDA-CREES, Washington State University, Washington State Potato Commission and private companies. The portion funded by CSREES is known as the Tri-State Potato Variety Development and Improvement project and is a joint effort between Washington, Idaho, Oregon, and the USDA-ARS. The Washington effort address two area's 1) field evaluation for adaptability to Washington growing condition and, 2) post harvest evaluation of all entries from the three cooperating Tri-State participants.

The in field evaluation in 1997 involved both early season (four clones and four check cultivars) and late season (four clones and two check cultivars) harvests. At the early season harvest, none of the clones had total yield equal to or higher than any of the four check cultivars. Percent U.S. No. 1's was however higher in two of the four clones. Tuber specific gravity of three of the clones was higher than any of the checks. At the late season harvest, the four clones had slightly lower total tuber yield than the two check cultivars, but percent U.S. No. 1's of all four clones was equal to or higher than the check cultivars. Tuber specific gravity of the clones was not equal to either of the check cultivars.

Cultural practice evaluation of Tri-State clones compared to commercial cultivars were carried out again this year. A study of the impact of two different pre plant nitrogen rates shows that the resultant petiole nitrogen levels in most of the Tri-State material nearing release are from 2,000 to 5,000 parts per million higher than petiole nitrogen levels of Russet Burbank under the same nitrogen fertility program. These clones also have a different plant and tuber growth profile while producing equal or higher total tuber yield. Root development profiles of these clones and cultivars were scanned using a new rhizotron system developed by William Pan, Washington State University Soil Scientist. Final analysis of these results are not available at this time, but preliminary evaluation indicates root mass and distribution are different for different clones and cultivars. Evaluation of results of in row spacing studies of near release Tri-State clones is not complete at this time.

Exposure of Tri-State clones to heavy two spot spider mite infestations in 1997, as in 1996 indicates that there are genetic differences in terms of how they respond to the presence of mites. The 1996 response information was made available to Dr. Pavek the USDA-ARS potato breeder at Aberdeen, Idaho as will the 1997 results. This information provides data on which mite "resistant" parental material can be identified and these incorporated into the crossing program.

Considerable effort has been devoted this past year to bring the post harvest evaluation process more in line with the methods and values used by the potato processing industry. As a result, the 1997 evaluations will be more meaningful to the industry. Using the new criteria, post harvest evaluation of entries from the early season harvest site in North Central Oregon shows all entries highly acceptable for processing at harvest. Post harvest evaluation of the entries from

the late season harvest from the three Tri-State sites shows that two clones consistently produced higher quality french fries better than the Russet Burbank check cultivar at all three locations. An additional clone outperformed the Russet Burbank check at two of the locations.

The effect of the Tri-State program on the Washington potato industry is demonstrated by the change in acreage planted to Russet Burbank vs. new cultivars and numbered clones during recent years. Ten years ago 76% of the potato acreage in Washington was planted to Russet Burbank. In 1996, only 50% of the potato acreage in Washington was planted to Russet Burbank. The majority of the acreage planted to other than Russet Burbank was planted to cultivars and/or clones shown to be adapted to Washington growing condition using Tri-State potato variety and other Washington State University variety testing program results. The total potato acreage in Washington State in 1996 was 161,000 acres with approximately 80,000 (50%) being planted to varieties other than Russet Burbank. At least 90% (72,000 acres) of this non-Russet Burbank acreage was planted to cultivars and clones that became important as a result of variety testing efforts. With a state wide average yield of 590 cwt/A, this acreage produced approximately 42,000,000 cwt. The average price paid to Washington growers in 1996 was approximately $4.00/cwt., resulting in a farm gate value of the potatoes planted to Tri-State and other Washington variety testing program derived cultivars of $168,000,000. During the 1986-1996 time period CSREES support for the Tri-State variety testing in Washington has averaged approximately $160,000. or $16,000,000 for the 10 years. This comes out to be $10 return in 1996 alone for each CSREES dollar invested over the entire ten year period. Other funds available for the program were more than equal to CSREES contribution which results in at least a $5 return on each dollar from all sources invested over the 10 years based on 1996 production alone.

EC12.117/sk

**1997 Research Report**
**Potato Variety Development in the Northwest - Idaho Contingent**
**CSREES Agreement No. 97-34141-4199**

Within the overall design of the Tri-state (Northwest) potato breeding research project, the Idaho contingent has four major responsibilities: 1) coordinate the cooperative Tri-state trial; 2) evaluate and release as new varieties the germplasm produced and initially tested by the Aberdeen USDA/ARS breeding program; 3) publish research based information concerning optimal management practices for all newly released varieties; and 4) supply industry with limited generation seed stocks of all advanced Tri-state selections for the purpose evaluation and commercialization.

Tri-state Trial Coordination

The cooperative Tri-state was organized to provide a stage for extensive evaluation of germplasm from the Aberdeen USD/ARS and Oregon State breeding programs. In 1997, four advanced selections and two check varieties were included in the trial. Seed was distributed to Aberdeen, Idaho; Hermiston, Oregon; and Othello, Washington; the three sites where the trial is grown. In the fall, tubers were taken from each site, shipped to Prosser, Washington and subjected to processing tests. Tri-state personnel at each trial site are currently summarizing the data from each site. This data will be shipped to Idaho where it will be compiled and reports printed in preparation for a January meeting of the Tri-state technical committee.

Clone Evaluation and Release

In 1997, 86 clones were grown in 14 trials at five locations across southern Idaho. Each clone was evaluated for yield, grade, internal defects, specific gravity, bruise susceptibility, disease resistance, and other agronomic and quality traits. Four clones have performed well in multiple trial over several years and are being considered for release. For two clones, A81473-2 and A82705-1R, the release process has been initiated and should be complete in early 1998. A81473-2 is high yielding clone with oblong, heavily russetted tubers. It is resistant to most field diseases including verticillium wilt, early blight, and several viruses. A combination of late maturity and stress resistance make it well-adapted to hot, long-season growing areas. It has already proven its value in western Idaho and the Columbia Basin of Washington and Oregon. A82705-1R is a smooth, high yielding clone with dark red skin and excellent eating quality. Along with its other traits, it has long dormancy which should make it valuable in the emerging storage red market. Although the red market in the northwest is limited, this clone, to be named IdaRose, should provide many advantages to the growers supplying this market.
Two other clones A8495-1 and NDO1496-1 are being prepared for release later in 1998. A8495-1 has already become established among potato producers in Idaho and Oregon. Its major advantage over existing varieties is a combination of good yield, excellent appearance and grade, along with outstanding quality. It has the potential to increase the useable amount of

tubers in a crop from 55% to 80%, making the industry more efficient and competitive. NDO1496-1 is a round, white chipping variety. It is one of the new generation cold chipping clones that can maintain low sugars under cold storage conditions. It also has exceptional ability to recondition. It provides yield and adaptation advantages over other cold chipping clones for growers in the northwest.

In support of the Oregon program, evaluation and commercialization of two additional clones continued in 1997. COO83008-1 will be released as Legend Russet and AO82611-7 as Umatilla Russet in 1998. Both produce long-shaped russettted tubers which have excellent quality and have been rapidly assimilated into portions of the northwest industry.

Cultural Management Studies

Three types of management optimization studies, herbicide sensitivity, nitrogen requirement, and seed-piece spacing, were conducted in 1997. The purpose of the herbicide sensitivity studies is to determine if advanced selections can tolerate recommended application rates of the four most common potato herbicides. The first year of this ongoing study was successfully completed. Distinct differences were present among clones for their ability to avoid herbicide injury. The yield and quality data from these trials has not yet been analyzed.

The nitrogen and spacing studies were designed to provide growers with practical information for managing new varieties. The data has not been analyzed, but when complete will allow recommendations to be made concerning amounts and timing of nitrogen application, critical petiole nitrate levels for use in seasonal tissue testing, and optimal within-row seed-piece spacing. Results of these and other similar trials will be compiled into management guides to be distributed through the extension systems of the three states.

Seed Production

Limited generation (tissue culture based, disease free) seed of nine advanced selections was produced in 1997. This seed will be distributed to seed growers before the 1998 growing season. It will be used for large scale evaluation and as an initial source of propagation material for commercial production of new varieties upon release. Efforts were made in 1997 to develop more cooperation with growers in producing and disseminating seed of unreleased clones. As a result, 21 Idaho seed growers were directly involved in the production and sale of seed of advanced selections during 1997.

Stephen L. Love
University of Idaho

# OBJECTIVES

## Overall Tri-state Objectives

The Northwest Variety Development Project has as its single major goal to develop, release, and commercialize new potato varieties that will help keep the northwest potato industry competitive in an ever-changing market place. Objectives for the Northwest Potato Variety Development Project will be monitored by a coordinating committee made up of industry personnel (members of the Idaho, Oregon, and Washington Potato Commissions), researchers from the University of Idaho, Oregon State University and Washington State University, and researchers from the USDA/ARS.

## University of Idaho Objectives

The Idaho component of this project has the following specific objectives:

1. Evaluate potato germplasm, provided by the USDA/ARS potato breeding program in Aberdeen, Idaho and other sources, for commercial potential. Evaluations will involve close cooperation with farmers and processing industry personnel. Superior germplasm will be released as varieties.

2. Provide farmers with crop management strategies for all newly released varieties, thus helping them benefit from the breeding efforts. This implies extensive research on varietal interactions with a number of crop management factors, including fertilization, irrigation, weed control, and storage conditions.

3. Provide sources of high quality seed tubers for all newly released varieties. In part, this means close involvement with, and a financial commitment from, potato seed industry personnel.

# PROGRESS REPORT

This research was previously funded by CSREES was an Idaho, Oregon, and Washington experiment station research effort commonly referred to as the "Tri-state" program. This research began in 1985, and has since been continuous. The major objectives of the research have not changed in the twelve years since its inception. This is largely due to the involvement of the northwest potato industry which strongly supports this research, consistently reconfirms the objectives, and actively seeks political support to maintain funding.

**Dave Lavway**

From: James Parochetti <jparochetti@MORRILL.REEUSDA.GOV>
To: Dave Lavway <npcd@ainop.com>
Subject: Re: Cornell Report
Date: Monday, December 22, 1997 8:56 AM

Dave,

Here it is in email:

CSREES Special Grant - Potato Program Progress Report - December 4, 1997

The Development, Testing and Multiplication of Round Potato Varieties

Robert Plaisted, Dept. of Plant Breeding
Steven Slack, Dept. of Plant Pathology
Donald Halseth, Dept. of Fruit and Vegetable Science
Cornell University, Ithaca, New York

Increased demand for better tuber quality, shifts in major pest problems and increased production costs require new potato varieties be developed with multiple characteristics which can help keep the eastern industry competitive. Round white and red varieties with superior culinary quality and freedom from defects are needed for the tablestock market. Chip processors require varieties with high specific gravity, long tuber dormancy, and cold storage ability that can produce light colored chips from long-term storage. Numerous pests and diseases, including the Golden Nematode (GN), Colorado potato beetle (CPB), late blight and scab, are best managed by multiple resistances to reduce production and environmental costs. New sources of germplasm need to be screened for the characteristics listed above, as well as for additional potential needs such as resistance to multiple races of the potato cyst nematode, root lesion nematode, and late blight.

In 1997 129 crosses were made producing over 1,050,000 seeds for white and red skinned potatoes with emphasis on developing desirable traits of chipping, cooking, resistance to scab, late blight, potato viruses X and Y, golden nematode (races RO1 and RO2), and increased insect resistance through trichome and MEBA characteristics. All entries beyond the 2nd generation are resistant to race RO1 of the GN. Chipping evaluation begins in the 2nd generation and continues through all following generations. Some 16 families from the 3rd generation were selected for late blight screening by Bill Fry of the Plant Pathology Dept. and over 400 selections began insect resistance (MEBA) evaluation. Scab screening began with the 4th generation, with 137 clones tested in a scab field trial. Intermediate level clones were tested at one yield trial location while advanced clones were grown in an early harvest and two full season yield trials. A trial was conducted on clones with special trichome characteristics resulting in 5 clones being worthy of saving. A similar trial was held for clones having specific nematode resistance (other than race RO1 of the GN) and 6 clones were saved. Additional screening of selected clones took

place for late blight, CPB and leafhopper resistance and MEBA levels. Advanced and intermediate level clones are tested for specific gravity (dry matter), chipping qualities from 45F storage, cooking (boiling) qualities and for tuber dormancy ratings.

After extensive field screening by Plaisted through 5 to 6 generations, 12 selected R generation clones were placed into Extension yield trials at the Vegetable Crops research farm for the first time. All these R clones surpassed Atlantic's marketable yield by 5% to 54%. Sixteen advanced clones were in their second or more season of testing at the research farm. Ten chip-processing lines and one potential dicing line were compared to 5 commercial varieties in two grower trials located on mineral soils in upstate NY. Chipping samples are currently in both grower storages and will be chipped in the Spring when their facilities empty. At a tablestock trial on muck soil, we evaluated one round red and 10 round white tablestock clones. NY101, with a light yellow flesh, continues to be the top yielder in all trials. NY103 has excellent tuber appearance, high yields, good chip color from 40F storage (from previous years) and medium specific gravity. NY103 also has tuber dormancy 7 weeks longer than either Katahdin or Monona. NY112 had very high yields, good specific gravity, good chip color from 45F (from previous years), and few external defects but occasional hollow heart. NY115 had fair-to-good yield, good tuber appearance and specific gravity, and in the past has had excellent cold temperature chipping ability as low as 40F.

Commercial scale trials of 12 advanced Cornell clones were conducted by 15 growers in 1997. They grew from 4 cwt to 84 cwt of 1 to 6 advanced NY clones each, from seed propagated by the Cornell breeding program or the Uihlein Seed Farm. Growers used standard cultural practices and are able to provide information on how these new lines hold up under large scale commercial production which cannot be simulated by research programs. For those clones with processing potential, this also provides a significant volume of material, including lots from grower storage, for chip processing plants to evaluate.

Regional trials were conducted by cooperators in the Regional Project NE184 (formerly NE107) "Development of New Potato Clones for Environmental and Economical Sustainability in the Northeast" where Reba (NY87), NY101, NY102 and NY103 were available for testing in seven eastern states and Canada. NY103 and NY115 have been in the Snack Food Association potato chip variety trials conducted in 7 states. Feedback on all clones was discussed at the annual "Show & Tell" held at Cornell on Oct 29 where over 60 growers, extension agents, processors, and research faculty from New York and Pennsylvania met to share experiences with all of the CU clones. In 1997 we conducted spacing and nitrogen rate studies on NY103 and NY109 at three locations. Written annual reports and oral presentations at numerous Winter potato meetings will dissiminate information on these new clones.

An integral link in the variety development project is the maintenance of disease free seed stocks of selected clones. When Cornell developed clones reach the intermediate to advanced stage (7th generation or more) they receive a NY designation and are entered into the Cornell Uihlein Farm, the official seed potato farm for NYS. This facility is used to develop disease-free nuclear seed stocks by extensive pathogen-testing of seed originating from tissue cultured plantlets. Plantlets grown in test tubes are thoroughly screened for bacteria, fungi, numerous

viruses and the potato spindle tuber viroid. Tests include assays for PSTV; and nutrient broth and Richardson's solution assays for systemic bacteria and fungi. Clones failing any of the pathogen test screens are submitted to a therapeutic treatment as in vitro plantlets that consists of chemical and heat treatments and meristem-tip culture. Currently 7 NY numbered clones and 11 Cornell developed varieties are in seed multiplication at the Uihlein Farm. In 1997 foundation and certified seed growers produced from 0.3 to 64 acres of seed of these 18 numbered clones and varieties. Utilization of this propagation technology allows for rapidly multiplying selected clones for earlier testing and commercial seed production as discussed above. Of the advanced clones mentioned in this report: NY101 and NY103 are in full scale production in the field from plantlets in 1997 and will be replanted for distribution to seed growers in 1998, and P49- 14R, Q237-25 and R6-4 have passed all pathogen test screens and are now at he Uihlein Farm and are ready for propagation. Other "Q" and "P" clones are being accessed from the breeding program this winter and will be processed through the pathogen test screens.

For future needs a diverse set of germplasms are being screened and developed for access to several desirable characteristics. One of the mid-generation selections is Q237-25 which has excellent late blight resistance as well as resistance to RO1 and our new race, RO2, of the golden nematode, to P4A, P5A, and P6A of the white form of the cyst nematode, and probably PVY. Q244-6 is a trichome selection with excellent resistance to leaf hoppers, fair resistance to Colorado potato beetles, and resistant to the golden nematode and PVY. R6-4 is resistant to RO1 and RO2 of the golden nematode and possibly to G. pallida.

> From: "Dave Lavway" <npcd@ainop.com>
> To: "James Parochetti" <jparochetti@reeusda.gov>
> Subject: Cornell Report
> Date: Fri, 19 Dec 1997 10:53:14 -0500

> Jim,
> Could you fax me the report from Bob Plaisted at Cornell. It is the only
> one I am missing. Thanks and Merry Christmas.
> Dave
>