

NEW LOOK OF THE NORTHWEST POTATO IMPROVEMENT PROGRAM

by

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ABSTRACT

Because of the critical need for new potato varieties adapted to production and utilization in the Northwest, particularly varieties resistant to diseases, pests and physiological disorders, an integrated varietal development program has been initiated and a proposal submitted for its expansion. The potato breeding efforts in the Northwest are being integrated into one comprehensive program with each researcher conducting the portion where he can make the greatest contribution. The USDA, Prosser, Wa., portion is concentrating on developing and identifying well-adapted lines with resistance to serious disease, pest and stress problems, combined with good productivity, handling, storability and processing characteristics and compatibility in crossing. The USDA, Aberdeen, Id. portion is also involved in germplasm enhancement but is concentrating on utilizing resistant parents from Prosser and other superior breeding lines in making crosses likely to yield progenies with potential to become commercial varieties, and then screening and evaluating these progenies. State personnel in all three states, along with USDA personnel in Washington and Idaho are screening and evaluating seedlings, along with early generation and late generation clones for important resistance, production, handling, storability and processing characteristics. USDA personnel at Prosser and state personnel in Idaho and Oregon are eliminating viruses from promising lines by meristem culturing and personnel in Oregon and Idaho are increasing seed for trial and eventual release as new varieties. This coordinated approach is fully and effectively utilizing the expertise available in the Northwest for the immense, complex task of developing superior new potato varieties and getting them out to the potato industry for large scale trials and commercial use. This approach should improve the probability of developing and identifying varieties superior to the trouble-plagued Russet Burbank. Such varieties will bolster the western potato industry and improve our ability to export potatoes to Pacific-Rim countries. A major increase in funding will be required to fully implement this integrated approach to varietal development.

INTRODUCTION

Three western states, Idaho, Washington and Oregon, produce approximately 46 percent of the total U. S. potato crop and account for well over half of the fall production. Over 150 million cwt. are produced on close to one-half million acres. Farm gate value of the 1981 northwest crop approached \$750 million but total value to the region was much higher, since about 50 percent of the crop was processed in local plants and many local businesses service the growers and processing companies. Total worth of potatoes to the region easily amounts to \$5 billion annually. This large industry has an important influence, directly or indirectly, on a significant portion of the labor force in the Northwest and involves many tens of thousands of jobs. The entire economies of many northwest communities revolve around the potato.

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Potato production practices are similar throughout the Northwest, although differences in temperature and length of growing season allow some local accommodations. Crops are grown under semi-arid, irrigated conditions. Yields are unsurpassed, almost doubling the national average in some cases. Quality is also outstanding. Almost two-thirds of the Idaho crop and up to 80 percent of Columbia Basin potatoes are processed into frozen French fries and other products. Northwest potatoes are marketed primarily in eastern U.S. population centers.

Northwest growing conditions are sufficiently uniform that the region relies almost exclusively on one variety, Russet Burbank. Russet Burbank is not especially high yielding, but is a russet-skinned variety which usually stores and processes satisfactorily. It's unique long shape, russet skin, and internal quality have also made it a favorite for baking and other fresh uses, and consumers have willingly paid a premium price for this variety. These attributes, plus the fact that it performs better in the arid west than in other areas have made Russet Burbank a trademark for the region. This variety has been grown for more than a century and still accounts for over 80 percent of the northwest crop and is largely responsible for the success of the northwest potato industry.

Russet Burbank has several good qualities but it also has serious deficiencies. It is susceptible to a number of early-dying diseases, including Verticillium wilt, caused by a soil-borne pathogen, which progressively reduces yield and quality each year that a field is cropped to potatoes. This and other early-dying diseases have reduced western yields by as much as 25 to 30 percent. In the Columbia Basin yields have declined from 35 tons/acre in virgin fields, to as little as 20 tons/acre after only four or five crops of potatoes. Similar decreases have occurred in Idaho and throughout the rest of the Northwest. The only effective control for Verticillium wilt at present is annual soil fumigation which costs up to \$300 per acre. Fumigation and all other non-genetic methods afford only expensive, temporary control.

Russet Burbank, unlike most potato varieties, is also susceptible to net necrosis caused by the aphid-transmitted potato leafroll virus. Growers are forced to use expensive insecticide control measures costing up to \$50 per acre.

Physiological disorders of Russet Burbank include hollow heart, internal necrosis, sugar-end, and off-shapes, which cause tens of millions of dollars in annual losses. High levels of irrigation and fertilization are required to produce an acceptable crop of Russet Burbank because it is so sensitive to any environmental stress.

These combined disease, pest and stress problems make Russet Burbank very expensive to grow. In the past, the Northwest has been blessed with the ready availability of cheap power, water and fertilizer, but these resources are now becoming scarce and expensive. The added expenses of using luxury amounts of these resources on Russet Burbank are rapidly making the production of this variety uneconomical.

High production costs were tolerable when transportation was cheap and western-grown Russet Burbanks commanded a premium price. But that situation is changing. It now costs \$5-\$6/cwt., about half the market value of fresh potatoes, to ship whole potatoes or frozen fries to major eastern markets from the Northwest and \$10-\$15/cwt. to ship the same potatoes to new markets opening in the orient. Improved irrigation methods and the opening of new land in the Midwest now allow Russet Burbank to be produced closer to the eastern markets. Promising new russets adapted to midwest and eastern growing conditions are now being released and are filling the markets normally reserved for western-grown Russet Burbanks.

The use of natural resources and production costs must be lowered for northwest growers, packers and processors to remain competitive. Refined cultural, pest control, and irrigation practices could reduce costs, but not enough. Better varieties are needed. Fortunately, genetic resistance to Verticillium wilt, net necrosis, and most of Russet Burbank's other faults is available in domestic potato or wild relatives of potatoes. However, combining

these traits into a variety which yields, handles, stores, processes and has a desirable appearance will be very difficult and expensive. It will require the combined efforts of seed and commercial growers, shippers, processors, state universities and the ARS, USDA.

Potato breeding efforts in the Northwest, and the remainder of the West, are now severely limited. Compared to the breeding effort and funding in other areas of the U. S. and other countries, the potato breeding program in the western states is very weak and inadequate. All varietal crosses for the West are made by only one breeding program, the USDA program with its two centers at Aberdeen, Id. and Prosser, Wa. Approximately 60,000 new seedlings (clones) are generated annually. Only a few of these will show enough promise to be evaluated throughout the region. This is not nearly enough to meet the critical and diverse needs of a huge region extending from the Canadian border to Mexico and from the Pacific coast to the Rocky Mountains and beyond into Colorado, Texas and even up into Alaska, now that the USDA potato breeding program there has been discontinued. Breeding programs in other areas of the U. S. are annually looking at several hundred thousand seedlings. Small countries like Poland, The Netherlands and Germany traditionally look at millions of seedlings each year in their breeding programs.

The potato is genetically complex and crosses are unpredictable. When two well-adapted commercial varieties are crossed they will produce progeny with a wide range of yield, size, maturity, shape, skin, color, quality, storability, handling and resistance characteristics and most of the progeny will be seriously weak in one or more of these characteristics. Only about 3% of the first generation are within the range of marketable type and quality. If disease resistance and other improvements are also used as a basis of selection, in combination with the acceptable type and quality, the probability of finding the desired combination of characteristics is even further greatly reduced. Therefore, the probability of developing and identifying improved potato varieties approaches "one in a million".

Workers in Oregon, Washington and other western states cooperate in testing advanced clones from our USDA program, which improves the effectiveness of this program. This cooperative testing and evaluation effort, which includes Western Regional Potato Variety Trials involving six states, has now been operating for several years. However, the success of this limited potato variety development and evaluation program has been minimal and it is evident that much more effort is needed.

Lack of funding has not only limited number of new seedlings and clones available for selection, but has also caused two other serious hinderances; first a lack of good resistant parents, and second, a great amount of virus contamination in the seed tubers used for breeding and performance trials. Much more funding and effort need to be devoted to development of superior parents and the elimination of viruses from breeding parents and early and advanced generation progeny lines being evaluated. Improved, resistant varieties can only be developed by use of parents that have the needed resistance, productivity, handling, storability, quality and processing characteristics. But it also does no good to produce more and higher quality seedlings and clones if they cannot be properly evaluated and later used for increases for large scale trials and commercial use, because of debilitating viruses in the seed.

It is easy to see that the use of better breeding parents, the production of cleaner seed, and the more accurate evaluation of larger numbers of clones in the Northwest is going to be needed if we are to have a chance of developing the desired superior new varieties so critically needed. The level of funding and effort presently being expended is very inadequate to accomplish this immense task. Increased funding, personnel, and equipment are critically needed and these needs are the basis for the following proposal.

PROPOSAL

A. Overall Objectives:

Recognizing that new varieties are urgently needed in the Northwest, potato industry personnel in Idaho, Washington and Oregon have developed a proposal which will provide adequate funding to (1) improve breeding parents and at least double the number of seedlings available for selection, (2) insure good quality tuber seed for the breeding, selecting and testing processes, and (3) promote cooperation and an organized approach among researchers and industry personnel in the three states in the search for new varieties. As envisioned, this effort would be one program with individual segments handled by those state, USDA or industry units best suited to the task, with coordination through a coordinating committee (Fig. 1).

Improving Breeding Parents and Increasing the Number of Selections. The Northwest breeding effort needs a larger quantity of higher quality seedlings from which to select new varieties. The quality of the seedlings will be improved by using improved parents developed through germplasm enhancement efforts at Prosser and Aberdeen. Germplasm enhancement efforts at Prosser will emphasize identification and characterization of disease, pest and stress resistances obtained from domestic, wild and exotic sources and combining these resistances with each other and other desirable characteristics (Fig. 2). Enhancement of a number of productivity, quality, storability and processing characteristics will be emphasized at Aberdeen. Intercrossing the lines from these two germplasm enhancement programs will result in superior breeding parents and thus, improved seedling populations for selection.

The 60,000 new seedlings currently screened in the Northwest will be at least doubled by additional new crosses at Aberdeen and production of seedlings at both Aberdeen and Corvallis, Or. (Fig. 3). The Oregon and Aberdeen programs would be similar, but with different clones during years 3 and 4. Early generation selection at Hermiston, Or. will be done under disease, pest and stress exposures representative of the Columbia Basin area of Oregon and Washington. This selecting will involve close cooperation of researchers from both Oregon and Washington and is intended to serve the needs of both Oregon and Washington potato industries. Information and clones would be freely exchanged between the three states. Some administrative matters and maintenance and compilation of records would be handled in common to reduce costs. Interchange of clones among the three northwestern states and with other western states would increase during years 5 and after.

Increased selection pressures will rapidly decrease the number of clones each year in a given breeding cycle. However, new crosses will be made each year and a new crop of seedlings produced so the "pipeline" will continually be refilled. Replicated trials will begin as soon as possible but will occur at a number of locations in year 5 and continue until each clone is either named and released, selected as breeding parent, or discarded. Cultural trials exposing clones to different fertilizer, tillage, and irrigation levels will be conducted in central Washington and south central Idaho and the information made available to all cooperators.

The reaction of clones to soilborne, foliar, viral, and storage diseases and pests, including Verticillium wilt, will be noted at all locations. But clones will be specifically screened for resistances in disease and pest nurseries at Prosser, and to some extent at Aberdeen and Hermiston.

Selections will be screened for internal quality and processing potential at Aberdeen (Aberdeen clones) and at Hermiston and/or Powell Butte (Corvallis clones). Promising clones entered in the regional trials and/or expected to be released will be thoroughly evaluated for storage potential and processing quality at Pullman and Aberdeen. Processing companies and fresh market shippers will also participate in large-scale tests of any advanced clones being considered for release as varieties.

Varieties will be named and released jointly according to guidelines developed by the USDA/state-sponsored WRCC-27 technical committee.

Insuring Good Quality Seed. Virus-infected seed tubers have been a major deterrent to varietal development in the Northwest. Sap- and insect- transmitted viruses, such as PVX, PLRV, and PVY, have been troublesome to the point that yield and quality comparisons between clones have often been meaningless. The availability of satisfactory seed is absolutely essential to the success of this varietal development program.

As shown in Fig. 2, at least one tuber from each of the Corvallis greenhouse seedlings will be planted at Powell Butte for the purpose of maintaining seed quality in year 3 and thereafter. The Powell Butte site is located in a good seed production area and also affords an excellent shortseason selection site. Station personnel there are familiar with varietal selection and seed production procedures.

A second tuber from each Corvallis seedling will be planted in field selection trials at Hermiston. Hermiston is an excellent long-season, disease-infested selection site for the Columbia Basin area of Oregon and Washington and some parts of Idaho. The Hermiston research station itself is in a commercial potato production area and subject to heavy aphid pressure which provides excellent virus disease exposure for resistance screening. However, this advantage can also be a serious disadvantage. Many of the promising selections will not be resistant to one or more of the aphid-borne virus diseases. Maintenance of clean seed of these virus susceptible clones for even a year or two is very difficult.

Means are being developed to maintain the identity of the individual seedlings at both the Hermiston and Powell Butte locations so that when promising seedlings are selected at Hermiston, clean tuber seed of that seedling can be saved from Powell Butte for further trials.

In spite of all precautions, some promising clones will become virus infected. Therefore, it will be necessary to eliminate viruses from some clones by meristem culturing. The virologist at Prosser will develop virological methods and resources needed to resolve the virus problems in the breeding program. Meristeming will be done at Prosser and Corvallis. Clean clones will be increased at Powell Butte for use in the Oregon and Washington evaluation programs. Throughout the maintenance and increase of tuber seed, appropriate precautions will be taken to insure that ring-rot, potato spindle tuber and other serious contaminants will not infect the seed.

Seed of Aberdeen clones will be maintained at Tetonia. Station personnel are familiar with seed production and Tetonia is ideally situated with respect to minimizing virus contamination. Stringent disease control and testing procedures will be used. Aberdeen clones which require and merit virus eradication, will be freed of disease by meristem culturing at Moscow and returned to Tetonia for increase.

Cooperative Testing and Selection. The proposed plan would not only increase the quality and quantity of new seedlings and clones and improve seed quality, but would also enable state, USDA and industry workers in the Northwest and other western states to become more organized and systematic in developing, selecting and testing clones. Assigning segments of the variety development process to various state and USDA units would increase efficiency and reduce duplication. Increased involvement by fresh market shippers and processing companies in the selection process would also expedite the identification of superior new lines which could be released as varieties. A systematic, organized selection and testing procedure is equally as important as the breeding of superior clones and the availability of a sufficient number of clones and clean seed of these clones.

B. Potential Benefits:

This proposal will hasten the development of new potato varieties adapted to production in the Northwest, the most efficient potato production area in the world. With new, improved varieties, the growing, shipping and processing of potatoes in the Northwest could continue to be profitable. The large number of employees in the potato industry and those companies which serve the industry, will continue to have jobs. Failure to implement this

integrated and expanded breeding effort could result in a serious decline in an industry which is extremely important to the economy of a wide area.

The Northwest is actively developing markets for seed, table stock and processed potatoes among Pacific-Rim countries. Russet Burbank is not as well adapted or accepted in these countries as in the U. S. It is difficult to grow and plagued by many disease, pest, stress and quality problems. It seems likely that new, productive, high quality, resistant varieties, some of which might be radically different in appearance from Russet Burbank, could enable the Northwest to be competitive in the export market that is so important to our country's balance of payments.

Fig. 1. Proposed Tri-State Potato Variety Development Coordinating Committee

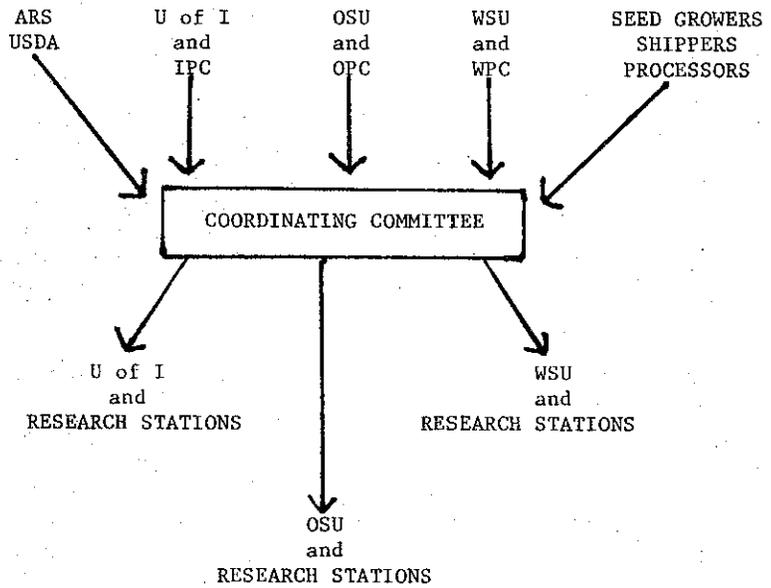


Fig. 2. Germplasm enhancement and maintenance procedures to provide superior breeding parents for the crosses leading to new varieties.

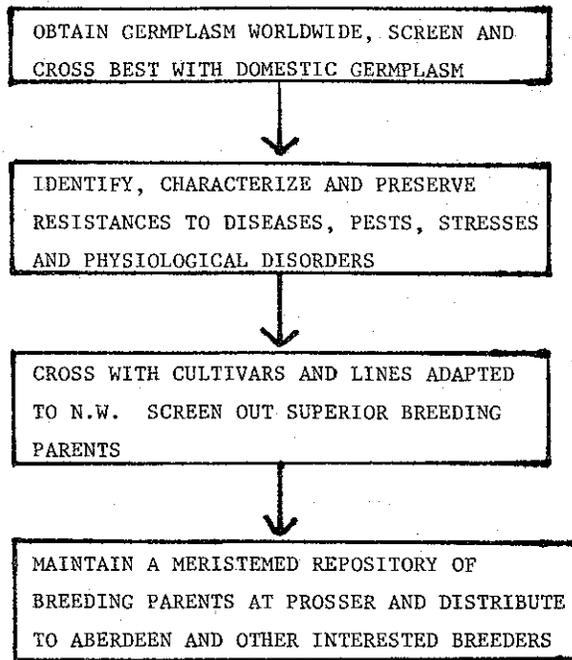


Fig. 3. Crossing and production of seedlings to be screened for improved new varieties.

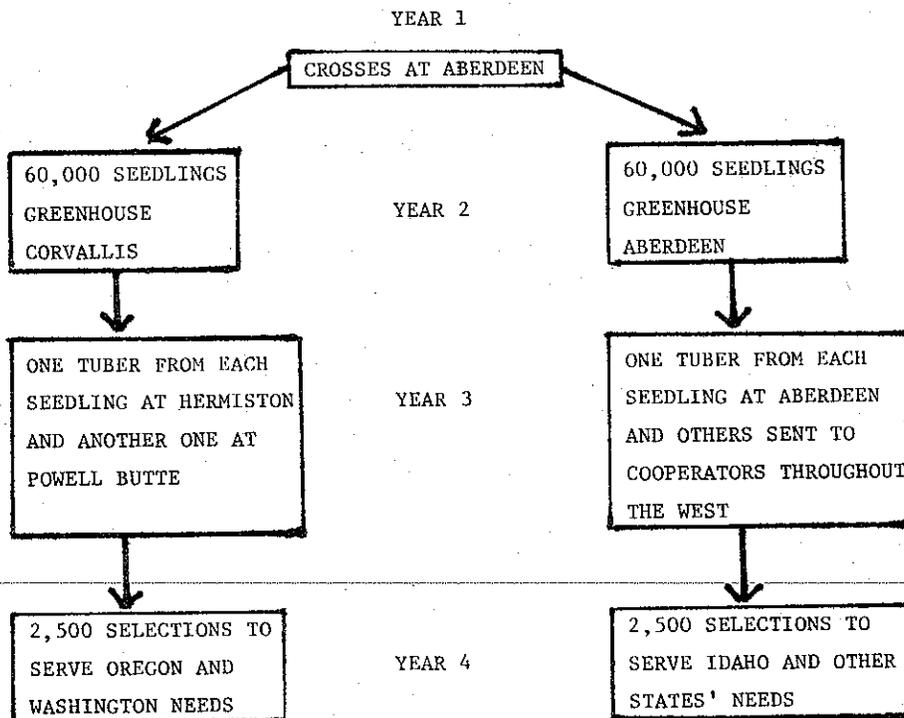


Fig. 4. Early generation screening of clones showing promise as improved new varieties.

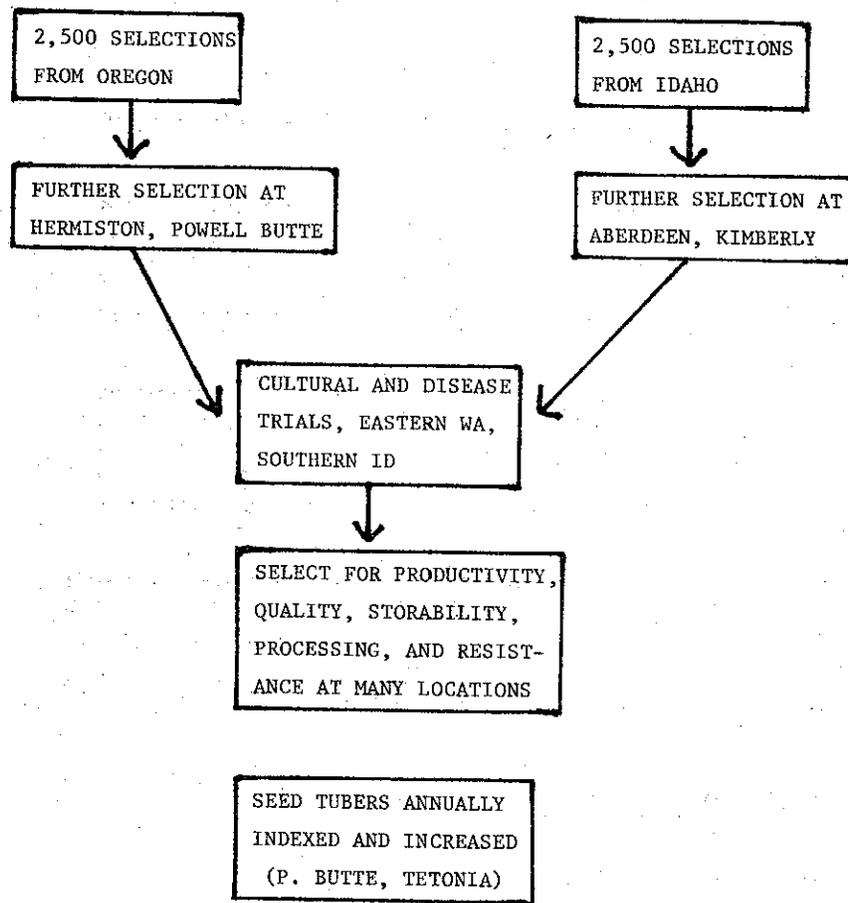


Fig. 5. Evaluation of advanced clones to determine potential for release as improved new varieties.

