POTATO IMPROVEMENT BY BREEDING

by
Mark W. Martin

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OLD VARIETIES HAVE SERVED US WELL

The Northwest is blessed with an ideal climate for producing potatoes and during the past 30 years has had a continuing supply of new land coming under irrigation. This new land is relatively free of soilborne potato diseases and has the capacity to produce very large yields of high quality potatoes. Fortunately, three potato varieties are available that are well adapted to production in the West. Two of these are also suitable for use in the frozen french fry industry which has become such a dominant factor in potato production in the Northwest. Limited acreage in the Northwest is planted to Norgold, and early fresh market variety, and Kennebec, an early processor. The bulk is planted to Russet Burbank, a 100 year old variety which Western growers have learned to grow well. They have exploited this variety and built a premium market upon its virtues, in the process making it the most important variety in the United States.

THERE IS ROOM FOR IMPROVEMENT

All three of these varieties have serious problems which detract from their usefulness and reduce their production potential. They are susceptible to most of the foliage, soilborne, rot and physiological diseases that affect potatoes and, in general, are very adversely influenced by environmental stresses. As new land becomes less plentiful and potatoes must be planted on the same ground repeatedly, the disease susceptibility of these varieties will become much more important. Also, water and energy resources in this country are depleting and it is important to have varieties that are not so adversely affected by drought and lower fertility levels. Even though the Northwest has been able to reach new highs in production/acre with the use of these old varieties, there is still a definite potential of making even further major advances in productivity, processing quality, disease resistance and nutritional value by breeding.

SOURCES OF GENETIC IMPROVEMENT

A cooperative USDA breeding program, being conducted at Aberdeen, Idaho, and Prosser, Washington, supplies most of the new clones being tested in the West. Some new clones are also brought in from breeding programs in North Dakota, Alaska and Maine. Horticulturists in Oregon, California, and Colorado also have intensive variety development programs in which they obtain early generation material from the various breeding programs and select for adaptability to production in their respective states. Genes for disease resistance and improved processing and nutritional quality are introduced into these breeding programs from throughout the world, including wild relatives of the potato from South America.

THE PROBLEM IS RECOGNIZING A GOOD ONE WHEN YOU SEE IT

By the use of flowers on our wide array of gene sources, crosses are made to lines known to be adapted to the West. True seed is thus produced in the small seedballs on the tops of plants. A wide range of plant and tuber characteristics are obtained when the seed of these crosses is planted. Hopefully, among the hundreds of highly variable new clones from each cross there will be at least one that will combine the favorable characteristics of the two parents and result in a line offering improvements over currently-grown commercial varieties.

The challenge is to sort out that rare outstanding clone. The fact that Russet Burbank with all of its weaknesses is still with us is good evidence that this is not an easy task.

The great majority of new clones resulting from crossing are worthless. Usually only 1 to 5% of them are considered worth taking a second look at. Most of these selected clones are soon eliminated because they don't look especially good in small plots. The standard practice in potato breeding, therefore, is to produce hundreds of thousands or even millions of clones from true seed and select thousands of individual hills for a small plot evaluation. As weaknesses (often of a cosmetic nature) become evident in these selections thay are eliminated and only a few are thoroughly evaluated to determine if they have the overall potential of replacing current varieties.

Potatoes respond greatly to small differences in their environment. A variety that looks great in one location or one year will often look very mediocre in another location or year. Therefore, to adequately judge the potential of a given clone it must be seen in as wide a range of environments as possible. Under current low budgets prevelant in agricultural research, only a small number of clones can be adequately looked at and, consequently, many hasty decisions are made based on very limited information or observations.

A NEW MASS SELECTION METHOD OF BREEDING

Rapid progress in potato breeding is being made at Prosser by a new highly efficient method of mass selection for specific tuber characteristics in F_1 and F_2 progenies. True seed from crosses and from natural pollinations is planted directly in fields infested with scab. Resulting tubers are bulk harvested, washed, run through a salt bath and the low specific gravity tubers that float in salt water are discarded along with those that have growth cracks, malformations, or scab lesions. Remaining tubers are stored on screens at 50 to 60°F and low relative humidity until tubers with poor storability can be eliminated. Tubers with hollow heart and other internal disorders are eliminated at seed cutting. From each year's seedling crop we hope to obtain 5000 to 8000 C_1 tubers that can pass through this initial screening. These are cut as tuber units and planted with red-skinned seed-pieces between units. At harvest, C_2 clones approaching acceptable types are saved and evaluated for the same characteristics as were the C_1 tubers. The best 1000 to 2000 clones are then each assigned a number and evaluated the following season in 4-hill plots in each of several cultural conditions and disease nurseries. Two seedpieces from each clone are also planted in a disease-free, seed-increase field. Three years from true seed selection of the clones to be placed in advanced performance trials can be made with confidence.

THE KEY IS A THOROUGH LOOK AT EACH CLONE

Our method of breeding emphasizes the evaluation of each of a large number of clones for adaptability to production on both sandy and loam soils and with both sprinkle and furrow irrigation. This adaptability at each location is measured by plant growth and the following tuber characteristics: yield, grade, size, shape, malformation, knobs, flatness, pear shape, uniformity of size, russet skin, elephant hide, growth cracking, specific gravity, hollow heart and raw color. The tubers are stored and evaluated for weight loss, sprouting, rot and sugar accumulation. In addition, each of the clones is placed in disease and insect pest nurseries to determine its reaction to leafroll, early blight, powdery mildew, Verticillium wilt, scab, deep-pitted scab, sclerotinia, Colorado potato beetle and spider mites. After evaluating 1000 clones for all these characteristics, we are able to choose the most promising clones with much better basis of judgment than in the traditional breeding program where early generation clones are looked at in single small plots at one location and the all important decision as to whether to save given clones is based on how they look when harvested.

EXCITING RESULTS BEING OBTAINED

After only limited experience with this method, we have selected many exciting lines with combined resistance to several diseases that produce high yields of tubers with excellent processing quality and high nutritional value. In only three years we have been able to accomplish the following:

1. We now have a number of lines that have the potential of replacing Russet Burbank, especially as a processing variety. These lines appear to offer significant improvements in yield, quality, grade and resistance to foliage, soil borne and physiological diseases.

2. We have selected four, early, fresh market lines that can be harvested at the same time as Norgold, but will yield more and have better quality, disease resistance, storability and processability.

3. We have found processing type lines that are as early and productive as Kennebecs, but yield a better processed product and store well.

4. In cooperation with C. E. Ryan, protein chemist at WSU, we have developed a series of lines with higher levels of protein than any commercial variety and yet they are high yielding and disease resistant.

5. In cooperation with P. E. Thomas, virologist at Prosser, we have developed lines with high levels of resistance to leafroll, both the foliar and tuber net necrosis phases of the disease.

6. In cooperation with G. D. Easton, pathologist at Prosser, we have developed lines with resistance to Verticillium, shallow and deep-pitted scab, powdery mildew and early blight. These diseases cause major losses to potato producers in the Northwest and large amounts of money are spent for their control.

7. In cooperation with R. S. Stark, entomologist at Prosser, we have developed promising lines with resistance to Colorado potato beetle and spider mites, both of which cause serious losses in the Northwest if not controlled by expensive insecticides.

8. In cooperation with D. E. Miller, soil scientist at Prosser, we have selected lines with the ability to produce a crop with less water and fertility than current varieties. This ability could be very important if energy to produce fertilizers and pump water becomes less plentiful and water supplies diminish.

We will now place major emphasis on developing methods and facilities to increase large quantities of pathogen free seed of these promising lines so they can be evaluated by growers and processors.