

Breeding For Improved Tuber Quality and Storage Characteristics

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Potatoes from the Red River Valley have a reputation for quality. This quality is a product of the varieties, the soils, and the dryland conditions under which they are grown. These conditions produce potatoes with a high specific gravity and a flavor superior to that found in potatoes grown in other areas. This high specific gravity and superior flavor make Red River Valley potatoes in demand on both the processing and table stock market.

Although the reputation of Red River Valley potatoes is second to none, there is always room for improvement, as standards move increasingly upward. The breeding program for tuber quality seeks to maintain the high quality of Red River Valley potatoes through the ongoing production and evaluation of new materials. This program addresses both basic and applied aspects of tuber quality and aims to produce materials which can be useful in the NDSU varietal breeding program.

COLD CHIPPING ABILITY

The *Solanum phureja* germplasm which has given rise to ND860-2 (a line which chips out of cold storage without reconditioning) has been a major focus of research. Understanding the nature of this characteristic is of considerable importance, and insights we are gaining into the nature of this characteristic will assist in better understanding sugar accumulation in potatoes in general and specifically will give better insights on methods for incorporating and selecting this trait within varietal materials.

Genetic studies which we have already completed have shown that ND860-2 and other cold-chipping materials have optimal combinations of genes for the control of reducing sugar accumulation. This maintenance of low sugar levels allows these materials to consistently produce light colored chips. This trait appears to be controlled by only a few genes, and in crosses evaluated so far, it has been readily recovered in even small populations (50 to 60 individuals). Typical recovery rates of superior clones average 2 to 3 percent of the population, and many more clones express low to intermediate values. This frequency of recovery should allow this trait to be incorporated into a wide range of lines.

Ongoing research studies are examining the physiological basis of this trait. One current project is evaluating what role respiration rates play in the maintenance of low sugars. High respiration levels may be one way that sugar is consumed and low reducing sugar levels maintained. Preliminary

studies suggest that this is a contributing factor, but not the exclusive factor in low sugar maintenance. A complementary study is getting under way to evaluate the role of the invertase enzyme in these materials to determine how its levels and composition differs in these materials.

GENERATION AND EVALUATION OF NEW MATERIALS

The tuber quality program screens 700 to 800 clones yearly for reducing sugar accumulation after several months in cold storage. These materials run the gamut from conventional breeding program materials to exotic species and somatic cell fusion hybrids. Some of these are acquired materials, others are ones generated through the program. In either case the goal remains to identify the best of the materials to funnel into the varietal breeding program for further evaluation and breeding.

Currently a number of interesting materials are being evaluated and developed through our program, each of which was selected for its particular merit.

One of the species being incorporated is *Solanum commersonii*. This species is a South American native which has high specific gravity and tolerance of a wide range of environmental conditions. Weather conditions of recent years have demonstrated the need for as much stress tolerance as possible in all kinds of crops. To this end, *S. commersonii* is reported not only to have considerable heat tolerance, but also to possess significant frost tolerance. This frost tolerance has been quantified in several studies at the University of Minnesota and also observed in our research plots. In September 1988 this species survived a 27 degree Fahrenheit frost with little or no damage. While survival of autumn frosts may not be critical in our area, survival of late spring frosts may be very important. This material has been incorporated into several crosses with well adapted materials and it is hoped that these advanced crosses will show as much promise as the species itself.

Among the more exotic materials being evaluated are somatic fusion hybrids of *S. brevidens* (a non-tuber-bearing species) with *S. tuberosum* cv. Russet Burbank. *S. brevidens* possesses a strong resistance to potato leaf roll virus (PLRV) and potato virus Y (PVY) and imparts these same resistances to the fusion hybrids which contain it. Studies at the University of Wisconsin have also indicated that as an added benefit, the tubers of these plants possess superior *Erwinia* decay resistance. Since *S. brevidens* itself possesses no tubers, it is unclear how quality characteristics are altered in the tubers produced by the hybrids. Currently 80 fusion hybrids are being evaluated for tuber characteristics, focusing

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mainly on sugars and specific gravity. Because these materials are in part composed of an exotic species, their yields are generally inferior. However, a few show some promise, and the best are being selected for further crossing.

Two current graduate students, Young-Doo Park and Byoung-OK Kim, are embarked on projects to generate varietal variants through tissue culture. These projects aim to produce useful variation in already highly selected materials by manipulating chromosome numbers and by altering fine scale DNA structure respectively. These projects may be expected to produce only minor changes and to yield elite lines which can be readily incorporated into advanced testing plots.

HOLLOW HEART

A new initiative being undertaken is the development of early generation screening methods for hollow heart susceptibility. This is an area of needed research since the large influence of environment on hollow heart makes it difficult to screen for susceptibility during early stages of a breeding program. Preliminary studies looking at several morphological characteristics of tuber tissue suggest that it may be possible with only modest effort to screen large numbers of clones quickly and retain only those with a low hollow heart susceptibility.