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Speeding Up Breeding of Superior Plants

Judy St. John
Crop Production, Product Value, and Safety

FORUM

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That oatmeal you ate for breakfast this morning is loaded with healthful compounds known as antioxidants. They help to protect your body from damage caused by molecules known as free radicals. Oats, for instance, are rich in the antioxidants alpha-tocopherol and alpha-tocotrienol.

But what if tomorrow's oats could provide even more of these health-imparting compounds? That's a goal of ARS oat researchers at laboratories in several states. Aiding this research is an invaluable tool of modern biotechnology. Known as biomolecular markers, gene markers, or DNA markers, these pieces of genetic material are signposts or clues. They are telltale indicators that, for example, the specific oat plant under scrutiny indeed contains the gene or genes for producing impressively high levels of antioxidants or other prized traits.

ARS scientists at Aberdeen, Idaho, and Madison, Wisconsin, are narrowing down the search for DNA markers linked to genes that unerringly indicate a high level of antioxidants in oats. Their studies suggest that superior oats for the future could have significantly more antioxidants than most conventional varieties. Similarly, they plan to use marker-assisted technology to greatly increase the amount of protein that oats can add to your breakfast. This work by scientists at the Aberdeen and Madison laboratories, done in collaboration with nutrition researchers, should greatly enhance the health benefits of tomorrow's cereal quite a bit.

The antioxidant and protein explorations demonstrate one of the most important benefits of DNA markers. The markers allow plant geneticists to move forward quickly even when the gene or genes that control the value-added traits have not yet been delineated. Relying on DNA markers sidesteps the immediate need to pinpoint the gene or genes for the prized traits. The DNA marker and the gene for the needed trait are always inherited together and so are called "reliably linked."

Capitalizing on DNA markers offers another important time-savings as well. In the past, breeders might have had to wait the full 3-month growing season to see if a newly bred oat plant had the traits they wanted. With DNA markers, however, the answer is already present in tissue that can be snipped from a tiny seedling only a few weeks old. DNA markers are detectable even in this early stage. This gives breeders the answer they need months earlier than previously possible.

In the laboratory, a DNA marker appears as a distinctive band or bands among the many bands on a thin gel. In all, the bands look somewhat like a bar code on a box of cereal. Plants lacking the trait won't have this distinctive marker pattern.

Our search for DNA markers encompasses many other crops as well, from grains to fruits to vegetables. For instance, ARS rice researchers in Beaumont, Texas, and their Texas A&M University colleagues have pinpointed markers that determine texture of cooked rice. (See "Rice Breeding Gets Marker Assists," *Agricultural Research,* December 2000, p. 11.) These markers indicate rices that are ideal for products such as canned soups or instant rice mixes. The markers were the first to be used to breed rice with tailor-made texture.

In the cocoa-producing cacao plant, and in snap beans and wheat, we are hunting for other markers that identify plants with much-needed resistance to their worst natural enemies. We fully expect our experiments in Miami, Florida, to hasten discovery of cacao plants resistant to monilia pod rot, black pod, witches broom, and other costly fungal diseases. (See "Cacao and Marker-Assisted Selection," *Agricultural Research,* August 2001, pp. 10–11.)

We are also tracking down biomolecular markers of a devastating fungal disease of snap beans, Sclerotinia white mold. (See "Looking for Genes To Protect Beans," *Agricultural Research,* March 2001, p. 21.) This disease costs U.S. growers of snap beans and other crops an estimated $18 million every year. Scientists at our Prosser, Washington, laboratory are leading these investigations.

We have also zeroed in on fungal diseases of wheat. Our team at Manhattan, Kansas, has already discovered markers for resistance to leaf rust in wheat. (See "Tagging New Leaf Rust Resistance Genes in Wheat," *Agricultural Research,* May 2001, p. 19.) These markers will be important in developing lines with multiple leaf rust-resistance genes, or "gene pyramids." This research will help breeders develop wheat with durable resistance to this disease.

Wheat plants also require multiple resistance genes to fend off attack by Karnal bunt. In this issue, we report this same team's finding of a marker for one such resistance gene. (See story on page 7.) Now, these scientists are pursuing the full complement of markers for protection against Karnal bunt.

These researchers plan to post their findings on the ARS-managed GRAINGENES database. Scientists worldwide use this fast-growing repository of new information about wheat genes and DNA markers to speed up the breeding of excellent wheat cultivars for the future. ARS is a world leader in the management of this and other genetic databases for crops of agronomic importance.

Judy St. John
Associate Deputy Administrator
Crop Production, Product Value, and Safety
National Program Staff
Beltsville, Maryland