Marker-assisted plant breeding: agricultural genetics without GMOs

As agricultural biotechnology goes, genetically modified crops (GM crops, GMOs) dominate the discussion — doubtless because of the endlessly raging debates on safety, regulation, and labeling that surround GM crops. But there's another type of biotech, one every bit as in step with modern genetics as genetic modification, poised to become at least as big a part of the agricultural landscape. It's called marker-assisted selection. Adrian Higgins, writing for the Washington Post, explains:

> [A] new generation of plant breeders [are] transforming the 10,000-year history of plant selection. And their work has quietly become the cutting-edge technology among today's major plant biotech companies. Instead of spending decades physically identifying plants that will bear fruits of the desired color and firmness, stand up to drought, and more, breeders are able to speed the process through DNA screening.

Simply put: marker-assisted selection minimizes the hefty "wait and see" period in traditional plant breeding. A plant's genes are the same when it's a seed as when it's a sprout as when it's in full fruit. Now, molecular markers are not perfect predictors of a plant's success: after all, growing up in a dynamic environment adds in variables unaccounted for in a simple genetic screening. However, it does over a powerful "preview" of large numbers of plants. As a result, breeders like Alan Krivanek, a tomato breeder for Monsanto and the subject of Higgins's piece, are able to process tens of thousands of seedlings at once and only choose a select few to keep growing. Higgins explains:

> When [Krivanek's] tomato plants were just a week old, technicians manually punched a hole in each seedling to get leaf tissue that was taken to a nearby lab, converted into a chemical soup and then scanned for genetic markers linked to desired traits.
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> Krivanek uses the information to keep just 3 percent of the seedlings and grow them until they fruit this spring, when he can evaluate fully grown plants, keep a few hundred, sow their seeds and then screen those plants.
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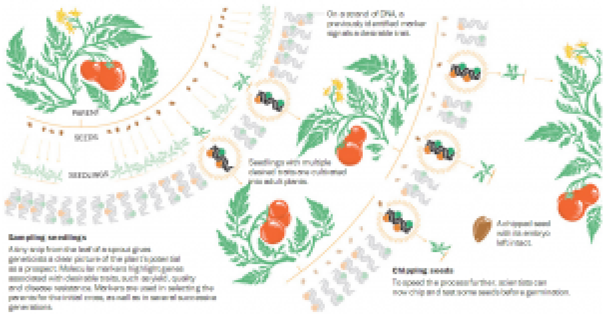
> "I'm improving my odds. Maybe I can introduce to market a real super-hybrid in five years," Krivanek said. "A predecessor might take a whole career."

The Washington Post has a helpful graphic, courtesy of Monstanto and Sygenta, showing the process of marker-assisted selection, which you can see below. (Click to view the full-resolution image on the original page.)



SOURCE: Monsanto, Syngenta, via Washington Post. Click to view full resolution original article.

Krivanek's tomatoes aren't the only example of this technology in action. In a recent GLP post (hat tip to Feris Jabr at Scientific American), I wrote about a Florida researcher using this very technique to try to breed heirloom flavors back into supermarket strawberries.

Higgins talks about differences between marker-assisted selection and genetic modification, and one of the differences is that marker-assisted selection is in some ways a more versatile tool. It essentially helps unlock the full genetic potential of a given plant more quickly. While genetic modification can provide very specific, very useful traits — and even do so across species boundaries — it has serious limitations. Some of those limitations are financial and political. Higgins writes:

> Marker-assisted breeding won't bring an end to GMOs, scientists say, because genetically engineered crops can achieve highly specific tasks now unobtainable through even marker-assisted breeding. But given the obstacles to GMO development — $100 million to create one variety, at least 10 years for regulatory approval and widespread public opposition — marker-assisted breeding has become alluring to such companies as Monsanto.
>
> It is attractive because it is a powerful tool to assemble an array of desirable traits in a plant. A GMO plant, by contrast, has been engineered for a specific task — such as containing a bacterium that would kill a certain pest.
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> "GM really hasn't delivered on its promises," said Janet Cotter, a scientist with Greenpeace's international science unit in Exeter, England. "For more-complex traits, I think people are seeing marker-assisted selection as a lot more valuable."

What amounts to an endorsement from Greenpeace, notoriously virulent in its opposition to GMOs, would seem to highlight that marker-assisted selection evades a significant portion of ire aimed at genetic modification, despite the two methods being large-scale agriculture based on cutting-edge tech.

The irony here being that, from Higgins's report, it sounds like Monsanto and the other Big Ag companies — so often portrayed as the antagonists in the GMO debate — might be moving away from GM.

> “In many ways, the company has gone beyond” genetic engineering, said Robert T. Fraley, Monsanto’s chief scientist. “The breeding technology has changed dramatically in the last few years.”

Regardless of whether marker-assisted breeding replaces genetic modification down the line as the technique of contention in the biotech culture wars, its growing success is a useful reminder of the breadth of applications for modern genetics in agriculture. It’s not all GMOs all the time.

Read Adrian Higgins’s original article at the Washington Post: “Trait by trait, plant scientists swiftly weed out bad seeds through marker-assisted breeding”

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Additional Resources:

“Screening genes for better breeding,” Patterson Clark | Washington Post

“Sleuthing The Secrets To A Scrumptious Strawberry,” Ferris Jabr | Scientific American (blog)

“Superior strawberries: How genetics can bring flavor back to the big red berry,” Kenrick Vezina | Genetic Literacy Project