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New DNA Device is a Breakthrough for Plant Breeding

by John Zakour

Geneva, NY - The matrix mill (MM) in Norm Weeden's laboratory at the New York State Agricultural Experiment Station in Geneva, NY, looks more like a high-tech waffle iron than a device that could revolutionize the science of selective plant breeding. It is an excellent example of emerging technology at Geneva that is in the process of being transferred to the private sector for commercial development.

Norm Weeden (pictured here) and co-inventors have developed a device called the 'Matrix Mill' that decreases DNA extraction time by a factor of 10. The device allows large numbers of plants to be screened at the same time and makes marker-assisted plant breeding feasible for small programs. Cornell University is looking for a partner to commercialize the technology.
Credit: R.Way/NYS Ag Expt Sta/Cornell

In the past, breeders had to go through lengthy analysis to identify the

plants that contained the specific traits they were looking for before they could use them to improve particular varieties. With the matrix mill, what once took months can now be accomplished in a matter of days.

Dr. Weeden, professor of horticultural science at Cornell who is one of the world's preeminent authorities on pea, apple, grape and bean genetics and breeding, was interested in developing the device because of the sheer numbers of plants he had to work with to find the traits he desired. "If we had to extract DNA from, for example, 2000 plants using the usual procedure, it took about 10 weeks and cost about $8,000 for extraction only," said Dr. Weeden. The MM reduces weeks to days, and the cost to about $50.

The true power of the MM comes into play with marker assisted selection (MAS). A marker is a short fragment of DNA that identifies a particular region of the genome. If that region also contains a gene of interest (e.g., disease resistance or flavor), then the marker may be used to identify plants that contain the desired trait.

"The MM makes marker assisted selection a viable alternative, especially for smaller breeding operations or crops where the profit margin is small," Weeden concluded.

The MM reduces the time it takes to separate DNA from tissue. It works by breaking up 96 small tissue samples simultaneously in sodium hydroxide which releases the tissue's DNA into the NaOH and denatures the protein. After the extraction there is one easy step: neutralizing the NaOH and simultaneous diluting the DNA sample. The DNA is then ready for analysis. This saves about 10 hours per 100 samples, i.e., 10 hours of technician time vs. about 5 minutes of technician time for the extraction.

Dr. Sue Gardiner, program leader for New Zealand's horticultural research apple gene mapping program, first used the matrix mill for rapid preparation of DNA from apple leaves last year. "The MM has the advantage of enabling rapid preparation (10 times the normal rate) of DNA suitable for molecular marker screening," she said, also noting that the MM is convenient to use without a sophisticated laboratory. "The MM was easily transported to our research orchard, where a team of orchard technicians supervised by our lab technicians performed the extractions of DNA from small seedlings prior to planting the nursery."

Last spring, Gardiner and company used the MM to prepare DNA from apple breeding populations that carry resistances to pests and diseases as well as apple scab. They use molecular markers to select the seedlings from the populations that carry the gene combinations they require. The

New Zealand apple gene mapping group works closely with WeedenÕs group, exchanging molecular markers for resistance genes as well as using Cornell's MM. "Our new apple scab resistant cultivars will have two resistances for scab pyramided into a single new cultivar of apple," said Gardiner. "Markers are necessary to identify the plants in our breeding populations that contain those two genes."

Thomas Björkman, of the horticultural sciences department in Geneva, is planning to use the MM to aid in MAS to help identify broccoli plants that are heat resistant. "Once we find a specific marker for heat resistance in broccoli, the matrix mill will allow us to identify broccoli plants that contain that marker in days instead of months," he said.

Weeden first conceived the technology for creating the MM in the spring of '95. The prototype was built and tested over the following winter with co-inventors Joe Celeste and Dale Loomis. In the 1980s, Celeste and Loomis worked with John Sanford, plant breeder at Geneva, on the development of the gene gun - a Cornell invention that so revolutionized the science of genetic engineering, its prototype sits in the Smithsonian Institute.

There are six matrix mills in existence. One is in Weeden's lab; five others are being field tested at sites that involve plant crops as well as animal tissue.

A standard MM costs around $5,000. Cornell University is looking for a partner to help commercially produce the MM. Weeden and co-inventors have applied for a patent with the help of the Cornell Research Foundation. Income generated by patents from technologies developed at GENEVA is returned to Cornell, the Experiment Station, and the inventor.

NOTE to EDITORS: Click on above photo for a 300 ppi version. If you would like a hard copy of the photo, contact Rob Way at 315-787-2357, or email rfw2@cornell.edu

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