Researchers begin to solve mystery of hybrid vigor

May 9 2006

Hybrid vigor: Corn lines B73 (left) and Mo17 (right) produce the hybrid F1 (center).

Hybrid vigor works, but no one understands how. ISU plant scientists have uncovered a key to understanding the complex molecular mechanisms of this biological process. Their findings were published in the May 2 edition of the *Proceedings of the National Academy of Science*.

For nearly 80 years, corn breeders and producers have taken advantage of hybrid vigor to grow high-yielding crops. Yet this biological process remains a scientific mystery. No one really understands why crossing specific lines of corn that are genetically quite different can produce a hybrid that outperforms both parent lines.

That could change, however, thanks to ongoing research in Iowa State University's Plant Sciences Institute. Researchers have uncovered a key to understanding the complex molecular mechanisms of hybrid vigor, also known as heterosis, which affects most aspects of plant growth and development. Once the gene activity behind hybrid vigor is well understood, scientists could more rapidly create hybrids that confer desired traits like ethanol production into the germplasm.

The research team, led by Patrick Schnable, professor of agronomy and director of the Center for Plant Genomics, includes Dan Nettleton, associate professor of statistics; and graduate students Ruth Swanson-Wagner, Yi Jia, Rhonda DeCook and Lisa Borsuk.

Their research is published in the May 2 issue of the scientific journal, *Proceedings of the National Academy of Science* ("All Possible Modes of Gene Action are Observed in a Global Comparison of Gene Expression in a Maize F1 Hybrid and Its Parents").

For the two-year experiment, the researchers used the maize F1 hybrid and its inbred parents corn lines, B73 and Mo17. The F1 is taller, matures more quickly and produces higher grain yields than both parents.

"We analyzed global patterns of gene expression in these three genotypes because this hybrid and its relatives are widely grown in the Corn Belt," Schnable said. "Also, the genetic map of corn is based on recombinant inbreds developed from this hybrid."

The researchers grew seedlings of the three genotypes in growth chambers to tightly control environmental effects. They isolated RNA from each of the three genotypes, and used a maize gene chip to determine the amount of RNA that accumulates for each gene in each of the three genotypes.

"We used this gene expression information to understand how each of thousands of genes behave in the genetic background, " Schnable said.

Using microarray technology, the researchers observed the activity of nearly 14,000 genes at the same time. The technology enabled them to look simultaneously at the gene expression of the hybrid and its inbred parents. This is the first study that has looked at hybrid vigor in any crop on such a large scale.

They found that some genes are more active in the hybrid than in both of the parental inbred lines (overdominant), some genes are less active than both inbred lines (underdominant) and most genes --78 percent -- have activity levels in between the level of the inbreds (additive).

"Several molecular models have been proposed to explain the phenomena of hybrid vigor. Some models require that genes exhibit overdominance or underdominance. Others assume that overdominant and underdominant gene expression is not an important contributor to hybrid vigor," Schnable said.

The results of the Iowa State experiment provide support for multiple mechanistic explanations for hybrid vigor.

"Although this research does not explain hybrid vigor, it begins to uncover what happens on a molecular level in a hybrid compared to the inbred parents. It shows us that there are multiple molecular mechanisms at work and that hybrid vigor is complex," Schnable said.

"To understand this important biological process, we will need to apply cutting-edge, high-throughput genomic technologies. The Plant Sciences Institute at Iowa State is one of very few public-sector organizations in the world that has the technology and resources necessary to conduct this research," he said.

The research findings provide a foundation for the Iowa State scientists to explore specific genes of interest, or investigate the contributions of the different mechanisms resulting in the gene expression patterns found. Their next step is to determine the genetic control of overdominance.

"Ultimately, it is likely that we would be able to predict which specific inbreds when crossed would produce a strong heterotic response. To a large extent, this is now a matter of trial and error. Consequently, we might be able to develop favorable hybrids more quickly for less cost. This would result in faster genetic gain," Schnable said.

Source: Iowa State University

Citation: Researchers begin to solve mystery of hybrid vigor (2006, May 9) retrieved 26 April 2024 from https://phys.org/news/2006-05-mystery-hybrid-vigor.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.