If GMO genes escape, how will the hybrids do?

November 1 2010

GMOs, or Genetically Modified Organisms, may raise concerns of genes escaping from crops and having unknown effects on natural, wild species. But what is the real risk that traits associated with GMOs will actually migrate to and persist in their wild relatives? Interest in plant ecology, crop production and weed management led John Lindquist and his colleagues from the University of Nebraska and USDA-ARS to investigate how gene flow from a cultivated crop to a weedy relative would influence the ecological fitness of a cropwild hybrid offspring. They published their findings in the recent October issue of the *American Journal of Botany*.

Grain sorghum (*Sorghum bicolor* subsp. *bicolor*) is an important food and feed crop throughout the world. The reduced digestibility of sorghum seed relative to other grains makes it a less efficient resource, even though it is highly adapted to growth in semiarid environments common to Africa, India, and the Southern and Western Great Plains of the United States. There has been considerable interest in modifying the quality traits of grain sorghum using GMO technology to enhance its nutritional value to both humans and animals raised for human consumption.

A major challenge to sorghum producers is the limited number of products available to control weeds within the crop—too many of the common products cause crop damage. To address this challenge, one of the major U.S. seed companies is developing herbicide-resistant grain sorghum using traditional breeding (non-GMO) strategies and plans to deploy them in the United States within the next 5 years.

There is inherent risk in deploying grain sorghum containing novel genes because several related species (e.g., johnsongrass, shattercane) are capable of interbreeding with grain sorghum.

Lindquist and his colleagues focused their research on gene flow between sorghum and its closely related, wild, weedy relative, shattercane (*Sorghum bicolor* subsp. *drummondii*). Lack of information on the potential gene flow from grain sorghum to shattercane is an important problem because it limits our fundamental understanding of gene transfer and potential hybridization between grain sorghum and shattercane. Their goal was to obtain baseline data using non-GMO sorghum and shattercane that would improve our ability to assess the potential risks of introducing novel genes in grain sorghum into U.S. agroecosystems.

Variation in alleles contributes to the ability of a population to adapt to a variable environment. Yet, this variation is often controlled in cultivated crops for ease of production—for example, with sorghum, all seeds germinate at roughly the same time, plants grow to a uniform height, and seeds ripen at the same time. In contrast, shattercane has seeds with variable states of dormancy, plants that grow taller than sorghum, and seeds that disperse via a shattering mechanism, ensuring dispersal before the sorghum crop is harvested. By crossing shattercane with cultivated sorghum, the authors compared how the crop-wild hybrid performed relative to its crop and wild parents in a number of traits that may be important to its ecological fitness.

By experimentally manipulating temperature conditions, the authors found different germination patterns for the three types of seeds. Although the crop-wild hybrid responded to low temperatures similarly to its wild shattercane parent—both in terms of percentage of seeds that germinated and by staying dormant and delaying germination—it responded to high temperatures similarly to its cultivated sorghum parent; non-germinated seeds of both sorghum and the hybrid died. This may be linked to their seed structures. Shattercane seeds are completely enclosed by glumes, whereas those of sorghum are only partially covered, a factor that makes them much easier to mill but does not protect them well from environmental extremes. The glumes on the hybrids are more similar to sorghum, so it is possible that despite their ability to be dormant, they may not survive well in extreme environmental conditions.

When the authors compared growth factors under natural field conditions, they found that the hybrid grew taller than either of its parent types, had greater leaf area than the shattercane but less than sorghum, and leaf emergence was earlier than in the shattercane. The authors speculate that if the three types were grown in mixture in the field, the hybrid would likely be able to capture more light and thus be more competitive than the two parent types. However, the hybrid produced fewer seeds than either sorghum or shattercane (although they were similar to shattercane at one site).

"Genes from grain sorghum, including a transgene or a traditionally bred specialty trait such as the herbicide resistance traits in sorghum, could be successfully transferred to a weedy shattercane population," Lindquist concludes. Indeed, in this case the relative fitness of the hybrid may be equivalent to that of the wild parent.

However, further research is needed. "It is imperative to know the rate of outcrossing from sorghum to shattercane," Lindquist emphasizes. "In other words, what proportion of seed on a shattercane plant will be pollinated by a nearby grain sorghum population, and how far can that pollen go?"

"Next, we want to be able to predict the overall likelihood that a gene from grain sorghum will enter the weedy shattercane population."

More information: Lilyrani Sahoo, Jared J. Schmidt, Jeffrey F. Pedersen, Donald J. Lee, and John L. Lindquist (2010). Growth and fitness components of wild x cultivated Sorghum bicolor (Poaceae) hybrids in Nebraska. American Journal of Botany 97(10): 1610-1617. [DOI:10.3732/ajb.0900170](DOI:10.3732/ajb.0900170)

Provided by American Journal of Botany