Technology Development & Agronomy by MONSANTO

Agronomic SPOTLIGHT

Biotechnology Benefits for Corn Production

- Many corn products have multiple biotech traits that provide insect protection and herbicide tolerance that promote better plant health, stress tolerance, and yield potential.
- University of Wisconsin field research trials show that genetically modified corn products (GM) have a number of benefits over conventional corn to help manage downside risk under variable yield conditions and protect yield potential.
- GM products with insect and herbicide tolerance not only protect corn yield potential, they provide other benefits as well.

The large productivity gains in corn production made during the last several decades have come primarily from advanced plant breeding techniques and improved corn management of the crop. Research has determined that about 50% of on-farm yield gains since 1934 can be attributed to improved management practices.[2] Breeding and management interact as both are necessary to sustain increased production. Yield stability across a wide range of environments is one of the most important selection targets for corn breeders.[1] Consequently, improved stress tolerance for higher planting densities, coupled with greater tolerance to environmental and pest stresses, has led to the continued corn yield improvement. [2,3,4,5,6]

Since 1996, corn products with biotechnology traits and associated agronomic practices have contributed to the steady increase in corn production by reducing pest and environmental stress on highly productive new corn genetics. GM corn products have increased corn production over a wide range of growing conditions, helping promote yield stability and reduce production risks.

Corn products with biotechnology traits have the latest technology integrated with seed genetics to help protect yield potential. Products with Genuity® SmartStax® and Genuity® VT Triple PRO® technology are innovative products that provide broad-spectrum above- and below-ground insect protection and multiple modes of herbicide action, offered with a single bag refuge solution.

Benefits of Biotechnology Corn

Improved production practices and stress tolerance in corn products can help achieve maximum yield potential. A recently published analysis of Wisconsin field research trials (1990 to 2010) shows that genetically modified corn products (GM) have a number of benefits versus conventional corn.[6] The study evaluated 2198 corn products (1250 conventional, 948 GM) at multiple sites in southern Wisconsin.

The benefits for GM corn found in this research include:

- GM corn provided more yield than conventional corn.
- GM corn responded to higher plant densities more than conventional corn.
- GM corn helped overcome the continuous corn rotation yield penalty that conventional corn experienced during the 2000 to 2005 comparison period.

The University of Wisconsin research shows that farmers planting GM corn products in a corn-on-corn rotation in 2000 had a lower potential risk of low yield (175 bu/acre) than farmers using a conventional corn-on-corn rotation (Figure 1). In 2005, the negative impact of the corn-on-corn rotation was not apparent for GM corn products but was still a problem in conventional corn-on-corn rotation (Figure 2).

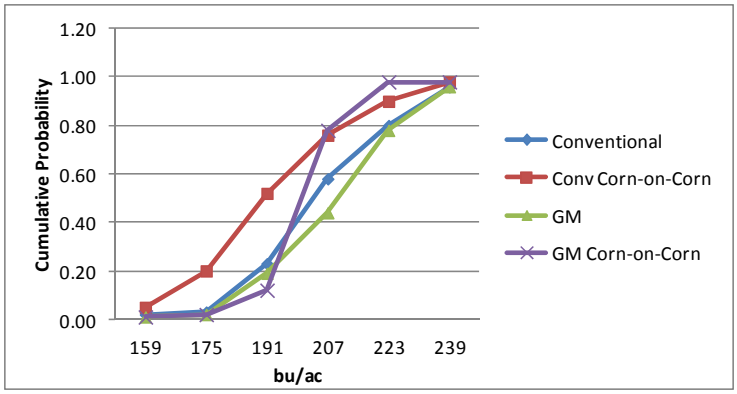

Figure 1. Corn yield distribution in 2000, comparing conventional and GM corn products in two crop rotations. Adapted from Chavas, J. et al.

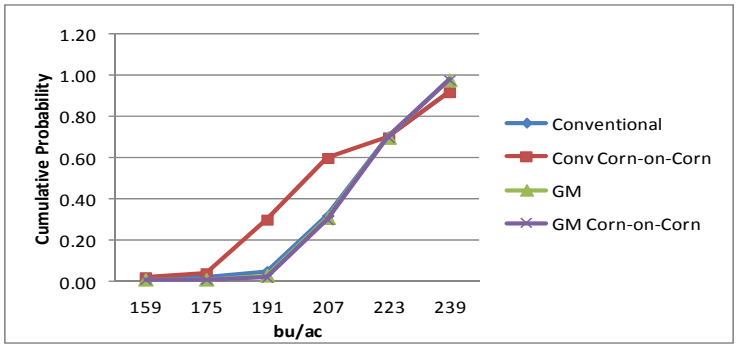

Figure 2. Corn yield distribution in 2005, comparing conventional and GM corn products in two crop rotations. Adapted from Chavas, J. et al.

Biotechnology Benefits for Corn Production

Insect Management Benefits

- Damage from the multi-pest complex (corn earworm, European corn borer, western bean cutworm, fall armyworm) causes stress and injury to plant tissue, reducing yield potential. Insect damage can allow fungi to infect, proliferate, and produce mycotoxins which have the potential to cause health problems in animals and humans.[8,9,10]
- GM corn rootworm protection has been shown to have agronomic benefits in addition to insect management. Improved root growth and activity can allow corn products to export more cytokinins from the roots and utilize nitrogen more effectively after flowering to promote higher kernel weight and yield potential.[11]
- Higher corn plant densities are important for maximizing grain yield potential. Recent agronomic research finds that economically optimal seeding densities have likely increased for many Midwestern corn farmers as a result of genetic improvements including new GM traits such as B.t. corn.[14]

Best Management Practices for Corn Rootworm

- Crop rotation to a non-host crop such as soybeans
- Plant Genuity® SmartStax® RIB Complete® corn blend products (two modes of action for CRW control)
- If rotation or Genuity® SmartStax® RIB Complete® corn blend is not an option, use a soil-applied insecticide with Genuity® VT Triple PRO® RIB Complete® corn blend products
- Regular scouting
- Planting the required structured refuge if a refuge-in-a-bag corn blend product is not utilized in the Corn-Growing Area

Weed Management Benefits

- Reduce plant stress due to weed infestations to protect yield potential and plant health.
- Remove hosts for insects, diseases, and nematodes.
- Facilitate the use of reduced-tillage for soil and water conservation.
- Roundup Ready PLUS® Crop Management Solutions provide weed management recommendations to help provide broad-spectrum weed control by using multiple modes of action.
- Corn products with Roundup Ready® 2 Technology contain in-plant tolerance to Roundup® agricultural herbicides. The system provides proven crop safety, over-the-top application flexibility, and broad-spectrum weed control.

Summary

Farmers planting biotechnology corn products with herbicide resistance and multiple modes of action insect traits can:

- Reduce plant stress due to corn borers and ear feeding insects, stalk boring insects, and root damage from corn rootworms.[15,16,17]
- Plant corn intensive crop rotations.
- Maintain higher plant densities to maximize corn production.
- Harvest better quality grain by preventing insect damage that can lead to stalk and ear rot diseases. Mycotoxins produced by these diseases have the potential to cause health problems in animals and humans.
- Reap the economic benefits of higher yield potential in feedstuffs for cattle.[12]

GM products with insect and herbicide tolerance protect corn yield potential and provide other benefits. The PG Economics annual report on the impact of GM crops shows that GM crops are credited with decreasing pesticide and fuel use, facilitating conservation tillage practices that reduce soil erosion, improving carbon retention, and lowering greenhouse gas emissions.[13]

Sources: [1]Mansfield, B.D. and R.H. Mumm. 2013. Survey of plant density tolerance in U.S. maize germplasm. Crop Science 54:157-173. [2]Duvick, D.N. 2005. Genetic progress in yield of United States maize (Zea mays L.). Maydica 50:193-202. [3]Lee, E.A., and M. Tollenaar. 2007. Physiological basis of successful breeding strategies for maize grain yield. Crop Sci. 47:S202–S215. [4]Tollenaar, M., and E.A. Lee. 2002. Yield potential, yield stability and stress tolerance in maize. Field Crops Res. 75:161–169. [5]Tollenaar, M., and J. Wu. 1999. Yield improvement in temperate maize is attributable to greater stress tolerance. Crop Sci. 39:1597–1604. [6]Chavas, J., G. Shi, and J. Lauer. 2014. The effects of GM technology on maize yield. Crop Sci. 54:1331-335. [7]Edgerton, M.D., J. Fridgen, J.R. Anderson Jr., J. Ahlgrim, M. Criswell, P. Dhungana, T. Gocken, Z. Li, S. Mariappan, C.D. Pilcher, A. Rosielle, and S.B. Stark. 2012. Transgenic insect resistance traits increase corn yield and yield stability. Nature Biotech. 30:493–496. [8]National Research Council. 2010. The Impact of Genetically Engineered Crops on Farm Sustainability in the United States. National Academies Press. [9]Folcher, L, Delos, M, Marengue, E, Jarry, M, Weissenberger, A, Eychenne, N, and Regnault-Roger, C. 2010. Lower mycotoxin levels in Bt maize grain. Agron. Sustain. Dev. 30: 711-719. [10]Hutchison, W.D. et al. 2010. Areawide suppression of European corn borer with Bt maize reaps savings to non-Bt maize growers. Science 330:222–225.[11]Haegele, J.W. and F.E. Below. 2013. Transgenic corn rootworm protection increases grain yield and nitrogen use of maize. Crop Science 53:585-594. [12]Hartnell G. F. 2010. Feeding transgenic feedstuffs to cattle. Proc. 21st Florida Ruminant Nutr. Symp., University of Florida, Gainesville, FL. [13]Brookes, G. and Barfoot, P. 2014 GM crops: global socio-economic and environmental impacts 1996-2012. PG Economics Ltd, Dorchester, UK. [14]Mitchell, P. et al. 2009. Information and the Use of New Technology: Evidence from Seeding Density Decisions of U.S. Corn Farmers. UW AAE Applied Economics Workshop, University of Wisconsin. [15]Wu, F. 2006. Mycotoxin reduction in Bt corn: Potential economic, health, and regulatory impacts. Transgenic Research:15 277-279. [16]Castillo-Lopez, E, Clark, K.J, Paz, H.A, Ramirez Ramirez, H. A, Klusmeyer, T.H, Hartnell, G.F, Kononoff, P.J. 2014. Performance of dairy cows fed silage and grain produced from second-generation insect-protected (*Bacillus thuringiensis*) corn (MON 89034), compared with parental line corn or reference corn. J. Dairy Sci. 97 :3832–3837. [17]Munkvold. G.P. and R.L. Hellmich. 1999. Genetically modified insect resistant corn: Implications for disease management. APSnet.