

## AGRONOMICS AND ECONOMICS OF USING CORM GMOs

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Use of GMO hybrids may help growers improve weed and insect control in corn as well as reduce costs of pesticide applications. GMO traits cost more compared to normal hybrids. Farmers are concerned about "yield drag" or "yield lag" in GMO corns. Several factors may contribute to lower yields in GMO corn. The conversion of normal corn to a specialty hybrid requires numerous cycles of backcrossing. The time that is required to complete the backcross process may result in GMO hybrids lagging behind that of the normal hybrid from which it is derived. Second the conversion of normal hybrids is not always "clean." Sometimes undesirable agronomic traits are strongly linked to the gene that conferred the specialty trait and this "linkage" decreases yield performance. The concept of yield drag and yield lag is real and as plant breeders spend more time and resources making sure that GMO traits work, it will come at a cost and yield progress will likely be slowed. Finally, like normal hybrids yield performance variability exists among GMO hybrids.

BT CORN is an abbreviation for the bacteria, *Bacillus thuringiensis*, which is found in the soil. Bt forms a crystal protein that is toxic to caterpillars (lepidopterans), beetles (e.g. corn rootworm and Colorado potato beetle), and aquatic flies (e.g. black flies and mosquitoes). After the insect eats Bt, the crystal dissolves to release a toxin that attacks the gut lining. Feeding stops within a few hours. The insect gut wall breaks down within 24 hours. Bacterial spores germinate and invade the body cavity of the insect. The

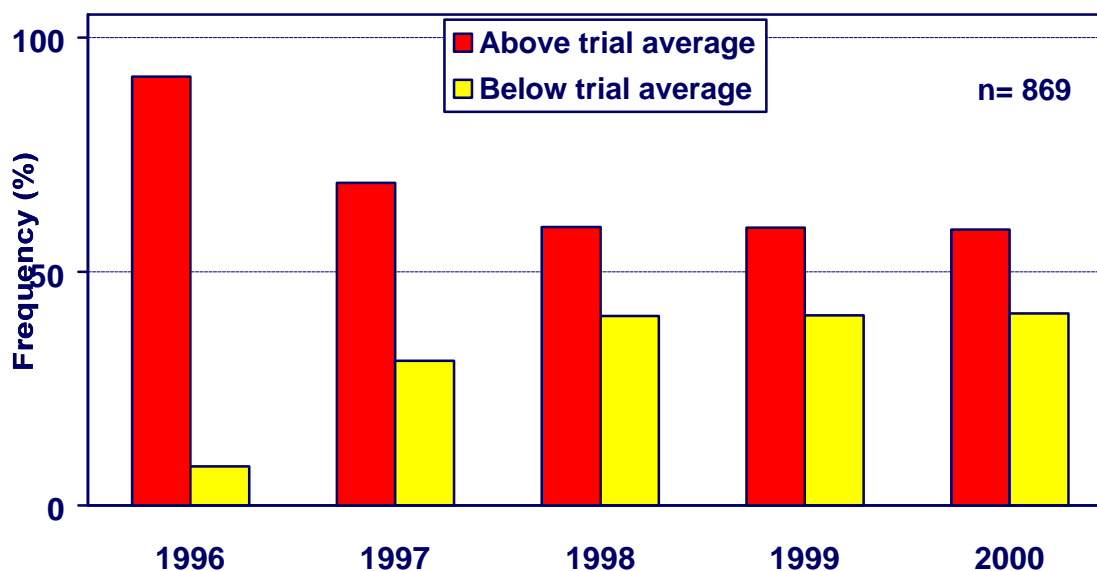


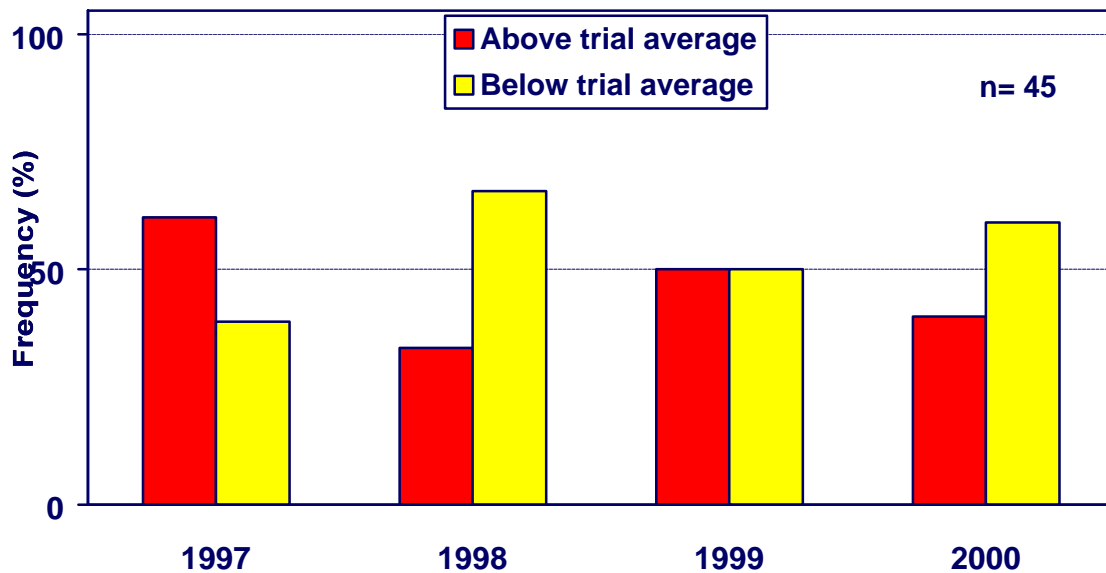
Figure 1. Yield of "Bt" Hybrids in Relation to the Trial Average in the WI Corn Trials.

insect dies from toxins attacking the gut wall, by a general body infection (septicemia) that is present within 48 hours, and food deprivation. Over 70 different toxins are formed from Bt crystal proteins. The activity of the toxin in an insect depends on gut pH, the

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presence of enzymes and reducing agents, and the presence of binding sites on cell membranes. Production of the Bt protein in corn continues as long as the corn is actively growing and declines after ear fill begins. Different plant parts will express differing levels of the Bt protein. Bt hybrid corn performance in Wisconsin trials has typically been better than normal dent corn in all years (Figure 1). Performance has been better than normal dent corn regardless of the amount of European corn borer pressure. In 1996 ECB pressure was greater than normal while between 1998 and 2000 ECB pressure was mostly absent. Bt hybrids more frequently beat the trial average than normal dent corn. A number of questions need to be addressed regarding long-term economics, since European corn borer outbreaks do not occur every year. In addition, special resistance management strategies may need to be developed.

LIBERTY LINK CORN is tolerant to broadcast applications of Liberty herbicide, glufosinate ammonium. The gene that gives resistance to glufosinate came from a naturally occurring soil bacterium, *Streptomyces hygroscopicus*. Glufosinate is a fast acting, post-emergent, foliar applied, non-selective contact herbicide that controls a broad spectrum of weeds. It has no translocation or root uptake. Liberty is used for broadcast control of annual weeds and suppression of perennials. It is most effective on small weeds but less effective on lambsquarters, drought stressed velvetleaf and large annual grasses. Liberty Link hybrid performance has been somewhat inconsistent in the trials (Figure 2).



**Figure 2. Yield of “Liberty Link” Hybrids in Relation to the Trial Average in the WI Corn Trials.**

ROUND-UP READY CORN is resistant to the herbicide glyphosate, a post-emergent, foliar applied, non-selective herbicide that controls a broad spectrum of weeds. It was first made available to farmers commercially in 1998 (Figure 3). Yield potential is similar to regular dent corn in that Round-up Ready hybrids yield above and below the trial average with equal frequency.

GENE STACKED CORN is the marketing name given to hybrids with more than one gene derived from genetically engineered methods. Currently, the only hybrids available include the Bt and Liberty Link technologies. Another group of hybrids is the Bt/IMI stack. It is still too early to evaluate market acceptance and yield potential (Figure 4).

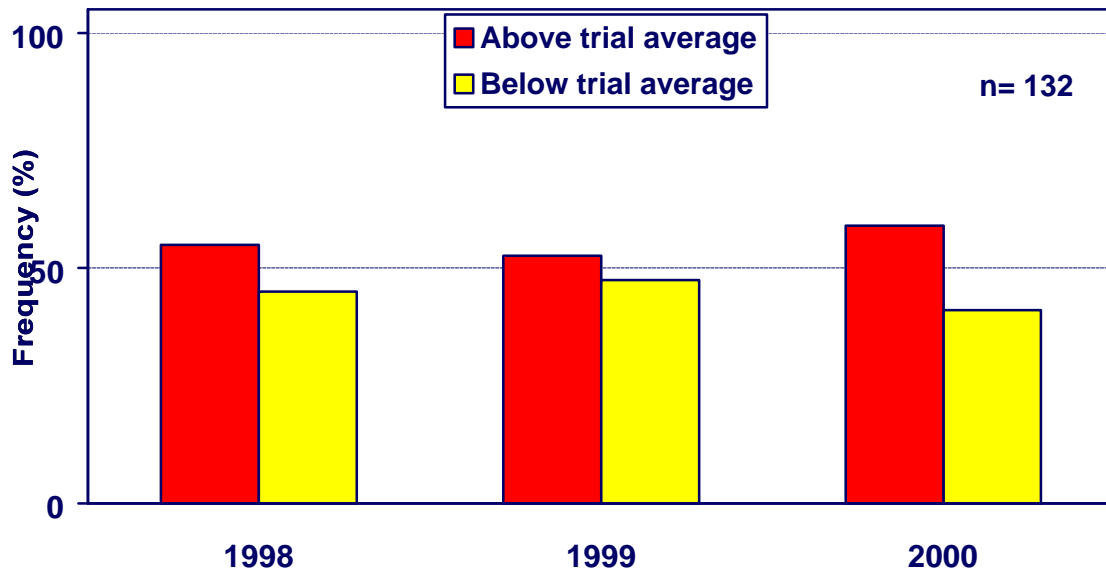


Figure 3. Yield of “Roundup Ready” Hybrids in Relation to the Trial Average in the WI Corn Trials.

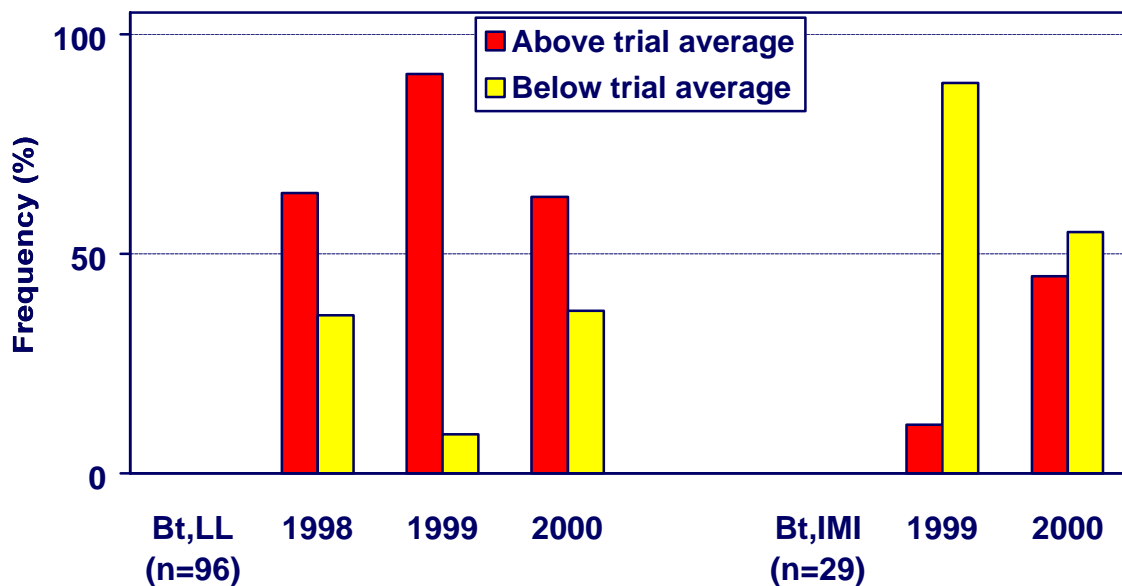


Figure 4. Yield of “Gene-stacked” Hybrids in Relation to the Trial Average in the WI Corn Trials.