

False reports and the ears of men

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In William Shakespeare's *Henry IV: Part Two*, the first lines of the play are spoken by a character called Rumor who stuffs "the ears of men with false reports" by spreading false information about the battle of Shrewsbury. Shakespeare describes a world in which Rumor creates false appearances that set in motion a chaotic series of events.

In many ways, Rumor seems to be playing a similar role in the current debate over the inherent risks of the use of genetically modified plants. And this distortion, however entertaining, is having profound consequences in the real world of science and public policy. Recent articles on *Bacillus thuringiensis* (Bt) modified plants have certainly created a modern drama of sorts, but unlike plays by the great bard, they continue to many unexpected turns and now have an uncertain ending.

The recent short correspondence in *Nature* reporting a laboratory study in which pollen from Bt-transgenic corn was fed to Monarch butterflies¹ has attracted considerable coverage in the popular press and widespread rebuttals and criticisms in the scientific press²⁻⁴. It is surprising, then, that a previous and more relevant and realistic field study⁵ has been largely overlooked. In that study, the authors examined Bt-corn pollen deposition on milkweed plants within, and adjacent to, field corn and then assayed the leaves with first instar larvae. Pollen levels were highest within the field (where Monarchs are scarce), but even there Monarch mortality was only 16% (ref. 5).

We believe that few entomologists or weed scientists familiar with butterflies or corn production (and the control of milkweed) give credence to the *Nature* article, but the public and its policy makers have reacted in a knee-jerk fashion: immediately after publication of the *Nature* correspondence, there was a nearly 10% drop in the value of Monsanto stock, possible trade restrictions by Japan, freezes on the approval process for Bt-transgenic corn by the European Commission (Brussels), and calls for a moratorium on further planting of Bt-corn in the United States. Was this reaction justified based on what can only be considered a preliminary laboratory study or could Rumor still be more entertaining than fact?

Another paper, also nominally about Bt-corn, appeared in May with still more potential for mischief. Huang et al.⁶ claimed that they had found

dominant resistance to Bt toxins in the major pest targeted by Bt-corn—the European corn borer. This pest causes an estimated \$1.2 billion in crop losses annually and, as an alternative to the use of broader spectrum synthetic insecticides, an estimated 24–28 million acres of Bt-corn were planted in the US in 1999 (ref. 8). If resistance to Bt-corn really is dominant, as Huang et al. suggest, the impact could be profound. The Environmental Protection Agency (Washington, DC) has already mandated a resistance management program for Bt-crops—the use of refuges to produce susceptible insects to "dilute" resistance—that is most effective when resistance is recessive⁷.

Several scientists (including us) have expressed concern about the methodology used in the Huang et al. paper, particularly as the



authors did not demonstrate that resistance was actually to the same Bt toxin as in the plant, and did not demonstrate that their "resistant" population could survive on Bt-corn engineered to express the toxin (a footnote implies that the larvae don't⁶). However, this questionable laboratory study has generated considerable debate over whether the present resistance management policy should be overturned.

Another study, this time on Bt resistance to pink bollworm, one of the major pests targeted by Bt-cotton, has just appeared in *Nature*⁹. This paper is reassuring in that resistance to Bt was recessive in inheritance (i.e., the resistant-susceptible heterozygotes died on the transgenic plants). In the only other cases in which inheritance of resistance to Bt was studied using transgenic crops^{10,11} this was also observed and considered to be the most important factor determining the success of the refuge strategy⁷.

However, because of the success of Rumor, we suspect that the message that will be popularly spread about this paper is that it raises questions about the refuge strategy because the resistant insects developed more slowly than their

susceptible counterparts and may therefore be out of phase for random mating and dilution of resistance in the field. In this context, it is important to remember that considerable overlap in generations of this insect occurs in the field, especially late in the season. Although Liu et al. suggest that such asynchronies must be considered in resistance management (a concept that is not new), we hope that the take-home message won't be converted into another premature claim that Bt crops are doomed. Liu et al. suggested only that the developmental delays "could reduce the expected benefits of the refuge strategy," not that it would nullify them.

Are studies such as these guilty of "stuffing the ears of men with false reports" or is it the willingness of people to accept uncritically any reports that fit their own perceptions that is really to blame? We do not live in a world where creatures like *A Midsummer Night's Dream's* Puck weave counterillusions behind the scenes to make everything turn out right. As such, our world should not be so easily swayed by laboratory reports that, when looked at with a critical eye, may not have any reality in the field... or even the laboratory.

The story is still unfolding and well-constructed scenes need to be developed to help guide the final acts in this most serious moment in the biotechnology drama. For the present, however, within the context of a large world made smaller by our modern communication methods, Rumor holds more power than ever before. If the methods are faulty or an author's implications are misleading, Rumor will more easily hold sway over public policies. Both scientists and the public must take note and move forward with even more selfless integrity. As the Shakespearean character Nick Bottom warns the audience as he sees his own fantasy unfolding, "truth and reason... keep little company together nowadays." And we must keep in mind what Bottom looks like when he utters these lines.

1. Losey, J., Raynor, L., & Carter, M.E. *Nature* **399**, 214 (1999).
2. Hodgson, J. *Nat. Biotechnol.* **17**, 627 (1999).
3. Fumento, M. *The Wall Street Journal* June 25, 1999.
4. Beringer, J. E. *Nature* **399**, 405 (1999).
5. Hansen, L & Obrycki, J. <http://www.ent.iastate.edu/entsoc/ncb99/prog/abs/D81.html>
6. Huang, F. et al. *Science* **284**, 965-967 (1999).
7. Roush, R.T. *Pest. Sci.* **51**, 328-334 (1997).
8. Steffey, K. Bt corn for management of the European corn borer: effectiveness, economics, and issues. *Society for Invertebrate Pathology (SIP) 1999 Program & Abstract*. p.72 (1999). <http://sipweb.reg.colony1.net/abstracts.pdf>
9. Liu, Y-B, Tabashnik, B.E., Dennehy, T. J., Patin, A. J., & Bartlett, A. C. *Nature* **400**: 519 (1999).
10. Metz, T.D., Roush, R.T., Tang, J.D., Shelton, A.M., & Earle, E.D. *Mol. Breeding* **1**, 309–317 (1995).
11. Gould, F., et al. *Proc. Natl. Acad. Sci. USA* **94**, 3519–3523 (1997).

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