CROP PROTECTION

NATURAL PESTICIDE A CHALLENGE TO MANIPULATE

SLATER, Ia.—The corn across the Midwest is lush and plentiful in August, with seemingly endless close-packed rows stretching in almost every direction. Although the Midwestern climate and soil are ideal for corn, this concentrated monoculture encourages pests such as the corn borer and root worm to establish themselves. As a result, a sizable group of biotechnology companies is trying to adapt the natural protein insecticides made by *Bacillus thuringiensis* (Bt) to protect corn. Participants at a research seminar hosted by Garst Seed (Slater, IA), a division of ICI Seeds (Fernhurst, U.K.), learned, however, that there are many skirmishes to win before engineered versions of the bacterial Bt insecticidal proteins are useful commercially.

Although not so potent as most synthetic chemical pesticides, the known Bt proteins are active at nanogram levels, show narrow host-range specificity, and break down rapidly in the environment, says Anthony Macaluso of Ecogen (Langhorne, PA), who spoke at the seminar. Marketed since the early 1960s, annual sales of Bt products are only about $60 million—a small sum compared to sales of major chemical pesticides. However, the sheer size of the U.S. corn crop points to huge rewards if engineered Bt products tap this potential market. According to some estimates, the market value added for Bt-engineered root worm-resistant seeds will be $200–300 million per year and that much, or more, for corn borer-resistant seeds.

The corn borer, a pest that weakens plant stalks and so decreases overall yields, is an attractive potential target for Bt insecticides. But because the corn borer enters plants through leaf whorls and then does internal damage to the stalk, external application of Bt-type pesticides is not very effective against it. Genetic engineers of at least a half-dozen corporate teams therefore are trying to incorporate bacterial Bt genes into corn plants to deliver the active molecule to plant tissues—where it is most needed. A major stumbling block is the difficulty of regenerating fertile corn plants from manipulated protoplasts—a problem that is only just being solved (*Bio/Technology* 7:548, June '89).

Other challenges also stack matters in favor of corn pests. Insects such as the corn borer and root worm respond differently to the several distinct forms of Bt now known. "There are many types of Bt with different activities," Macaluso says. "And for many of the crystals, we have no idea what the target insect is." A good deal of careful testing is needed to identify the most effective candidate pesticides.

Identifying effective bacterial insecticides and manipulating the genes for them are themselves difficult tasks, Macaluso and other scientists say. For example, proving that a new, purified Bt protein effectively kills a particular corn pest can be especially tricky because current bioassays often provide ambiguous results. Obtaining amounts adequate for testing of a potential pesticide molecule also can pose problems. For instance, simply producing the molecule before Bacillus cells form spores, although preferable, is difficult, he notes. And, according to some experiments, the molecules may differ when harvested from growing versus sporulating cells.

Typically, sporulating cells form crystals of Bt pesticidal proteins that must be separated from mixtures containing the spores, points out Kenneth Nickerson, a biology professor at the University of Nebraska (Lincoln), who also spoke at the seminar. Surprisingly, he and his collaborators find that the purified protein pesticide molecules are glycosylated. While evidence of glycosylation of bacterial proteins still is considered rare, such an assertion is no longer tantamount to biological heresy, he says.

The presence of sugars may be "important for insecticidal activity" of several Bt proteins, Nickerson continues. For instance, one type of Bt protein whose sugar content was reduced experimentally is "ten-fold less toxic to mosquitoes" than is a version of the protein containing normal amounts of sugars, he finds. Thus, appropriate glycosylation could be another heretofore unrecognized hurdle in making Bt genes work effectively in engineered corn plants.

Meanwhile, ecologists and environmentalists are readying yet other arguments against Bt insecticides. Some Bt critics are arguing that widespread use of such insecticides will invite development of resistant pests. Others are worrying about the potential health hazards of Bt proteins in plant tissues—presumably a matter of less concern for field corn that will be consumed by livestock than for crops consumed directly by humans. Doubtless there will be additional fodder for controversy if corn is successfully engineered and readied for field trials. —**Jeffrey L. Fox**

IMAGE UNAVAILABLE FOR COPYRIGHT REASONS

JEFFREY L. FOX

Corn borers can reduce crop yields by tunneling through and weakening plant stalks, causing them to topple, according to entomologist Von Kaster of Garst Seeds, who prepared this field sample.