



Extension FactSheet

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Commonly Used Methods for Detecting GMOs in Grain Crops

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As market restrictions for various transgenic (genetically modified organism or GMO) crops (e.g., Bt-corn, Roundup Ready soybeans and corn) continue, there is increasing interest among growers in determining the presence of GMOs in crops. Growers producing non-GMO grains for specialty markets need to verify that there is no GMO contamination, or that contamination levels meet tolerance levels established by an end user. The default standard for certification as GMO free has been taken to be zero in many cases, although experience shows that meeting such a standard will be difficult. There have been proposals for setting maximum allowable levels in the range of 1 to 3%, and it is likely that some tolerance level above zero will be accepted in the future.

Japan recently established new legislation that sets a zero tolerance for seed and food imports containing unapproved biotech material, e.g., StarLink corn (containing the Cry9C Bt transgene). The Japanese legislation will allow food products containing less than 5% of approved biotech crops, like corn and soybeans, to be labeled as non-GMOs.

The European Union (EU) has recently proposed rules on the labeling and traceability of foods containing GMOs. According to these new rules, accidental traces of GMOs that have been cleared by the EU's scientific advisers, even if they have not received final official approval, will be allowed in food and feed up to a maximum of 1%, without being subject to labeling requirements. Tolerances similar to those of Japan and the EU are being considered by other countries importing U.S. grains.

GMO testing may be useful in crop production under other circumstances, such as when troubleshooting crop disorders during the growing season. If an allegedly herbicide resistant corn or soybean field exhibits extensive injury following herbicide application, the grower may want to confirm that plants in the field are actually herbicide resistant. Similarly, a grower, if uncertain, may need to determine what fields, or what parts of fields, he planted to GMO crops.

There are several commonly used GMO testing protocols, including biological tests, as well as ELISA and PCR tests, for herbicide and insect tolerance. Growers and end-users should consider the advantages and disadvantages of the various testing methods before harvest. Exporters should probably resign themselves to the most rigorous testing protocol, to anticipate the additional scrutiny their products will receive overseas.

Some major end-users, i.e., large food processors, are currently using a combination of tests for identity-preserved (IP) grains.

Herbicide bioassays are used to detect GMO herbicide resistant traits in Roundup Ready and Liberty Link soybeans and corn. The tests involve placing seeds in a germination media, moistened with a diluted solution containing the herbicide, or spraying the herbicide on seedlings. Seeds that test positive for the presence of the herbicide-tolerant GMO trait will germinate and develop normally, whereas those that die or do not develop normally will be GMO-free. This procedure is widely used by seed and grain companies exporting soybeans. Advantages of the bioassay method: It is relatively inexpensive (\$20 - \$30), user friendly, and produces straightforward results. Disadvantages of the test: It takes up to a week to complete, its use is limited to the Roundup Ready and Liberty Link herbicide-resistant GMO crops, and the seeds need to germinate for the test to work. Herbicide bioassays can also be used to detect herbicide resistant traits in non-GMO corns, such as Clearfield® hybrids which are tolerant to imidazolinone herbicides (Pursuit, Scepter, Lightning).

ELISA (enzyme-linked immunosorbent assay) tests for the presence of the specific protein that the genetically modified DNA produces in the plant. ELISA procedures use antibodies that react with specific proteins produced by the GMO. There are different versions of the ELISA method used for GMO detection. One version uses lateral flow strips and delivers results in two to five minutes (Figure 1). This "strip test" technology is similar to that used in home pregnancy tests. Strip tests are commonly used at grain elevators, where a rapid assessment to determine the presence or absence of GMOs is needed. These tests are referred to as the "dipstick" procedure by some companies marketing this ELISA technology for seed testing.

Another version of the ELISA test, the "plate test," provides some indication of the quantity (percentage) of the tested sample that is the GMO in question (Figure 2). Intensity of color indicates the amount of the protein present. The plate test can take two to four hours and is more laborious, and costly than the strip test.

Advantages of the ELISA strip tests are speed, relative ease of use, and low cost. The major disadvantage of the strip test is that it cannot quantify how much GMO is present. ELISA tests have limited application for testing GMOs in processed foods



Figure 1. ELISA strip or “dipstick” tests can detect GMOs in grain and seed in three to five minutes.



Figure 2. ELISA “plate tests” can provide some quantitative assessment of the GMO present.

because heat processes denature the proteins, thereby making detection of proteins difficult.

The **PCR** (polymerase chain reaction) method is more sensitive than the ELISA method and tests for the presence of the specific DNA sequence of the gene itself. The major advantage of PCR tests is sensitivity, i.e., detection of GMOs at very low levels. PCR is the only one of these methods that can effectively detect GMOs in processed foods. Major disadvantages of the PCR protocol include length of time needed (two to three days), and cost (\$75 to \$300 per sample). PCR tests also require more sophisticated equipment and greater expertise. While more sensitive to GMOs, PCRs in some cases tend to show false positives. PCR procedures were originally developed as research tools for analyzing genes and assisting in the movement of genes among organisms. Given the expense, time, and expertise required, PCR testing has limited potential in the field or at grain elevators.

As the number of GMO traits increases (e.g., GMO corns with resistance to Roundup, European corn borer, and western corn rootworm), it will become more costly to monitor the presence of GMOs in crops, since each different gene requires a separate test. However, if the demand for non-GMO crops increases, it is possible that tests for different genes may be combined on the same ELISA test strip.

Although some of these GMO testing procedures, such as the ELISA strip tests, can be used in the field and elevators, the other procedures for detecting GMOs require more sophisticated training and equipment to be used effectively. A list of some of the laboratories that offer GMO testing of grain crops for a fee is presented here. The websites for these labs provide an overview of the specific GMO testing procedures they conduct.

Some Commercial Laboratories Testing for GMOs in Crops (as of 7-10-01)

AGDIA
30380 Country Road 6
Elkhart, IN 46514
219-264-2014; fax 219-264-2153
www.agdia.com

Biodiagnostics Inc.
507 Highland Dr
River Falls, WI 54022
715-426-0246; fax 715-426-0251

Biogenetic Services Inc.
801 32nd Ave
Brookings, SD 57006
605-697-8500; fax 605-697-8507
www.biogeneticservices.com

California Seed & Plant Lab, Inc.
7877 Pleasant Grove Rd
Elverta, CA 95626
916-655-1581; fax 916-655-1582
www.calspl.com

Central Hanse Analytical Lab LLC
101 Wordland Hwy
Belk Chasse, LA 70037
504-393-5290; fax 504-393-5270
www.rmgcal.com/cal

Genetic ID
1760 Observatory Dr
Fairfield, IA 52556-9030
888-229-2011; fax 641-472-9198
www.genetic-id.com

Illinois Crop Improvement
3105 Research Rd, PO Box 9013
Champaign, IL 61826-9013
217-359-4053; fax 217-359-4075
www.ilcrop.com

Indiana Crop Improvement
770 Stockwell Rd
Lafayette, IN 47909
765-523-2535; fax 765-523-2536
www.indianacrop.org

Mid-West Seed Services
 236 32nd Ave
 Brookings, SD 57006
 605-692-7611; fax 605-692-7617
 www.mwseed.com

Ohio Seed Improvement Association
 6150 Avery Rd, Box 477
 Dublin, OH 43017-0477
 614-889-1136; fax 614-889-8979
 www.tgstech.com/osia

Other References Relating to GMO Testing

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Chen, H., and R. A. Vierling. 2000. *Polymerase Chain Reaction*. p. 63-68. In M. B. McDonald, T. Gutormson, and B. Turnipseed (eds.) Seed technologists training manual. Society of Commercial Seed Technologists.

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