

MON 88017 maize

YieldGard VT Rootworm/RR2[®]

**Rootworm protection
with glyphosate tolerance**

Key Facts



**Monsanto Europe-Africa
November 2009**

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Maize, a key crop

After wheat and rice, maize is the third most frequently cultivated crop worldwide. Following European discovery of the Americas where this crop is indigenous, maize was rapidly adopted in Europe, Africa and Asia. Today, it is one of the few intensively cultivated crops in European agriculture. Significant areas of production include the Danube basin from southwest Germany to the Black Sea and southern France through to the Po Valley of northern Italy.

As in other world areas, maize use in Europe is dominated by the demand for animal feed. Maize is also processed into valuable industrial and food products such as ethyl alcohol, maize meal, starch and sweeteners.

In 2008, the area of maize harvested in the European Union (EU) was approximately 10 million hectares, with a production of around 59.1 million tons¹. The EU is a large importer of maize, importing about 10 million tonnes of maize grain per year² (the majority from Brazil and Argentina).

What is MON 88017?

MON 88017 YieldGard VT Rootworm/RR2 was developed by *Agrobacterium* mediated transformation of maize and combines two traits of agronomic interest: protection to corn rootworm, one of the most pernicious pests affecting maize crops in the US, and tolerance to the broad-spectrum herbicide glyphosate.

Insect protection

MON 88017 carries a gene coding for a Cry protein, Cry3Bb1³, which is selective for coleopterans (Chrysomelidae) of the *Diabrotica* family (Ostlie, 2001; Siegfried *et al.*, 2005).

Cry proteins naturally occur in the *Bacillus thuringiensis* (*Bt*) bacterium. Several Cry proteins exist and are classified by structure and by insects they control. Susceptible insects contain receptors in their midgut that bind to the specific Cry protein. This leads to the creation of pores which interfere with ion transport systems across the midgut wall causing lysis of the midgut epithelium and, depending on the dose, subsequent paralysis of the gut or death of the insect (Nester *et al.*, 2002). No

receptors for these proteins have been identified on intestinal cells of mammals to date.

A large number of insecticidal products based on this bacterium and/or its proteins have been developed and sold commercially since the late 1930's. Historically, *Bt* has been considered a safe option for pest control. Using biotechnology, the genes coding for specific *Bt* proteins were isolated and introduced into various crop plants.

Herbicide tolerance

MON 88017 also expresses CP4 EPSPS which confers tolerance to Roundup® herbicide, containing glyphosate, allowing use of this herbicide for weed control in the crop not just in pre-emergence, but also throughout the growth season.

Glyphosate is a broad-spectrum herbicide that acts via inhibition of the protein "5-enolpyruvyl-shikimate-3-phosphate synthase" (EPSPS) in the green parts of plants. This protein, found naturally in all plants, fungi and bacteria is important in the production of essential aromatic amino acids. Inhibition of EPSPS by glyphosate blocks the production of these amino acids, interfering with growth and leading ultimately to plant death (Alibhai and Stallings, 2001). MON 88017 plants produce glyphosate-tolerant EPSPS. This ensures the continued function of the aromatic amino acid pathway, even in the presence of the herbicide (Heck *et al.*, 2005).

More information on this product can be obtained from the Agbios website⁴.

Worldwide plantings of MON 88017

Genetically modified crops protected against insect pests and/or tolerant to a specific herbicide were first commercialized in the US in 1997. In 2008, over 125 million hectares of GM crops were grown worldwide, from which 37.3 million hectares were maize (James, 2008).

MON 88017 has been planted commercially for the first time in 2007 in the US.

A strict regulatory system for genetically modified crops in the EU

In the EU, the regulatory system for genetically modified (GM) crops comprises several directives and regulations, including Directive 2001/18/EC for deliberate release of GMOs in the environment (repealing Directive 90/220/EEC) and Regulation (EC) No. 1829/2003 concerning GM food and feed (replacing Regulation (EC) No. 258/97 on novel foods and novel food ingredients for GM products).

¹ Eurostat: http://www.eds-destatis.de/de/downloads/sif/qa_08_041.pdf (Accessed on November 13, 09)

² Eurostat: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database - Search for *food_in_imp5*, open the highlighted file, in the *Select Data* tab under the *PROD_CN* subtab, select only *maize or corn* and click on *update*. (Accessed on November 13, 09)

³ The amino acid sequences of the Cry3Bb1 proteins expressed respectively in MON 88017 and MON 863 shares an identity of 99.8% (they differ by only one of 653 amino acid residues). MON 863 is a similar maize product that provides protection against coleopteran pests (Chrysomelidae).

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⁴ Agbios: <http://www.agbios.com/> (Accessed on November 13, 09)

Furthermore, a regulation on traceability and labeling of genetically modified organisms (GMOs) and products produced from GMOs (Regulation (EC) No. 1830/2003) entered into application on 18 April 2004.

Regulatory status of MON 88017 in the EU

MON 88017 expresses Cry3Bb1 and CP4 EPSPS proteins that are similar to the proteins expressed in MON 863, NK603 and MON 863 x NK603 that have been considered safe by EFSA^{5,6,7}. Both MON 863 and NK603 have been approved under Directive 2001/18/EC for import, feed and processing by the European Commission (Commission Decision, 2004; Commission Decision, 2005a; Commission Decision, 2005b; Commission Decision, 2006). In addition, existing feed materials, feed additives and food additives produced from MON 863, NK603 and MON 863 x NK603 were listed in the community register, according to Regulation (EC) No. 1829/2003 concerning GM food and feed⁸. Renewals of authorisations for those products have been submitted to the Commission in April 2007 and the EFSA review is ongoing.

On October 04, 2005, Monsanto submitted an application for food and feed uses, import and processing under the Regulation (EC) No. 1829/2003 on GM Food and Feed to the European Food Safety Authority (EFSA) via the Czech Republic.

The European Food Safety Authority (EFSA) evaluated the application as well as Monsanto's responses to comments and reasoned objections from certain Member States. EFSA adopted a scientific opinion on April 21, 2009, concluding that *"MON 88017 is as safe as its non genetically modified counterpart with respect to potential effects on human and animal health or the environment. Therefore the GMO Panel concludes that MON 88017 is unlikely to have any adverse effect on human or animal health or on the environment in the context of its intended uses."*⁹.

The EFSA overall opinion, which fulfils the requirements of Articles 6 and 18 of Regulation (EC) No. 1829/2003, was published on May 06, 2009¹⁰.

After consideration by the Standing Committee on the Food Chain and Animal Health (SCFAH) on July 22, 2009, and the Council of Agriculture Ministers on October 19, 2009, MON 88017 was approved by the European Commission on October 30, 2009 for food, feed, import and processing in accordance with Regulation (EC) No. 1829/2003 on GM food and feed (Commission Decision, 2009)¹¹, which adopted the proposals for 10 years authorisation. MON 88017 is listed in the Community Register¹².

Detection method

An event-specific method for the quantification of MON 88017 using real-time PCR has been validated by the European Commission Joint Research Centre (JRC). It was published on the Community Reference Laboratory (CRL) website on October 14, 2008¹³.

Traceability, labelling, unique identifier

Operators importing, handling or using MON 88017 grain and derived foods and feeds in the EU will be informed of the legal obligations regarding traceability and labelling, laid down in Regulation (EC) No. 1830/2003 and in the conditions of placing on the market of the consent.

The unique identifier of YieldGard VT Rootworm/RR2 (MON 88017) is MON-88Ø17-3.

Food, feed and environmental safety of MON 88017

Food and feed safety

The food and feed safety of MON 88017 was established through:

- The long history of safe use of *Bt* Cry proteins (including members of the Cry3 class) and the CP4 EPSPS proteins;
- The evaluation of CP4 EPSPS activity and its homology to EPSPS proteins present in a diversity of plants, including those used for foods;
- A large margin of safety resulting from the low dietary exposure to the Cry3Bb1 and CP4 EPSPS proteins;
- The rapid digestibility of Cry3Bb1 and CP4 EPSPS proteins in simulated mammalian gastric and intestinal fluids (SGF and SIF);
- The lack of toxicity or allergenicity of the introduced proteins as demonstrated with bioinformatics as well as *in vitro* and *in vivo* safety studies of the Cry3Bb1 and CP4 EPSPS proteins.

⁵ EFSA Scientific Opinion on MON863: http://www.efsa.europa.eu/EFSA/Scientific_Opinion/opinion_gmo_06_en1.2.pdf?ssbinary=true (Accessed on November 13, 09)

⁶ EFSA Scientific Opinion on NK603: http://www.efsa.europa.eu/EFSA/Scientific_Opinion/opinion_gmo_02_final_en1.pdf?ssbinary=true (Accessed on November 13, 09)

⁷ EFSA Scientific Opinion on MON 863 x NK603: http://www.efsa.europa.eu/EFSA/Scientific_Opinion/gmo_opinion_ej255_mon863xnk603_en1.0.pdf?ssbinary=true (Accessed on November 13, 09)

⁸ European Commission: http://ec.europa.eu/food/dyna/gm_register/index_en.cfm (Accessed on November 13, 09)

⁹ EFSA Scientific Opinion on MON 88017: http://www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1211902517555.htm (Accessed on November 13, 09)

¹⁰ EFSA website: <http://registerofquestions.efsa.europa.eu/roqFrontend/questionLoader?question=EFSA-Q-2005-280> - the overall

opinion can be found under "Question Documents" tab (Accessed on November 13, 09)

¹¹ Europa EUR-Lex: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:289:0025:0028:EN:PDF> (Accessed on November 13, 09)

¹² European Commission : http://ec.europa.eu/food/dyna/gm_register/gm_register_auth.cfm?pr_id=35 (Accessed on November 13, 09)

¹³ CRL: <http://gmo-crl.jrc.ec.europa.eu/statusofdoss.htm> (Accessed on November 13, 09)

MON 88017 was found to be as safe and nutritious as conventional maize by analysis of key nutrients, including protein, fat, carbohydrates, amino acids, fatty acids and minerals, as well as by a feed performance study using broiler chickens.

Environmental safety

The environmental safety of MON 88017 was established through extensive laboratory and field testing of plant tissue or purified Cry3Bb1 and CP4 EPSPS proteins, and with a wide range of non-target species. No adverse effects have been observed in non-target species exposed to maximum expected concentrations of Cry3Bb1 protein. Furthermore, environmental fate studies demonstrate that Cry3Bb1 and CP4 EPSPS proteins rapidly degrade in a variety of soil types. Agronomic, morphological and pest susceptibility observations have been recorded in multiple field trials conducted across major maize growing regions of the US as well as in the EU. Results of these trials confirm that MON 88017 is phenotypically equivalent to conventional maize except for its protection against *Diabrotica* and tolerance to glyphosate.

MON 88017, the expected benefits

MON 88017 will benefit both farmers and the environment.

Its potential benefits will be similar to those of MON 863 (for corn rootworm control because it produces a Cry3Bb1 protein that is equally efficacious against this target pest) and NK603 (for weed control because it produces the same CP4 EPSPS protein which confers tolerance to glyphosate). These benefits have been proven with several years of commercial plantings of either MON 863 and NK603 or MON 863 x NK603¹⁴.

They will be expected for MON 88017 and will provide:

- A method to control corn rootworm, compatible with integrated pest management (IPM) approaches, that offers improved pest control and higher yields, while at the same time being safe for humans and the environment. This is combined with a successful broad-spectrum weed control option that allows over-the-top applications of glyphosate in maize on an “as needed basis” (Johnson *et al.*, 2000; Marra *et al.*, 2002);
- An estimate reduction in insecticide use (75.2% reduction in active ingredient) if transgenic maize protected against the corn rootworm was planted on 10 million hectares in the US (Rice, 2004);
- MON 88017 allows the control of a wide spectrum of weeds using a smaller number of herbicides. This is particularly important since a number of active ingredients are being re-assessed for toxicological and environmental safety under Directive 91/414/EEC. Glyphosate has already been approved under this directive and can provide an environmentally sustainable, flexible, and profitable alternative to conventional weed control programs (Dewar, 2009);

- Increased benefits for farmers linked to the reduced exposure to insecticides, ease of use and handling, time and labor savings, as well as better pest control (Alston *et al.*, 2002; Brookes and Barfoot, 2008; Marra *et al.*, 2002);
- Resource conservation linked to reduced insecticide and herbicide use, e.g. less diesel fuel consumed in the manufacture and delivery of insecticides, less water used for insecticide application, conservation of aviation fuel and reduced use of insecticide containers (Carpenter *et al.*, 2002; NCGA and USGC, 2007; Phipps and Park, 2002);
- An excellent fit with reduced tillage systems, which are linked to many environmental advantages including improved soil and water quality, reduced soil erosion and runoff, improved wildlife habitat and reduced fuel use and CO₂ emissions (Fawcett and Towery, 2002; Phipps and Park, 2002);
- Negligible to no risks for adverse effects on beneficial, non-target organisms when compared to fields treated with conventional pesticides or with untreated controls, attributed to the reduction in insecticide use, low toxicity of glyphosate and compatibility with conservation tillage practices (Ahmad *et al.*, 2005; Al-Deeb and Wilde, 2003; Ammann, 2003; Fawcett and Towery, 2002; Giesy *et al.*, 2000; Lozzia, 1999; Orr and Landis, 1997; Pilcher *et al.*, 1997; Reyes, 2005);
- Negligible to no risks for adverse effects on soil organisms attributed to the low persistence of Cry3Bb1 released into the soil from exudates and biomass from MON 863 (Icoz and Stotzky, 2007).
- A socio-economic ex-ante impact assessment suggests that MON 88017 may provide a significant yield advantage and economic benefits to growers cultivating this product in areas with corn rootworm infestation (Dillen *et al.*, 2009).

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¹⁴ Monsanto:
http://www.monsanto.com/pdf/investors/2009/q4_biot_ech_acres.pdf
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