MON 810

YieldGard® Corn Borer

Lepidopteran-protected maize

Key facts

Monsanto Europe

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Maize, a key crop

Maize (*Zea mays)* is one of the most frequently cultivated crops in the world, together with rice and wheat[1]. 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 (Goodman, 1988). 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. In 2016, over 1 billion metric tons of maize were produced in the world, which represents approximately 187 million hectares of maize harvested globally. Significant areas of production included the US, China, Brazil, the European Union (EU) and Argentina representing in total over 75 % of the global maize productions[2].

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 2016, the maize area harvested in the EU accounted for approximately 8.8 million hectares, with a production of around 62.7 million metric tons[1]. The EU imported about 15 million tons of maize grain in 2016[3]. The major exporters of maize to the EU are Ukraine and Brazil, followed by Russia[4].

What is MON 810?

MON 810 is a genetically modified (GM) maize containing insect protection trait against certain Lepidopteran insect pests. MON 810 produces Cry1Ab protein via the incorporation of a *cry1ab* coding sequence derived from *Bacillus thuringiensis*. The Cry1Ab protein provides protection against feeding damage from certain lepidopteran pests, including the European corn borer (*Ostrinia nubilalis*) and the Mediterranean corn stalk borer (*Sesamia* spp.). The larvae of these species damage maize by feeding on the ears and producing feeding tunnels in the stalks. This interferes with the flow of nutrients, enhances infection by stalk diseases, and causes stalk breakage and ear drop prior to harvest, reducing maize yield. The expression of Cry1Ab protein in MON 810 ensures the protection of the maize plant from damage by such lepidopteran insect pests.

Crystalline (Cry) proteins derived from *Bacillus thuringiensis* including Cry1Ab can selectively kill insects. Susceptible insects contain receptors in their midgut that bind to a specific Cry protein. The receptor-protein interaction 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. Hitherto, no mammalian receptors that bind the "Cry" proteins have been identified in gastro-intestinal cells.

The gene coding for the Cry1Ab protein is stably integrated in the genome of MON 810 and is expressed to provide selective protection against the lepidopteran pests *Ostrinia nubilalis* and *Sesamia* spp. of the Pyralidae and Noctuidae families, respectively (Gonzalez-Nunez *et al.*, 2000). More information on this product can be obtained from the Center for Environmental Risk Assessment (CERA) GM Crop Database[5] and the EuropaBio website[6].

Worldwide plantings and regulatory status of MON 810

In 2016, approximately 185 million hectares of GM crops were grown worldwide[7]. Of the 185 million hectares of global maize planted in 2016, 33% or 60.6 million hectares were biotech maize.

MON 810 has received regulatory approval for cultivation in Argentina, Brazil, Canada, Colombia, Egypt, the EU, Honduras, Paraguay, the Philippines, South Africa, Uruguay, the US. MON 810 also received regulatory approvals for import in Argentina, Australia/New Zealand, Brazil, Canada, China, Colombia, Egypt, the EU, Honduras, Japan, Korea, Malaysia, Mexico, Paraguay, Russia, Singapore, South Africa, Taiwan, Uruguay, the US, and Vietnam[7].

A stringent regulatory system for genetically modified (GM) crops in the EU

In the EU, the regulatory system for GM crops comprises several regulations and directives, including Directive 2001/18/EC for deliberate release of genetically modified organisms (GMOs) in the environment, Regulation (EC) No 1829/2003 on GM Food and Feed and Commission Implementing Regulation (EU) No 503/2013.

Directive 2001/18/EC includes procedures for the authorisation of deliberate release into the environment of GMOs, whereas Regulation (EC) No 1829/2003 includes procedures for the authorization of deliberate release (cultivation and/or import, and processing), in addition to food and feed use, according to the "one door, one key" principle. Commission Implementing Regulation (EU) No 503/2013 includes requirements for applications for authorisation of GM food and feed in accordance with Regulation (EC) No 1829/2003.

1 FAOSTAT, 2017 - http://faostat.fao.org/site/339/default.aspx (Accessed on 26 January 2018)

2 USDA, 2017 - https://apps.fas.usda.gov/psdonline/app/index.html#/app/home (Accessed on 26 January 2018)

3 Index mundi, 2017 - http://www.indexmundi.com/ (Accessed on 26 January 2018)

4 Eurostat, 2017 - http://ec.europa.eu/eurostat (Accessed on 26 January 2018)

5 CERA, 2017 - http://www.cera-gmc.org/GMCropDatabase (Accessed on 26 January 2018)

6 EuropaBio, 2017 - http://www.europabio.org/information-operators-product-information (Accessed on 26 January 2018)

7 ISAAA, 2017 - http://www.isaaa.org/resources/publications/ (Accessed on 26 January 2018)

A regulation on traceability and labelling of GMOs and products produced from GMOs (Regulation (EC) No 1830/2003) entered into force on 18 April 2004.

Furthermore, a regulation laying down the methods of sampling and analysis for the official control of feed as regards presence of GM material for which an authorisation procedure is pending or the authorisation of which has expired (Commission regulation (EU) No 619/2011) entered into force on 24 June 2011.

Regulatory status of MON 810 in the EU

On 11 July 2004, Monsanto submitted a notification of existing MON 810 products to the European Commission following the entry into force of Regulation (EC) No 1829/2003 and according to Articles 8 and 20 of this Regulation. On 18 April 2005, existing products including feed materials, feed additives and food additives produced from MON 810 were listed in the community register. Processed feeds such as maize gluten feed and meal are therefore approved in the EU[8].

Between 11 April 2007 and 4 May 2007, Monsanto addressed to the European Commission (EC) three applications for renewal of authorisations of the existing MON 810 maize products[9]. In support of these renewal applications, the information required under Articles 11(2) and 23(2) of Regulation (EC) No 1829/2003 was enclosed. This information confirms the conclusions of the original safety assessment.

In addition, as requested in the European Food Safety Authority (EFSA) *Guidance document of the Scientific Panel on Genetically Modified Organisms for renewal of authorisations of existing GMO products lawfully placed on the market, notified according to Articles 8 and 20 of Regulation (EC) No 1829/2003*, the information required under Articles 5(3) and 17(3) of Regulation (EC) No 1829/2003 was provided. For the renewal of the authorisation of the existing MON 810 maize products that were authorised under Directive 90/220/EEC, an environmental risk assessment (ERA) and a monitoring plan according to Directive 2001/18/EC were provided.

On 30 June 2009, the EFSA published a positive Scientific Opinion on MON 810 adopted on 15 June 2009 (EFSA, 2009). The EFSA GMO panel concluded that "*maize MON810 is as safe as its conventional counterpart with respect to potential effects on human and animal health. The EFSA GMO Panel also concludes that maize MON810 is unlikely to have any adverse effect on the environment in the context of its intended uses, especially if appropriate management measures are put in place in order to mitigate possible exposure of non-target Lepidoptera*".

On 8 July 2016, the European Commission (EC) presented the Draft Commission Implementing Decision authorising the placing on the market of food and feed products containing, consisting of, or produced from the GM maize MON 810 for all uses as any other maize, with the exception of pollen and cultivation, to the Standing Committee on Plants, Animals, Food and Feed (PAFF) for a vote. After this vote, since no qualified majority was reached, the draft decision was passed to the Appeal Committee who met for a vote on 15 September 2016, again without reaching a qualified majority. Therefore, the Appeal Committee forwarded the draft decision to the EC who granted the authorization on 4 July 2017 (European Commission, 2017).

MON 810 pollen

In March 2012, Monsanto submitted an application for authorisation of the use of MON 810 pollen as or in food under Regulation (EC) No 1829/2003 to the EFSA, via the Dutch Competent Authority. This application was submitted upon request from the European Commission following the ruling of the European Court of Justice[10] which considers MON 810 pollen as a (non-viable) product derived from maize, which needs an authorisation under Reg 1829/2003.

On 18 December 2012, the EFSA published a positive Scientific Opinion adopted on 6 December 2012 (EFSA, 2012). The EFSA concludes that "w*hile the EFSA GMO Panel is not in a position to conclude on the safety of maize pollen in or as food in general, it concludes that the genetic modification in maize MON 810 does not constitute an additional health risk if maize MON 810 pollen is to replace maize pollen from non-GM maize in or as food.*"

On 10 June 2013, the European Commission presented the Draft Commission Implementing Decision for this MON 810 pollen application, to the Standing Committee on the Food Chain and Animal Health (SCFCAH) for a vote. After this vote, the draft decision was passed to the Appeal Committee who met for a vote on 11 July 2013. The Appeal Committee forwarded the draft decision to the European Commission with a recommendation for an approval. The authorisation was finally granted by the European Commission on 6 November 2013[11].

Traceability, labelling, unique identifier

Operators handling or using MON 810 and derived foods and feeds in the EU are required to be aware of the legal obligations regarding traceability and labelling of these products, laid down in Regulations (EC) No 1829/2003 and 1830/2003. The unique identifier for this product is MON-ØØ81Ø-6.

A MON 810-specific PCR-based detection method allowing the identification and quantification of MON 810 was provided to the Joint Research Centre (JRC), acting as the European Union Reference Laboratory (EURL). The validated methods, as well as the validation report for MON 810, prepared by the EURL in collaboration with the European

[8] EU Food and Feed Safety, 2017 – http://ec.europa.eu/food/dyna/gm_register/index_en.cfm (Accessed on 26 January 2018)

[9] Food additives, feed materials and feed additives produced from MON 810; food and food ingredients produced from MON 810 and MON 810 maize products that were authorized under Directive 90/220/EEC

[10] http://curia.europa.eu/juris/liste.jsf?language=en&num=C-442/09 (Accessed on 26 January 2018)

[11] EUR-LEX – 2013, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D0649 (Accessed on 26 January 2018)

Network of GMO Laboratories (ENGL), were published on 10 March 2006 on the EURL website[12].

Food, feed and environmental safety of MON 810

Food and feed safety

The food and feed safety of MON 810 was established based on the following:

- A detailed molecular characterization of the inserted DNA, where the results confirm that a single copy of the *cry1Ab* expression cassette was integrated at a single locus within the maize genome;
- The long history of safe use of the Cry1Ab protein;
- The compositional and nutritional equivalence of the seed and forage derived from MON 810 with those of conventional maize; and
- The rapid digestibility of the Cry1Ab protein by proteases found in the human gastrointestinal tract (pepsin and pancreatin);
- The lack of toxicity or allergenicity of the Cry1Ab protein generally and as demonstrated with bioinformatics as well as *in vitro* and *in vivo* safety studies of the Cry1Ab protein;
- A large margin of safety resulting from the low dietary exposure to the introduced Cry1Ab protein in MON 810.

MON 810 was shown to be as safe and nutritious as conventional maize by analysis of key nutrients, including protein, fat, carbohydrates, amino acids, fatty acids and minerals (EFSA, 2009). In the EFSA Scientific Opinion on MON 810, the EFSA confirmed the conclusions of the initial food and feed safety assessments and stated that "*maize MON810 is as safe as its conventional counterpart with respect to potential effects on human and animal health*".

Further details on the safety of MON 810 are available in the EFSA scientific opinion published on 30 June 2009 (EFSA, 2009).

Environmental safety

The environmental safety of MON 810 was established through extensive laboratory and field testing conducted of plant tissue or purified Cry1Ab protein demonstrating that MON 810 poses negligible risk to human and animal health or to the environment (EFSA, 2009).

Results from the agronomic and phenotypic assessments confirm that MON 810 does not possess weediness or invasiveness characteristics compared to conventional maize. Data on the environmental interaction also confirm that, except for the intended lepidopteran insect protection trait, MON 810 does not confer any biologically meaningful difference in susceptibility or tolerance to specific disease, insect or abiotic stressors compared to conventional maize. This, together with the history of safe use of the Cry1Ab protein, demonstrate that the ecological interactions of MON 810 with non-target organisms or soil processes are not different from conventional maize.

Maize has no indigenous wild relatives in Europe to which the introduced trait could outcross. Teosinte, not native to Europe, has been observed in in-field situations in South France and Spain. The impact and interaction of teosinte with MON 810 commercial fields is not different from those observed with conventional maize. When evaluating this topic, the EFSA concluded that *"there are no data that indicate the necessity to revise the previous ERA conclusions and risk management recommendations."* (EFSA, 2016).

The likelihood of MON 810 spreading into the non-agronomic environment is negligible, since it is not more invasive in natural habitats than conventional maize. Moreover, the scope of the authorisation covers the import, processing and all uses of food and feed products containing, consisting of, or produced from MON 810 as any other maize, with the exception of pollen and cultivation in the EU. Therefore, no deliberate release of the viable plant material in the EU environment is expected, thereby limiting the environmental exposure to accidental spillage only.

In conclusion, the environmental impact of growing MON 810 is not different from that of growing conventional maize, as stated in the June 2009 EFSA scientific opinion (EFSA, 2009).

MON 810, the benefits

The benefits that MON 810 provides to farmers and the environment are following:

- An improved corn borers control method that is compatible with integrated pest management (IPM). Use of MON 810 at the same time ensures safety for humans, animals and the environment as well as higher yields for the farmers (Brookes and Barfoot, 2005; Heimlich *et al.*, 2000);
- Increased benefits for farmers linked to reduced exposure to insecticides, ease of use and handling, as well as time and labor savings (Brookes and Barfoot, 2006; Marra *et al.*, 2002);
- Negligible to no impact on beneficial, non-target organisms (Eckert *et al.*, 2006; Griffiths *et al.*, 2005; Lopez *et al.*, 2005);
- Reduced associated adverse health effects of fungal mycotoxins on humans and animals (CAST, 2003). Use of MON 810 decreases crop damage by lepidopteran pests, leading to reduced fungal infections of the maize plant and ultimately decreased associated adverse effects due to mycotoxin production (Bakan *et al.*, 2002; Hammond *et al.*, 2003; Magg *et al.*, 2003; Masoero *et al.*, 1999; Munkvold, 2003; Wu, 2006);
- Improvement in economic profitability attributed to the use of insect protected biotech crops in the European Union (Brookes, 2008). In Spain where the maize growing regions are affected by corn borer pests, the adoption of MON 810 has consistently improved yield per hectare (Park *et al.*, 2011).

[12] EURL - http://gmo-crl.jrc.ec.europa.eu/StatusOfDossiers.aspx (Accessed on 26 January 2018)

References

Bakan B, Mecion D, Richard-Molard D and Cahagnier B, 2002. Fungal growth and *Fusarium* Mycotoxin content in isogenic traditional maize and genetically modified maize grown in France and Spain. J. Agric. Food Chem., 50, 728-731.

Brookes G, 2008. The impact of using GM insect resistant maize in Europe since 1998. International Journal of Biotechnology, 10, 148-158.

Brookes G and Barfoot P, 2005. GM crops: the global economic and environmental impact - the first years 1996 - 2004. AgBioForum, 8, 187-196.

Brookes G and Barfoot P, 2006. Global impact of biotech crops: Socio-economic and environmental effects in the first ten years of commercial use. AgBioForum, 9, 139-151.

Eckert J, Schuphan I, Hothorn LA and Gathmann A, 2006. Arthropods on maize ears for detecting impacts of *Bt* maize on non target organisms. Environmental Entomology, 35, 554-560.

EFSA, 2009. Scientific opinion on application (EFSA-GMO-RX-MON 810) for renewal of authorisation for the continued marketing of (1) food containing, consisting of, or produced from genetically modified maize MON 810; (2) feed containing, consisting of, or produced from maize MON 810; (3) other products containing or consisting of maize MON 810 with the exception of cultivation, all under Regulation (EC) No 1829/2003 from Monsanto. The EFSA Journal, 1149, 1-85.

EFSA, 2012. Scientific Opinion on an application (EFSA-GMO-NL-2012-107) for the placing on the market of maize MON 810 pollen under Regulation (EC) No 1829/2003 from Monsanto. The EFSA Journal, 10 (12), 1-9.

EFSA, 2016. Relevance of new scientific evidence on the occurrence of teosinte in maize fields in Spain and France for previous environmental risk assessment conclusions and risk management recommendations on the cultivation of maize events MON810, Bt11, 1507 and GA21. The EFSA Journal, 1-13.

European Commission, 2017. Commission implemeting decision (EU) 2017/1207 of 4 July 2017 renewing the authorisation for the placing on the market of genetically modified maize MON 810 (MON-ØØ81Ø-6) products pursuant to Regulation (EC) No 1829/2003 of the European Parliament and of the Council. Official Journal of the European Union, L 173/18, 1-5.

Gonzalez-Nunez M, Ortego F and Castanera P, 2000. Susceptibility of Spanish populations of the corn borers *Sesamia nonagrioides* (Lepidoptera: *Noctuidae*) and *Ostrinia nubilalis* (Lepidoptera: *Crambidae*) to a *Bacillus thuringiensis* endotoxin. J. Economic Entomology, 93, 459-463.

Goodman MM, 1988. The history and evolution of maize. CRC Crital Rev. Plant Sciences, 7, 197-220.

Griffiths B, Caul S, Thompson J, Birch ANE, Scrimgeour C, Andersen M, Cortet J, Messean A, Sausse C, Lacroix B and Krogh P, 2005. A comparison of soil microbial community structure, protozoa and nematodes in field plots of conventional and genetically modified maize expressing the *Bacillus thuringiensis* Cry1Ab toxin. Plant and Soil, 275, 135-146.

Hammond B, Campbell K, Degooyer T, Robinson A, Richard J, Segueira J, Rubinstein C, Cea J, Plancke M, Pinson L, Radu C, Esin H, Tatli F and Grogna R, 2003. Reduction of fumonisin mycotoxins in Bt corn. Oxford Univ Press, 250 (item 1217).

Heimlich R, Fernandez-Cornejo J, McBride W, Klotz-Ingram C, Jans S and Brooks N, 2000. Genetically engineered crops: has adopion reduced pesticide use? Agricultural Outlook August, 13-17.

Lopez MD, Prasifka JR, Bruck DJ and Lewis LC, 2005. Utility of ground beetle species in field tests of potential nontarget effects of Bt crops. Environmental Entomology, 34, 1317-1324.

Magg T, Bohn M, Klein D, Meriditaj V and Melchinger AJ, 2003. Concentration of moniliformin produced by *Fusarium* species in grains of transgenic *Bt* maize hybrids compared to their isogenic counterparts and commercial varieties under European corn borer pressure. Plant Breeding, 122, 322-327.

Marra M, Pardey P and Alston J, 2002. The payoffs to agriculture biotechnology - an assessment of the evidence. Environmental and Production Technology Division (EBTD) of the International Food Policy Research Institute (IFPRI), 87, 1-57.

Masoero F, Moschini M, Rossi F, Prandini A and Pietri A, 1999. Nutritive value, mycotoxin contamination and *in vitro* rumen fermentation of normal and genetically modified corn (Cry1A(B)) grown in northern Italy. Maydica, 44, 205-209.

Munkvold GP, 2003. Cultural and genetic approaches to managing mycotoxins in maize. Annu. Rev. Phytopathol., 41, 99-116.

Park J, McFarlane I, Phipps R and Ceddia G, 2011. The impact of the EU regulatory constraint of transgenic crops on farm income. New Biotechnology, 28, 1-11.

Wu F, 2006. Mycotoxin reduction in Bt corn: potential economic, health, and regulatory impacts. Transgenic Research, 15, 277-289.