MON 87708

Dicamba tolerant soybean

Key Facts

Monsanto EMEA
May 2015

MON 87708 soybean

Soybean, a key crop

Soybean (*Glycine max*) is a high-protein legume grown mainly as food for humans and livestock. It is the highest natural source of dietary fiber. Eight essential amino acids are found in soybeans, which are necessary for human nutrition and are not produced naturally in the body[1]. This crop is also used in industrial products including oils, soaps, cosmetics, resins, plastics, inks, solvents, and biodiesel.

The first record of domesticated soybean dates back to the 11th centuries BC in the eastern half of China where it was grown as food. Soybean was cultivated for the first time in Europe in the early 1700's and in North America in the early 1800's.

In 2013-2014, approximately 284 million metric tons of soybean were produced in the world, which represents approximately 114 million hectares of soybean harvested globally. Significant areas of production included the US, Brazil, Argentina and China representing 26.9%, 26.5%, 17.2% and 5.7% of the global soybean hectares, respectively (Oil World Annual, 2014).

The EU is not a significant soybean producer. In 2013-2014, the soybean area harvested in the EU-28 accounted for approximately 504 thousand hectares distributed principally between Italy, Romania, Croatia, Hungary, Austria, France, and Slovakia (43.7%, 13.7%, 9.5%, 8.5%, 8.3%, 8.1% and 5.8% of the harvested area in Europe, respectively) (Oil World Annual, 2014). Because of its low production and its high demand, especially for animal consumption, the EU is the world's largest importer of soybean meal and the second largest importer of whole soybeans, after China. In the period 2013-2014, the EU-28 expected to import 43.4 million metric tons of soybean meal and 13.9 million metric tons of whole soybeans (Oil World Annual, 2014). Spain, Germany, The Netherlands, Italy and France are among the largest importer EU Member States (Oil World Annual, 2014).

Countries in North America and South America export large quantities of soybeans to the EU. In 2013-2014, about 41.6% of the EU imports came from Brazil, 23.7% from the US, 14.4% from Paraguay, and 8.3% from Canada (Oil World Annual, 2014).

What is MON 87708?

MON 87708 was developed by Monsanto Company through *Agrobacterium*-mediated transformation of soybean meristem tissues. MON 87708 is tolerant to dicamba (3,6-dichloro-2-methoxybenzoic acid) herbicide.

MON 87708 contains a gene derived from *Stenotrophomonas maltophilia (S. maltophilia)* that expresses DMO, a mono-oxygenase enzyme that rapidly demethylates dicamba rendering it inactive, thereby conferring tolerance to dicamba.

MON 87708 offers an expanded use of dicamba in soybean production from the current pre-plant and pre-harvest labeled uses. The tolerance of MON 87708 to dicamba facilitates a wider window of application in soybean, allowing pre-emergence application up to the day of crop emergence and in-crop post-emergence applications through the early reproductive (R1/R2) growth stage. Dicamba provides effective control of over 95 annual and biennial weed species, and suppression of over 100 perennial broadleaf and woody plant species.

Mode of action

DMO was initially purified from *S. maltophilia* strain DI-6, isolated from soil at a dicamba manufacturing plant (Krueger *et al.*, 1989). DMO is an enzyme that catalyzes the demethylation of dicamba to the non-herbicidal compounds 3,6-dichlorosalicylic acid (DCSA) and formaldehyde (Chakraborty *et al.*, 2005). DMO is a Rieske-type non-heme iron oxygenase, that is part of a three component system comprised of a reductase, a ferredoxin, and a terminal oxygenase, in this case the DMO. These three enzymes work together in a redox system similar to many other oxygenases to transport electrons from nicotinamide adenine dinucleotide (NADH) to oxygen and catalyze the demethylation (Behrens *et al.*, 2007).

The crystal structure of a DMO is known (D'Ordine et al., 2009; Dumitru et al., 2009) and shows that the DMO monomers contain a Rieske [2Fe-2S] cluster domain and a non-heme iron center domain typical of all Rieske-type mono-oxygenases (Ferraro et al., 2005). To catalyze the demethylation of dicamba, electrons transferred from NADH are shuttled through an endogenous reductase and ferredoxin to the terminal DMO. The electrons are received by the Rieske [2Fe-2S] cluster on one DMO monomer and transferred to the non-heme iron center at the catalytic site of an adjacent monomer (D'Ordine et al., 2009; Dumitru et al., 2009), where it reductively activates oxygen to catalyze the final demethylation of dicamba. As a result of the reaction, DCSA and formaldehyde are formed. DCSA is a known soybean, soil, and livestock metabolite whose safety has been evaluated by the EPA and FAO/WHO (EFSA, 2007; FAO/WHO, 2011; US EPA, 2005). Formaldehyde is found naturally in many plants at levels up to several hundred ppm (Adrian-Romero et al., 1999).

[1] SoyStats® 2014 - http://soystats.com/composition-of-a-soybean (Accessed on 5 May 2015)

Worldwide plantings and regulatory status of MON 87708

Genetically modified crops protected against insect pests and/or tolerant to a specific herbicide are commercialized in the US by Monsanto since 1996. In 2014, approximately 182 million hectares of GM crops were grown worldwide (James, 2014). In the case of biotech soybean, it remained the principal biotech crop in 2014, occupying 90.7 million hectares (James, 2014).

MON 87708 has received regulatory approval for production in Canada and the US MON 87708 has also received regulatory approvals in Australia, Japan, Korea, Mexico, New Zealand, the Philippines, and Taiwan for import[2].

MON 87708 will be cultivated solely for the production of the combined product MON 87708 × MON 89788 (dicamba and glyphosate tolerant traditionally bred soybean), the targeted article of commerce which will be cultivated in Canada and the US.

A stringent regulatory system for genetically modified 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 GMOs in the environment and Regulation (EC) No 1829/2003 on GM Food and Feed.

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.

A regulation on traceability and labeling 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 genetically modified material for which an authorization procedure is pending or the authorization of which has expired (Commission regulation (EU) No 619/2011) entered into force on 24 June 2011.

Regulatory status of MON 87708 in the EU

On 31 January 2011, Monsanto submitted an application for import, food and feed use of MON 87708 soybean as any other soybean (excluding cultivation) under Regulation (EC) No 1829/2003 to the European Food Safety Authority (EFSA) via the Dutch Competent Authority. This application received the reference number EFSA-GMO-NL-2011-93 and was declared valid on 13 May 2011. The EFSA evaluated the application as well as Monsanto's additional information, scientific comments submitted by the EU Member States and relevant scientific publications. On 3 October, the EFSA published its Scientific Opinion on MON 87708 (adopted 12 September 2013) (EFSA, 2013).

The EFSA concluded that "*the soybean MON 87708 is as safe as its conventional counterpart with respect to potential effects on human and animal health or the environment in the context of its intended uses*".

On 24 April 2014, the European Commission presented the Draft Commission Implementing Decision authorizing the placing on the market of products containing, consisting of, or produced from genetically modified soybean MON 87708 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 10 June 2014. The Appeal Committee forwarded the draft decision to the European Commission with a recommendation for an approval. The authorization was finally granted by the European Commission on 24 April 2015 (Commission Decision, 2015).

Traceability, labelling, unique identifier

Operators handling or using MON 87708 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-877Ø8-9.

In January 2011, a MON 87708-specific PCR-based detection method allowing the identification and quantification of MON 87708 was provided to the Joint Research Centre (JRC), acting as the Community Reference Laboratory (CRL). The validated method, as well as the validation report for MON 87708, prepared by the CRL in collaboration with the European Network of GMO Laboratories (ENGL), were published on 16 May 2013 at the CRL website[3]. A report on the validation of the DNA extraction method for soybean seeds was also published on the same date.

Food, feed and environmental safety of MON 87708

Food and feed safety

The food and feed safety of MON 87708 was established based on:

- A detailed molecular characterization of the inserted DNA, where the results confirm that a single copy of the *dmo* expression cassette was integrated at a single locus within the soybean genome;
- An assessment of the toxic and allergenic potential of DMO protein based on a history of safe use, extensive information collected and safety evaluations performed, demonstrates that DMO is unlikely to be a toxin or allergen;
- The compositional and nutritional analyses confirmed that the seed and forage from MON 87708 are compositionally and nutritionally equivalent to, and as safe as, those of conventional soybean; and

[2] Crop Life International - http://www.biotradestatus.com/ (Accessed on 5 May 2015)

[3] EU-RL GMFF - http://gmo-crl.jrc.ec.europa.eu/StatusOfDossiers.aspx (Accessed on 5 May 2015)

- A dietary risk assessment showed that the intake of the introduced DMO protein resulting from consumption of foods derived from MON 87708 soybean does not raise nutritional concerns.

Also "*The EFSA GMO Panel is of the opinion that soybean MON 87708 is as safe and as nutritious as its conventional counterpart and non-GM reference varieties, in the context of its intended use.*" (EFSA, 2013).

Environmental safety

The environmental safety of MON 87708 was established through extensive laboratory testing and field trials conducted in the US since 2005 and in Argentina, Chile, and Canada since 2006, 2007, and 2008, respectively. All these field trials demonstrated that MON 87708 poses negligible risk to human health or to the environment. Results from the phenotypic and agronomic assessments demonstrate that MON 87708 does not possess characteristics that would confer a plant pest risk compared to conventional soybean. Data on environmental interactions also indicate that MON 87708 does not confer any biologically meaningful increased susceptibility or tolerance to specific disease, insect, or abiotic stressors, or changes in agronomic and phenotypic characteristics.

Soybean does not have wild relatives in Europe to which the introduced trait could outcross. The likelihood of this soybean spreading into the non-agronomic environment is negligible, since it is not more invasive in natural habitats than conventional soybean. Moreover, the scope of the authorization covers the import, processing and all uses as any other soybean, but excluding cultivation in the EU, and no deliberate release of the viable plant material in the EU environment is expected thereby limiting the environmental exposure to accidental spillage only.

The herbicide tolerance trait in MON 87708 can be regarded as providing only a potential agronomic and selective advantage for this GM soybean plant where and when dicamba herbicides are applied. Survival of soybean plants outside cultivation where dicamba herbicides are applied is mainly limited by a combination of low competitiveness, absence of a dormancy phase and susceptibility to plant pathogens and cold climatic conditions. It is actually expected that the production of MON 87708 and the associated use of dicamba herbicide could have less impact than the agronomic practices used to grow conventional soybean today, and in addition, provide benefits to farmers and the environment (*see* below).

In their scientific opinion on MON 87708, the EFSA concluded that "*the genetically modified soybean MON 87708 is unlikely to have any adverse effect on human and animal health or on the environment in the context of its intended uses*"(EFSA, 2013).

MON 87708, the benefits

MON 87708 provides the following benefits:

- Upon commercialization, MON 87708 will be stacked with MON 89788 soybeans to provide soybean farmers with more weed management options, and further facilitate growers' ability to implement more diverse weed management systems as recommended by university co-operative extension services and private sector weed scientists.
- Dicamba has been shown to improve weed control performance and consistency while also controlling glyphosate-resistant weeds like marestail, Palmer pigweed, waterhemp and other tough-to-control weeds such as lambsquarters and velvetleaf that can rob farmers of yield (Bradley et al., 2012; Edwards et al., 2012; Johnson et al., 2010; Maxwell et al., 2011; Moechnig et al., 2010; Peterson et al., 2011; Steckel and Montgomery, 2008). Dicamba kills weeds by a different mechanism of action than glyphosate. Therefore, the use of dicamba offers the grower an effective and sustainable way to manage glyphosate-resistant broadleaf species.
- Dicamba displays excellent crop tolerance in weed control systems that include sequential pre-emergence and in-crop post-emergence applications of dicamba or in systems including two sequential in-crop post-emergence applications of dicamba (Bauerle et al., 2012; Bernards et al., 2011; Edwards et al., 2012; Peterson et al., 2011; Steckel et al., 2012; Steckel and Montgomery, 2008; York et al., 2012).
- MON 87708 will allow farmers to extend the application flexibility of dicamba in soybean for both pre-emergence and post-emergence applications in soybean. University weed control specialists indicate that the dicamba-tolerant soybean technology will be important because it will enable pre-plant and pre-emergence applications of dicamba without a pre-plant interval for control of existing weeds in no-till cropping systems (Peterson et al., 2011) (Steckel et al., 2012).
- MON 87708 will provide 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 (Brookes and Barfoot, 2011; Fawcett and Towery, 2000).

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