MON 87427 × MON 89034 × NK603

Genuity® VT Double PRO® with Roundup® Hybridization System[1]

Glyphosate-tolerant and insect-protected maize

Key facts

Bayer Agriculture BVBA

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[1] Roundup, Genuity and VT Double PRO are registered trademarks of Monsanto Technology LLC.

Maize, a key crop

Maize (*Zea mays)* is one of the most frequently cultivated crops in the world, together with rice and wheat[2]. Following European discovery of the Americas where this crop is indigenous, maize was rapidly adopted in Europe, Africa and Asia. In 2018, over 1 billion metric tons of maize were produced in the world, which represents approximately 184 million hectares of maize harvested globally[3]. 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[4].Today, maize 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 2018, the maize area harvested in the EU accounted for approximately 8.3 million hectares, with a production of around 59.8 million metric tons[4]. The EU imported about 18 million tons of maize grain in 2018[4]. The major exporters of maize to the EU are Ukraine and Brazil, followed by Canada[5]. 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.

What is MON 87427 × MON 89034 × NK603?

MON 87427 × MON 89034 × NK603 was obtained by traditional breeding of three independent genetically modified maize events, MON 87427, MON 89034, NK603. MON 87427 × MON 89034 × NK603 combines the traits of agronomic interest from the three parental lines, *i.e.* glyphosate tolerance and lepidopteran protection. Maize is a segregating crop and therefore MON 87427 × MON 89034 × NK603 grain includes the combined event product and any combination of these events (sub-combinations).

MON 87427 × MON 89034 × NK603, as well as the genetically modified parental maize lines (MON 87427, MON 89034 and NK603) have been developed by Monsanto Company.

More information on the parental lines can be found on the European Association for Bioindustries (EuropaBio) website[6].

Worldwide plantings and regulatory status of MON 87427 × MON 89034 × NK603

In 2017, approximately 189.8 million hectares of GM crops were grown worldwide[7]. Of the 189.8 million hectares of global maize planted in 2017, 31.5% or 59.7 million hectares were biotech maize.

MON 87427 × MON 89034 × NK603 has received regulatory authorisation for production in Canada. MON 87427 × MON 89034 × NK603 also received regulatory authorisations for import in Canada, Colombia, Japan, Korea, Mexico, Philippines, South Africa, Taiwan and US.

A stringent regulatory system for 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 authorisation 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.

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 genetically modified 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 87427 × MON 89034 × NK603 in the EU

On 30 August 2013, Monsanto Company submitted an application for import for food and feed use of MON 87427 × MON 89034 × NK603 maize as any other maize (excluding cultivation) under Regulation (EC) No 1829/2003 to the European Food Safety Authority (EFSA) via the Belgian Competent Authority. The application received the reference number EFSA-GMO-BE-2013-117 and was declared valid on 22 January 2014. The EFSA evaluated the application as well as additional information provided by Monsanto Company, scientific comments submitted by the EU Member States and relevant scientific publications.

[2] FAOSTAT, 2018 - http://faostat.fao.org/site/339/default.aspx (Accessed on 07 September 2018).

[3] USDA, 2018 - https://apps.fas.usda.gov/psdonline/app/index.html#/app/home (Accessed on 07 September 2018).

[4] Index mundi, 2018 - https://www.indexmundi.com/agriculture/?commodity=corn&graph=production (Accessed on 07 September 2018).

[5] Eurostat, 2018 - http://ec.europa.eu/eurostat (Accessed on 7 September 2018).

[6] EuropaBio, 2018 - http://www.europabio.org/information-operators-product-information (Accessed on 07 September 2018).

[7] ISAAA, 2018 - http://www.isaaa.org/resources/publications/ (Accessed on 07 September 2018).

On 1 August 2017, the EFSA published a positive Scientific Opinion on the safety of MON 87427 × MON 89034 × NK603 and its sub-combinations independently of their origin (EFSA, 2017). The EFSA GMO panel concluded that *"the three-event stack maize is as safe and as nutritious as its conventional counterpart in the context of its scope. The GMO Panel considered that its previous conclusions on the two-event stack maize MON 89034 × NK603 remain valid. For the two maize sub-combinations for which no experimental data were provided the GMO Panel assessed the likelihood of interactions among the single events, and concluded that their combination would not raise safety concerns. These two sub-combinations are therefore expected to be as safe as the single events, the previously assessed maize MON 89034 × NK603 and maize MON 87427 × MON 89034 × NK603"*.

On 16 January 2018, the European Commission (EC) presented the Draft Commission Implementing Decision authorising the placing on the market of products containing, consisting of, or produced from genetically modified maize MON 87427 × MON 89034 × NK603 and its sub-combinations independently of their origin, 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 26 February 2018, again without reaching a qualified majority. Therefore, the Appeal Committee forwarded the draft decision to the EC who granted the authorisation on 3 August 2018 (European Commission, 2018)

Regulatory status of the parental lines

The EC authorised MON 87427, MON 89034, and NK603 for import, food and feed use as any other maize (excluding cultivation) under Regulation (EC) No 1829/2003 on 4 December 2015, 30 October 2009 and 24 April 2015, respectively (Commission Decisions 2015/2281/EC; 2009/813/EC; 2015/684/EC).

Traceability, labelling, unique identifier

Operators handling or using MON 87427 × MON 89034 × NK603 and its sub-combinations 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 the products covered by the Commission Implementing Decision (EU) 2018/1111/EC of 3 August 2018 (European Commission, 2018) are MON-87427-7 × MON-89Ø34-3 × MON-ØØ6Ø3-6; MON-87427-7 × MON-ØØ6Ø3-6; MON-89Ø34-3 × MON-ØØ6Ø3-6[8] and MON-87427-7 × MON-89Ø34-3.

On 22 July 2013, MON 87427 × MON 89034 × NK603 samples of food and feed and control samples were received by the Joint Research Centre (JRC), acting as the European Union Reference Laboratory (EURL).

The EURL considers that the detection methods validated on the parental maize events, MON 87427, MON 89034, and NK603, show a comparable performance when applied to MON 87427 × MON 89034 × NK603. The detection methods for MON 87427, MON 89034, and NK603 had been previously validated by the EURL and were published at the EURL website on 12 June 2015, 5 November 2008 and 10 January 2005, respectively[9]. The validation report for MON 87427 × MON 89034 × NK603, prepared by the EURL in collaboration with the European Network of GMO Laboratories (ENGL), was published on 30 June 2016 on the same website[9].

Food, feed and environmental safety of MON 87427 × MON 89034 × NK603

Food and feed safety

MON 87427 × MON 89034 × NK603 was obtained by traditional breeding of three independent genetically modified maize lines, MON 87427, MON 89034 and NK603. The safety assessment was essentially carried out in two steps:

- Demonstration that the characteristics of the parental lines are maintained in MON 87427 × MON 89034 × NK603.
- Safety assessment of the combined product, taking into consideration the safety of the parental lines.

The molecular analysis of the DNA inserts present in MON 87427 × MON 89034 × NK603 confirmed that the insert structures of the parental maize lines were retained. Also, CP4 EPSPS[10], Cry1A.105 and Cry2Ab2 protein levels in seed and forage of MON 87427 × MON 89034 × NK603 were comparable to the levels in the corresponding parental maize lines.

The conclusions of safety for the CP4 EPSPS, Cry1A.105 and Cry2Ab2 proteins, as already demonstrated in the context of MON 87427, MON 89034 and NK603, remain applicable when these proteins are produced in combination in MON 87427 × MON 89034 × NK603. It is unlikely that when interactions between CP4 EPSPS, Cry1A.105 and Cry2Ab2 would occur, these would raise any safety concerns.

The compositional and nutritional analysis showed that, except for the intended CP4 EPSPS, Cry1A.105 and Cry2Ab2 proteins expression, there are no biologically relevant differences in the characteristics of MON 87427 × MON 89034 × NK603 as compared with its conventional counterpart and that the composition fell within the range of non-GM maize varieties.

Also, in their scientific opinion, the EFSA concluded that *"Maize MON 87427 × MON 89034 × NK603 is as nutritious as the non-GM comparator and the non-GM commercial varieties tested"* (EFSA, 2017).

[8] Commission Decision 2010/420/EU of 28 July 2010 authorising the placing on the market of products containing, consisting of, or produced from genetically modified maize MON89034 × NK603 (MON-89Ø34-3 × MON-ØØ6Ø3-6) pursuant to Regulation (EC) No 1829/2003 of the European Parliament and of the Council repealed by Commission Implementing Decision (EU) 2018/1111/EC.

[9] EURL - http://gmo-crl.jrc.ec.europa.eu/StatusOfDossiers.aspx (Accessed on 07 September 2018).

[10] NK603 expresses CP4 EPSPS and CP4 EPSPS L214P, further referred to as CP4 EPSPS.

In conclusion, combining MON 87427, MON 89034, and NK603 via traditional breeding does not lead to safety concerns, and, as the parental lines, MON 87427 × MON 89034 × NK603 has shown to be as safe and nutritious as conventional maize.

As maize is a segregating crop and MON 87427 × MON 89034 × NK603 is produced using traditional breeding methods; the conclusions derived in this section are equally applicable to MON 87427 × MON 89034 × NK603 as to any of its sub-combinations.

Environmental safety

The environmental safety of MON 87427 × MON 89034 × NK603 was established based on the following:

- The agronomic and phenotypic analyses confirmed that MON 87427 × MON 89034 × NK603 does not possess characteristics that would confer a plant pest risk compared to conventional maize.
- The environmental interaction analyses confirmed that MON 87427 × MON 89034 × NK603 does not confer any biologically meaningful increased susceptibility or tolerance to specific disease, insect or abiotic stressors.

Also, in their scientific opinion, the EFSA GMO Panel concluded that *"the three-event stack maize MON 87427 × MON 89034 × NK603 would not raise safety concerns in the event of accidental release of viable GM maize grains into the environment"* (EFSA, 2017).

The likelihood of MON 87427 × MON 89034 × NK603 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 as any other maize, 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.

MON 87427 × MON 89034 × NK603, the benefits

MON 87427 × MON 89034 × NK603 provides the following potential benefits to both farmers and the environment:

- *Increased flexibility in hybrid seed production*: each year approximately 0.5 M acres used for hybrid maize seed production must be detasseled in order to meet commercial growers' hybrid maize seed needs and to meet established seed purity criteria in seed producing countries. The critical time period for detasseling is after the tassel has emerged but prior to pollen shed and silk emergence, and encompasses an average of 3-4 day window. Current detasseling practices may require up to two passes with mechanical detasseling equipment and up to three passes if hand detasseling is used. Further complicating detasseling activity is the logistical planning required for transporting the necessary labour force and resources to the designated hybrid seed production fields at the appropriate time. Glyphosate applications to MON 87427 × MON 89034 × NK603 fields, that will result in the male sterile phenotype through tissue-selective glyphosate tolerance, will take place during maize vegetative growth stages ranging from V8 to V13. The two glyphosate applications would take place during an approximate 14 day window within these growth stages, a much longer time period compared to an average 3-4day window between tassel emergence and pollen shed and silk emergence available for current detasseling practices. This timing accounts for significantly improved flexibility in hybrid seed production;
- *Economic benefits for hybrid seed producers*: seed manufacturers continually seek ways to improve hybrid seed productivity and reduce the inputs and land area used to produce high quality hybrid seed. Agricultural field labour costs tend to outpace inflation in typical maize seed producing markets. Compounding this increase in cost is shrinking of the agricultural labour workforce due to population migration towards urban areas, thus reducing a reliable labour pool for agricultural work. Costs associated with labour recruitment and deployments to perform detasseling work, represent one of the largest opportunities for cost improvements associated to hybrid seed production. MON 87427 × MON 89034 × NK603 will decrease hybrid seed production costs primarily from a reduction in direct costs and from associated labour costs;
- A method to control corn borers and other lepidopteran pests of maize, 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);
- Better control of fall armyworm (*Spodoptera* sp.) and corn earworm (*Helicoverpa zea*) compared to the first generation insect protected maize, MON 810 (MON 89034 has a wider spectrum of activity);
- An effective insect resistance management tool due to the presence of two insecticidal proteins, Cry1A.105 and Cry2Ab2;
- Decreased occurrence of fungal mycotoxins associated with adverse health effects, as a result of lower damage to maize plants by lepidopteran pests (Bakan *et al.*, 2002; Brookes, 2008; de la Campa *et al.*, 2005; Munkvold, 2003; Wu, 2006)
- Glyphosate use rates, timings and recommendations for weed management will not be different than those previously recommended for NK603 allowing flexible broad-spectrum weed control options that allows over-the-top applications of glyphosate

in maize on an "as needed" basis (Johnson *et al.*, 2000);

- Contribution to achieve more consistency in the weed control results combined with the full and superior selectivity of Roundup® on MON 87427 × MON 89034 × NK603 hybrids to protect the yield potential of those hybrids;
- Flexible broad-spectrum weed control options that allows over-the-top applications of glyphosate in maize on an "as needed" basis (Johnson *et al.*, 2000);
- 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 existing weed control programs (Dewar, 2009);
- The opportunity to replace several selective herbicides with a single broad-spectrum herbicide with a favorable human health and environmental profile. The active ingredient glyphosate is non-persistent and has limited mobility as it binds tightly to soil. The compound presents very low toxicity to humans. Furthermore, it does not bioaccumulate and presents minimal risk to terrestrial and aquatic species including fish, birds, mammals and invertebrates (Giesy *et al.*, 2000; Williams *et al.*, 2000);
- 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 (Brookes and Barfoot, 2008; Marra *et al.*, 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; this is attributed to the reduction in insecticide use, low toxicity of glyphosate and compatibility with conservation tillage practices (Ammann, 2003; Fawcett and Towery, 2002; Giesy et al., 2000; Lozzia, 1999; Orr and Landis, 1997; Pilcher et al., 1997; Reyes, 2005);
- 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 CO_2 emissions (Brookes and Barfoot, 2014); Fawcett and Towery, 2002; Phipps and Park, 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; Phipps and Park, 2002).

Contact point for further information

Since traders may commingle MON 87427 × MON 89034 × NK603 with other commercial maize, including authorised GM maize, Bayer is working together with other members of the plant biotechnology industry within the European Association of Bioindustries (EuropaBio) and trade associations representing the relevant operators, to implement a harmonised monitoring methodology.

Operators in the food and feed supply chain and/or any other person wishing to report a potential adverse effect associated with the import or use of Bayer's GM maize products, can refer to the EuropaBio website at:

http://www.europabio.org/agricultural-biotech/trade-and-approvals/operators-product-information/product-contact-point

If required, additional comments or questions relative to MON 87427 × MON 89034 × NK603 can also be addressed at:

http://www.bayer.com

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