Abstract

In an attempt to prove GM foods are of no harm to the environment at large, two farmers in Italy planted MON810 seeds from the Monsanto company in open field in direct contravention of local law on GM crops. MON810 seeds contain a gene from *Bacillus thuringiensis* (Bt), a bacterium found in soil across the world which is naturally toxic to a group of insects known as corn borers (Order: *Lepidoptera*), specifically European corn borer (*Ostrinia nubilalis)*. The farmers were public about their intentions, and once discovered by the authorities, their fields seized by the government, and later destroyed by environmental activists to prevent alleged contamination of surrounding fields. The local government acted outside EU law in this case, and their actions deemed illegal by Brussels. This report intends to inform the reader as to the nature of the crop, and address some of the concerns raised by the activists regarding Bt-resistant corn cultivation, and consequently, inform the law on the matter from the perspective of a plant scientist involved in the GM industry. The consultant panel finds that MON810 is safe to cultivate, and the law should be changed accordingly to allow for its cultivation both in the region in question, and within the wider EU. The farmers should therefore be compensated for their destroyed fields.

Introduction

The Italian judiciary system put together a team of consultant experts from varying competent fields to improve their understanding of the matter, and to hear a set of recommendations for both the matter regarding compensation for the involved farmers and for potential changes to the legal framework. This matter is being closely monitored by the appropriate bodies within the EU, as they were previously (illegally) left out of the matter when it initially was brought to the Italian courts' attention.

My role within the group is to concisely confer the current and potential risks that the cultivation of Bt-resistant corn may/may not have on the plant diversity in the areas where MON810 maize has already been grown. My secondary role is to explain the process of creating GM Bt-resistant corn to those whose expertise falls outside of this area, and to ensure the decision-makers understand the process. The other members of the consultancy team include:

- XX – Scientific Expert

A member of the European Food Safety Authority (EFSA) Genetically Modified Organisms Panel to represent the view of the European Commission (EC) and address the various proposed risks associated with the GM crop MON 810 Maize

- XX – Environmental Ethicist

Environmental concerns associated with the GM process in terms of environmental impacts and additional possible risks not yet established.

- XX – Professor of Agronomy

Factual science behind the genetics of creation, physiology of producing and use of Bt-resistant corn in food and other practices.

- XX – Insect Biologist

Effect of Bt-resistant corn on target and non-target insects in terms of mechanism of exposure and eradication.

- XX – Corn Market Expert

Potential current loss/profit of the corn market upon commercialisation of Bt-resistant corn factoring the reduction of herbicides, pesticides and fungicides.

What is BT-resistant Corn?

Bt refers to *Bacillus thuringiensis*, a soil-dwelling bacteria which is capable of selectively killing a specific insect group through protein production. The protein (Cry1Ab) specifically examined in this report is toxic when ingested by these insects. Farmers (both conventional and organic) have been using Bt as an insecticide for many years, and a plant growing its own insecticide have both time and economical benefits [1] over the use of sprayed on chemicals or other alternatives (such as the release of parasitic wasps [8]).

The corn is created by the artificial insertion of the Cry1Ab protein from Bt into the DNA of the plant. This renders the gene ‘transgenic’, as an exotic gene is transferred into the target organism (the corn).

The whole genetic sequence (DNA) of Bt is extracted, and then through gene cloning, the specific gene required is extracted from the DNA. A process called gene design then changes the promoter at the beginning of the gene sequence so it behaves as desired in the new organism. The promoter can be thought of as the trigger for the plant to make the protein, it is the part of the gene that RNA transcriptase receives its instructions on when and how much of each protein to make, and controls where within the plant the gene expresses (one may only want to express the gene in the green tissues of the plant, for example, if the insect only feeds on the green tissues then this genes expression in other areas is useless). In the case of Bt-resistant corn, it is expressed in all parts of the plant [2]. At this point, microscopic gold particles coated in the desired gene are fired at a special clump of plant cells called a callus. This process was designed specifically to achieve gene insertion, or transformation, and to avoid cell death. The calluses are then cultivated into an entire plant and allowed to produce seeds. The seeds will have inherited the new gene. The seeds are then cross-bred with plants which have other desirable traits such as high yield, and the offspring repeatedly crossed with the high-yield plants to produce a high-yield, insect-repellent crop. Figure 1 below also mentions a marker gene. The inclusion of a marker gene is like a flag for the genetic engineer to identify the cells which include the transgene. Currently, marker genes typically encode for resistance to herbicides or antibiotics [2]. The use of such markers is currently cause for quite some concern, and critics of GMOs argue antibiotic resistance is potentially harmful to humans and other animals [3] if the marker makes its way into the genetic make-up of gut bacteria. Little evidence exists to support this claim (even a rather detailed search produces no recent studies in support), and typically, the antibiotic which the plant gains resistance to, kanamycin, is rarely used in human or animal healthcare [4], and acquired resistance would be of little or no concern.

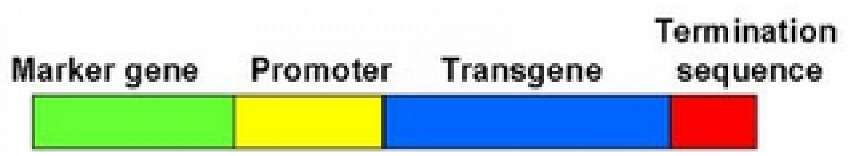

Figure 1: Parts of the new gene required for gene expression [2]

Why is Bt-resistant corn of concern to plant diversity?

The short answer here is: it is of no concern. In over 40 years of cultivation and study of MON810 in the US, EU and further afield, no studies have shown any impact on the plant diversity of surrounding areas, be it cultivated crops, or field borders/local native species [5]. However, there remains some disquiet among those opposed to GM.

One issue that arises from the debate is if new genetic traits could cause a crop to become more weed-like (persistent) in both agricultural and natural environments. Currently, the evidence stands in opposition to this, Dale et al. writes:

"If a crop species has very few weedy characteristics, the addition of one or a few genes would be unlikely to cause the crop to become a weed problem." [5]

In addition, crops engineered to be herbicide-tolerant (the most extensively studied), have been shown to be no more invasive than a non-GM crop [5], despite their resistance to human-applied limiting factors.

Another worry is that hybridisation with compatible species may occur (the mating of different species to create a hybrid), which may be undesirable for the environment. Much work has been put in to this area, and the primary concern is with pollen movement. As with non-GM crops, pollen movement is concentrated to the area of cultivation, and while mathematical models and field research have shown the ability of pollen to travel several kilometres, when this research is combined with that of flowering times (times when a plant can accept pollen is limited); and of whether or not the species that do manage to mix are indeed compatible with one another; it has been generally concluded that hybridisation is unlikely to occur, from either GM or non-GM crops [5]. It should also be noted that standard corn produces a heavy pollen, which is not suited to long travel distances, though Bt-resistant corn out-crosses (passing of a genetic trait from one individual to another) at rates of up to 1% up to 28 m away. Corn (like most crops) is a completely human cultivated crop and cannot compete with wild plants naturally [6][7].

Conclusions/Recommendations

It can be concluded from the available evidence that Bt-resistant corn is a controversial topic and it is quite clear that the cultivation and trade of corn should be closely monitored for some time to come. This would be necessary both out of scientific interest, and to lessen the fears of opponents and the public in general. It is with that in mind, that I present the following recommendations:

Firstly, some of the loudest complaints come from those taking issue with the use of markers which code for herbicide or antibiotic resistance. While extensive study has shown this method to be safe, any new developments in the Bt-resistant corn should incorporate significant research into other alternatives [9]. It should be noted that I would recommend the court rule that MON810 is human-consumption safe in terms of genetic markers.

In the case of persistence or hybridisation of Bt-resistant corn, it is important to remember that corn itself is a cultivated crop, not a naturally occurring one, originating in Mexico hundreds of years ago. It is only through selective breeding that it has come to be cultivated elsewhere, and through modern conventional breeding, corn can now be cultivated in far colder latitudes than ever before [10]. Corn therefore has no natural relatives in Europe (Italy included), and so its natural compatibility with native species is indeed very unlikely. Hybridisation may only occur in the case of a genetically engineered species tailored to mate with MON810. With this and the findings of pollen travel from above, it is my recommendation the MON810 is safe to grow within close proximity to any other plant or crop, however, some caution may be exercised, and a list prepared of crop/other species known to be non-compatible with MON810 or non-GM corn, and only these crops be permitted to be grown within a certain distance of MON810. Since 1% of pollen travel was within 28m of the MON810 field, it should be that distance must be at least 30m wide on all sides, to create an adequate buffer-zone to limit any possibility (however infinitesimal) of hybridisation as much as possible.

I would recommend to those listening closely in the EU that strict rules must be put in place surrounding both MON810 cultivation and overall GM cultivation, and a more unified approach from member states should be adopted. While the rules surrounding GM cultivation are suggested to be strict, it is important to recognise that this remains a relatively young enterprise, and there is always the chance for those in favour to be incorrect in their findings, and the intent should be to protect the farmer from those seeking to derail the GM movement, potential damages in the future in the unlikely event of adverse effects being found in the future, and above all else, to protect the interests, health and welfare of those consuming the products.

It is with these points in mind that I recommend the farmers in question should receive compensation for their destroyed property. MON810 is indeed safe to cultivate, and the farmers, while ignoring the ban on growing GM foods in a declared GM-free region, did not deserve to have their property damaged, particularly not while proceedings were on-going; proceeding which were deemed illegal by the EU.

References

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