GREENPEACE Briefing

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GE insect resistant (Bt) maize in Europe: an unnecessary threat to wildlife and GE-free choice

Maize has been genetically engineered (GE) in a number of ways to produce different types of GE maize, including pharm GE maize types, which produce pharmaceuticals in the plant. However, commercial GE maize consists of only two major types, herbicide tolerant (e.g. Monsanto's Roundup Ready) and insect resistant (e.g. Monsanto's MON810 and Syngenta's Bt11). These GE maize types have already been grown on a commercial basis in countries such as USA, Canada and Argentina. Contamination of non-GE maize has already occurred in these countries and there are concerns that insect resistant maize could be affecting wildlife.

Now, there is a threat that insect resistant (*Bt*) maize (MON810) could be grown in Europe. This briefing describes the environmental threat of GE *Bt* maize to European wildlife and the inevitability that contamination of non-GE crops will occur on European farms. It concludes that, as in the Americas, GE *Bt* maize has potential to adversely affect Europe's wildlife and GE maize cannot be contained and co-existence will be impossible. Hence, *Bt* maize should never be grown in Europe.

1) GE *Bt* crops: environmental concerns

In its natural form, farmers practising organic and other sustainable growing methods have used *Bt* since the 1950s as a spray to kill pests without damaging non-targeted insects or other wildlife. However, the *Bt* toxin produced by GE insect resistant maize (known as Cry1Ab) is significantly different, it is a shorter, or truncated form. This truncated form is less selective than *Bt* sprays and therefore has potential to harm non-target insects that as well as the pests for which it is intended[1].

The environmental effects of growing *Bt* maize in Europe include:

a) Toxic effects on non-target organisms such as butterflies

Current *Bt* maize crops are genetically engineered to be toxic to certain species of moths and butterflies (Lepidoptera). Larvae of non-target moths and butterflies may inadvertently ingest the *Bt* toxin whilst feeding on plants growing nearby *Bt* crops. The impact of pollen from *Bt* maize on larvae of the monarch butterfly in North America is the most well known example of this phenomenon[2]. Long-term exposure to *Bt* pollen from two *Bt* maize types that could be grown in Europe, MON810 and Bt11, has been shown to cause adverse effects on larvae of the monarch butterfly[3]. Many species of butterflies in Europe already face multiple threats, such as climate change and loss of habitat[4]. Increased stress from exposure to *Bt* pollen could further threaten certain species of butterflies and moths.

A recent review of the ecological effects of GE maize[5] concluded: *"New studies … show that also MON810 and Bt11 maize pollen or anthers may adversely affect lepidopteran larvae especially under prolonged exposure. … Exposure of non-target lepidopteran larvae* *to Bt maize pollen under field conditions can be highly variable and is still unknown for the majority of European butterfly species."*

Current EU Environmental risk assessments for *Bt* crops do not require long-term exposure studies to non-target organisms and it has been suggested that longer periods of exposure would improve the risk assessment[6]. The case of the monarch butterfly shows it is vital these studies are performed because no short-term adverse effects (4-5 days) were noted[7]; it was only when longer-term studies (2 years) were carried out that the adverse effects became clear.

b) Toxic effects on beneficial insects
GE *Bt* maize has potential to adversely affect beneficial insects that are important in the natural control of maize pests, including parasites and predators of maize pests[8]. This has been shown for green lacewings[9]. The toxic effects of GE *Bt* crops on lacewings were via the prey that they ate, either which in turn had been ingesting the GE *Bt* crop.

The environmental risk assessments for *Bt* crops include only single species studies, which would not detect any effects on organisms higher up the food web, such as the effects on lacewings. This approach has been highly criticised and scientists have suggested that the effects of *Bt* crops need to be studied at multiple levels of the food web[10].

Thus, the *Bt* toxins from GE maize can kill non-target species and be passed higher up the food chain, an effect that has never been observed with the *Bt* toxin in its natural form. As a recent study concluded, "*Clearly, further research is required to reveal the magnitude and consequence of toxins flowing through the food chain, either by feeding on Bt pollen … or the consumption of more nutritious prey which contain Bt endotoxins.*"[11]

c) Adverse effects on soil ecosystems
The *Bt* protein exuded by GE *Bt* maize has been shown to persist in the soil whilst remaining biologically active[12]. The long-term, cumulative effects of the continued growth over several years of GE *Bt* maize have not been adequately considered in a European context, even though they are thought to be highly important in terms of the risk assessment[13].

GE *Bt* maize varieties generally contain higher lignin than their non-GE counterparts[14]. Lignin is well known for its capability to influence palatability of plant material to herbivores and could slow the decomposition of *Bt* maize residues in the soil. Indeed, GE *Bt* maize decomposes less in soil and considered this might be related to the higher lignin content[15].

Soil organisms play a crucial role in soil health. Therefore, it is necessary to understand how different agricultural practices affect them. *Bt* crops may be problematic for long-term soil health, as they express proteins that are known to be toxic to certain insects and are suspected of being toxic to a range of non-target organisms as well, including earthworms and nematodes[16]. An unknown number of species make up the soil food web and could be affected by *Bt* – yet tests have been conducted on very few, in very few soil types and ecosystems.

d) Emergence of pest resistance, leading to increased spraying of insecticides.
In the US there are complex requirements for planted areas of non-*Bt* crops, in order to slow down insect resistance to the *Bt* toxin. However, refugia may not be practical on small farm holdings in Europe and elsewhere, which are very different to the large field

sizes in the US. It has also been shown that GE contamination of non-*Bt* maize refugia, caused by cross pollination, could undermine refugia, as pest insects will still be exposed to *Bt* in the refugia[17].

There is overwhelming scientific data to support concerns of insect pest resistance[18]. If widespread resistance were to occur, the insect resistant properties of the GE crops would become ineffective. The application of new and even more toxic chemical pesticides would therefore be almost inevitable. Furthermore, increased resistance would pose a serious threat to sustainable and environmentally friendly agricultural methods.

Hence, the release of GE *Bt* crops has potential to cause serious harm to wildlife in Europe.

2) GE maize: contamination threat

Maize has one of the highest out crossing (or cross-pollination) rates of any commercially grown GE crop. Therefore, contamination of neighbouring maize crops is a serious concern.

The high potential for maize to contaminate is demonstrated by the finding that 35% of all cases of GE contamination recorded (since GE crops were first introduced in the mid 1990s) involve maize (http://www.gmcontaminationregister.org), but GE maize only accounts for an average of less than 25% of the acreage of GE crops over these years[19]. Indeed, not only has GE maize been involved in many GE cases, it has been involved in some of the worst cases, including StarLink, Bt10 and Mexican maize[20].

StarLink maize

In 2000, a variety of GE maize known as StarLink was discovered in taco shells being sold for human consumption even though it was not approved for this use and should only have been used for animal feed[21,22]. As a result of the discovery, StarLink contaminated taco shells, an action which is estimated to have cost millions of dollars. The contamination appeared to have been caused by a lack of post-harvest segregation between StarLink and other maize varieties and cross contamination of other non-GE maize varieties because farmers were not aware of, or did not observe, separation distances or that separation distances are inadequate measures. Although the US FDA has purchased over US$13 million of StarLink seed since then, the Cry9C gene sequences were still being detected in seed in 2003 and Canada required testing up until November 2004. StarLink has also turned up in Egypt, Japan, and South Korea and as food aid in Bolivia and Guatemala[23].

Mexican maize

In 2001, it was reported GE contamination in native landraces of maize even though no GE maize should have been grown there commercially[24]. It seems that farmers may have kept and sown maize imported for food. The findings of the study came under considerable attack but the finding of contamination has since been confirmed. However, a later study[25] failed to detect any GE contamination one of the Mexican states where contamination had been found. In a preliminary response to this publication, Ignacio Chaplea and David Quist, the authors who originally detected GE contamination of maize in Mexico said "*On first approach, it seems to us highly suspect that transgenic DNA may have been widespread in local landraces of maize in Mexico in 2000-2001, as demonstrated in at least 3 separate studies, would suddenly become absent within a couple of years*". However, if the absence can be confirmed over the coming years, this clearly shows the effectiveness and need for fast, strong actions and measures as taken in this case by the local communities to raise awareness and their efforts to find and eradicate contamination.

Unauthorized Bt10 maize
In 2005, GE maize was associated with five incidents of contamination, the most prominent of which is the Bt10 debacle[26]. In March 2005, it was revealed[27] that Syngenta had inadvertently produced and distributed a variety of GE maize, Bt10, which did not have regulatory approval. Between 2001 and 2004, several hundred tonnes of the Bt10 maize had been distributed and grown in the US and probably exported elsewhere and used in field trials in Spain. The mix up arose because Syngenta's quality control procedures were not sufficiently rigorous and did not differentiate between Bt10 and Bt11. As a result, Bt10 lines were mistakenly used in breeding. Originally, in making reassurances about safety, the company emphasised the similarity between the insecticidal *Bt* toxin produced by Bt10 and another GE maize variety Bt11, which has approval in the USA. However, later it emerged that Bt10 also contains a gene that gives resistance to the antibiotic ampicillin[28]. Bt10 was subsequently found in a shipment of maize gluten arriving in Ireland[29] and in several shipments arriving in Japan[30].

GE maize has been involved in many cases of GE contamination: it cannot be contained.

3) Coexistence is impossible

There are many studies confirming long distance pollination events from GE maize up to 1 000 m away[31]. In all the EU reports published on geneflow and coexistence (e.g. EEA, 2002; IPTS/JRC, 2002, IPTS/JRC/ESTO, 2006[32]) maize has been shown to be the most difficult GE crop to contain in terms of high out crossing rate and the large distances that viable maize pollen can travel. GE maize is described as presenting a "medium to high risk" for cross-pollination with other crops[33].

There is a possibility of maize plants surviving in Mediterranean Europe to contaminate future non-GE maize. Maize plants have been shown to survive over a growing season, even in a comparatively cold part of Europe, the UK[34]. Maize volunteers have been noted occasionally from spilled seed in uncultivated fields and by roadsides in the year following maize production[35]. Should any volunteer GE maize plants inadvertently grow near a maize crop, the resulting pollen could cross-pollinate with maize in fields, producing genetic contamination.

Coexistence relies on keeping non-GE (i.e. conventional or organic) maize free of GE contamination. This is done by establishing a threshold level above which the seed or grain is considered to be contaminated. Whilst the legislative threshold level for GE contamination of maize seed is currently under discussion in the EU, Greenpeace and other organisations such as IFOAM, the worldwide umbrella organization for the organic movement demand that the threshold must be the lowest practical detection limit (currently 0.1%). Setting the limit as this level is the single most important measure needed to guarantee GMO free products to farmers and consumers. Setting the thresholds at the level of 0.3% -0.7 % -as the European Commission has proposed- will (ridiculously low as these figures may sound) lead to massive genetic contamination of the Europe's maize fields. These percentages would imply that 30 to 70 square meters of GE varieties would be grown per hectare of conventional maize in the field without farmers even knowing about it.

The latest EU report[36] identifies as key sources of maize contamination: traces of GE seeds in non GE seed lots, cross-pollination from neighbouring GE fields, and the sharing of harvesting machinery between GE and non GE fields. Hence, maize co-existence in the EU is reliant on cleaning machinery properly, but human error has already led to GE maize contamination and is not sufficiently robust to prevent contamination. Similarly, year-on-year contamination of maize will make co-existence more increasingly impossible.

Co-existence is impossible. Non-GE maize (conventional and organic) will become contaminated in Europe. There is no liability legislation in place that would award compensation for farmers whose crops will be contaminated and therefore devalued by GE maize in Europe.

4) GE maize is not necessary for biofuels or bioplastics

There is some discussion about how GE maize can be used for biofuels and bioplastics. However, whilst many of these applications can use GE maize, conventional maize can be used just as easily[37]. GE crops are not necessary. There is also discussion of GE maize to produce ethanol, with GE maize containing a gene to produce an enzyme to help digest the maize[38]. But other approaches, such as adding enzymes to breakdown the maize in a bioreactor have already shown promise. Some of these approaches may involve the contained use of GE organisms, but do not entail any deliberate releases of GE organisms to the environment[39].

Conclusion

GE *Bt* maize has potential to adversely affect Europe's wildlife. These potential effects include:

- **effects on non target organisms, including indirect and long-term effects;**
- **effects on soil health and**
- **the build up of insect resistance to *Bt* and the impacts on sustainable farming practices.**

The numerous contamination incidents from GE maize in the Americas demonstrate that GE maize is uncontrollable because of the high out crossing rate and large distances that maize pollen travels. In Europe, as elsewhere, co-existence of conventional and organic maize with GE *Bt* maize will be impossible. Hence, the cultivation of GE maize will erode consumer choice to say no to GE crops. GE *Bt* maize should never be grown in Europe.

Greenpeace is opposed to the release of GE organisms because of the irreversibility of such releases and the potential of GE organisms to cause serious harm to the environment.

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