

Position on the potential environmental impact of Bt-maize:

Scientific conclusions from the BMBF-supported research projects (each 3 years): “Safety research and monitoring methods for the cultivation of Bt-maize” and “Ecological impacts of insect-resistant Bt-maize on various insects and the European corn borer”

Bt-maize contains a gene responsible for the production of a protein. This protein reacts as a selective Bt toxin against lepidopteran caterpillars, for example European corn borer. This small lepidopteran is active at night; its caterpillars can damage maize plants and cobs. Bt protein from *Bacillus thuringiensis* has been used as a spray in biological plant protection for decades.

The above-mentioned BMBF research projects dealt with the potential environmental impact of Bt-maize over three vegetation periods (1999 – 2002 and 2001 – 2004). The studies assessed potential effects on non-target organisms in the soil, on the soil surface and on maize plants. The scientific results and conclusions were published on the following website: <http://www.biosicherheit.de/de/mais/zuensler/317.doku.html>

The results with regard to organisms (arthropods) in maize fields can be summarized as follows:

1. Bt-maize had no negative effect on soil and plant-dwelling organisms. Butterflies were also not affected by Bt-maize (MON 810). Harmful effects were only seen after treatment with chemical control agents (insecticides):
<http://www.biosicherheit.de/de/sicherheitsforschung/32.doku.html>
2. Bt-maize had no negative effects on aphids:
<http://www.biosicherheit.de/de/sicherheitsforschung/17.doku.html>
3. Bt-maize had no negative effects on beneficial arthropods:
<http://www.biosicherheit.de/de/sicherheitsforschung/15.doku.html>
4. Bt-maize had no negative effects on scents, which could attract pests or beneficial organisms:
<http://www.biosicherheit.de/de/sicherheitsforschung/23.doku.html>
5. Bt-maize had no negative effects on spiders:
<http://www.biosicherheit.de/de/sicherheitsforschung/16.doku.html>
6. Bt-maize had no negative effects on bees:
<http://www.biosicherheit.de/de/sicherheitsforschung/68.doku.html>
7. Bt-maize caused inconsistent effects on sciarids:
<http://www.biosicherheit.de/de/sicherheitsforschung/14.doku.html>
8. Bt-maize had no negative effects through accumulation of Bt protein in soil:
<http://www.biosicherheit.de/de/sicherheitsforschung/21.doku.html>
9. Bt-maize only had negative effects on butterflies when Bt protein was present at high concentrations in pollen (for example in Bt176 maize). This maize variety will no longer be planted in the EU as of 2007:
<http://www.biosicherheit.de/de/sicherheitsforschung/112.doku.html>

The analysis methods employed were so sensitive that **differences between maize varieties** could be detected; there were however no effects related to the genetic modification. One example of this is the work conducted on sciarids: in the first year, the highest diversity of species, eclosion rate and decomposition rate in this important group

of organisms was found in Bt-maize. However, in the following two years, the positive trend in Bt-maize was not confirmed. In the laboratory, sciarids showed a longer pupation time when fed Bt MON 810 Novelis maize litter or its conventional near-isogenic line, treated with insecticide, compared to litter from the other maize variants. When sciarid larvae, raised on MON 810 maize, were fed to larvae of predatory coleopteran species in the laboratory, delayed development was also observed. However, Bt 176 maize did not show this effect, even though the concentration of Bt protein in this variety is a thirty-fold higher than in MON 810 maize.

Conclusion: Altogether, the results confirm the biological safety of Bt-maize MON 810, especially when compared to a chemical insecticide treatment. The methods and groups of organisms used in the research project could be of help for regulatory monitoring programs.

<http://www.biosicherheit.de/de/zuensler/341.doku.html>

The results of each project can be summarized as follows:

Investigation on possible effects of Bt-maize on arthropods living in maize fields: Soil and plant-dwelling arthropod communities were assessed over a three year period. The results do not indicate any effect of Bt-maize on the numbers and diversity of non-target organisms. In contrast, a clear effect on some insect groups was seen when a chemical insecticide was sprayed. Significant effects of Bt-maize on butterfly larvae could not be shown at any time.

<http://www.biosicherheit.de/de/sicherheitsforschung/32.doku.html>

Effect of Bt-maize on aphids and other specialized antagonists: There were no effects of the transgenic maize varieties on the development of aphid populations. An influence of the transgenic maize line on parasitizing performance of parasitoids was not seen. There were no impacts on the composition of ichneumon populations (parasitoids and hyperparasitoids).

<http://www.biosicherheit.de/de/sicherheitsforschung/17.doku.html>

Toxicity of Bt-maize to ichneumon: No effects were seen on *Trichogramma* wasps for either of the tested Bt-maize lines.

<http://www.biosicherheit.de/de/sicherheitsforschung/15.doku.html>

Effects of Bt-maize on butterflies and their antagonists: No qualitative differences in scent production were found between the maize varieties (transgenic/non-transgenic), either in the field or in the laboratory. However, there were significant differences between MON 810 and the isogenic maize line with regard to the amounts produced. It could be shown that this deviation was not caused by the inserted Bt-gene but was due to a cultivar effect. The differences between commercial cultivars in types and amount of scents produced exceeded by far the differences observed between MON 810 and its isogenic counterpart. <http://www.biosicherheit.de/de/sicherheitsforschung/23.doku.html>

Effects of Bt-maize on flower visiting insects and predatory spiders: The amount of maize pollen present in spider webs decreased significantly with increasing distance from the maize field. In general, less pollen was found when raining. In maize field

borders, up to 40% of the bait in spider webs was constituted by bees collecting pollen, depending on the spider species. Where the flower density around maize fields was lower, the amount of bees in the bait spectrum was close to nil. In laboratory experiments, no effects were seen on three net spider species after exposure to Bt-toxin, Bt-maize pollen and/or bees carrying Bt maize pollen.

<http://www.biosicherheit.de/de/sicherheitsforschung/16.doku.html>

Effects of Bt-maize pollen on honeybees: Bt-maize varieties Bt176 and MON 810 did not show chronic toxicity to healthy honeybees. Considering the worst-case experimental conditions (period of six weeks, high Bt protein concentration), a toxicological effect on healthy bees under field conditions can be excluded with high certainty, based on this comprehensive investigations.

<http://www.biosicherheit.de/de/sicherheitsforschung/68.doku.html>

Effects of Bt-maize on sciarids as decomposer: In the first year, the highest diversity of species, eclosion rate and decomposition rate for sciarids was found in Bt-maize. However, in the following two years, this positive trend in Bt-maize was not confirmed. In the laboratory, sciarids showed a longer pupation time when fed Bt MON 810 Novelis maize litter and its conventional near-isogenic line (with insecticide treatment) than when fed with litter from the other maize cultivars. When sciarid larvae, raised on MON 810 maize, were fed to larvae of predatory coleopteran species in the laboratory, delayed development was also observed. However, Bt 176 maize did not show this effect, even though the concentration of Bt protein in this variety is a thirty-fold higher than in MON 810 maize.

<http://www.biosicherheit.de/de/sicherheitsforschung/14.doku.html>

Degradation of Bt-maize in soil and impacts on soil microorganisms: The expression of Bt protein in plant roots may lead to minor structural changes in bacterial communities of the rhizosphere. These changes are small compared to those linked to soil type, age of the plants or variable field conditions. Bt protein is found in soil when Bt plants are cultivated; the main source is root residues from harvested maize plants. Minor amounts of Bt protein may persist one vegetation period and, in monocultures, potentially lead to an accumulation of the protein in soil. However, Bt protein amounts released are below the effect threshold for target organisms – an effect on non-target organisms is therefore unlikely. MON 810 genes can be detected in degrading plant material after harvest but a role in horizontal gene transfer is very unlikely.

<http://www.biosicherheit.de/de/sicherheitsforschung/21.doku.html>

Joined research project on: Ecological impacts of insect resistant Bt-maize on different insects and European corn borer: The pollen from Bt 176 affected larvae of *Plutella* and *Pieris* larvae (Cabbage butterfly) in laboratory feeding experiment. Larvae of a soil pupating Noctuida species were not observably affected. The choice of maize cultivars – Bt-maize or conventional isogenic lines – had no visible influence on arthropods, aphids and their antagonists. Concentrations of one particular type of fungal toxin (mycotoxin) were lower by half in Bt maize compared to conventional maize affected by corn borer. However, the concentration of another mycotoxin in the grains was not significantly lower in Bt-maize. The different European corn borer populations did not differ in their sensitivity to Bt protein. None of the larvae collected in the Bt-maize fields were resistant to Bt protein.

<http://www.biosicherheit.de/de/sicherheitsforschung/112.doku.html>