

Exposure of maize harvest by-products to aquatic ecosystems and protected nature reserves in Brandenburg, Germany

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Project background and aims

During 2005–2008, Brandenburg was one of the leading federal states in growing genetically engineered Bt-maize MON810 in Germany. Bt-maize MON810 expresses the protein Cry1Ab – originally derived from the bacterium *Bacillus thuringiensis* – which is toxic to the European corn borer. However, previous studies have also emphasized negative effects amongst others on aquatic non-target organisms (e.g. Bøhn et al. 2008; Rosi-Marshall et al. 2007), whereas Jensen et al. (2010) could not find any negative effects. Apart from insufficient knowledge on the impact level, little attention has been paid to maize pollen and harvest by-product inputs into aquatic ecosystems until today. To our knowledge, only these few studies have been published dealing with this issue so far.

Brandenburg offers plenty of aquatic ecosystems that make up to 3.4 % of its land cover. Many of them are under nature protection, e.g. by the European FFH-Directive. The aim of our project is to measure and to model the exposure of maize pollen and harvest by-products to aquatic ecosystems in Brandenburg and to evaluate appropriate measures for nature protection. Here we present preliminary results of our investigations in 2009 on deposition rates of harvest by-products in relation to the distance to the field.

Materials and methods

Study site: Harvest by-product measurements were taken on a maize field near Angermünde, Brandenburg. Formed by glacial moraines, this hilly region is one of the main maize production areas in the state Brandenburg, with annually increasing area of cultivation (Grimmert et al. 2009).

Measurements: To measure distance-related deposition rates of harvest by-products, 20 litter traps (metal pans) were placed at the ground in lee-position at a partly reaped maize field at the edge of the harvest process. For this first investigation, measurements

were taken on ground and not on open water assuming no relevant differences in deposition. To test different trapping methods, traps consisted of 20 metal pans (covering 0.1 m²) placed at the ground for collecting all particle sizes. By clearing the traps after the maize harvester passed by we could measure the aerial input of by-products at defined distances (1.3, 2.7, 4.0, 5.3, 6.7, 9.3, 17.3, 25.3, 33.3, 49.3, 81.2, 127.8 m).

Samples were fractionated into three particle size classes by dry-sieving and vacuum-filtration, respectively (> 1 mm, > 63 µm and > 12 µm), dried at 60° C for 24 h and weighed. Additionally, samples were collected directly from the harvester to determine overall particle size fractions. Hereby, another two particle size classes were separated (> 125 µm and > 180 µm) and samples processed as described above. All fractions were further analysed microscopically for examining particle composition and form.

Results

Due to maize usage for silage and methane production, the whole plant is harvested and simultaneously shredded into 1–2 cm sized pieces. On a mass basis, harvest residuals are dominated by coarse particles (CP, > 1 mm), which consists of fragments of leaves, stems, cobs and kernels (Table 1). As particle size declines in the fine particle fraction (FP, < 1 mm), its gravimetric proportion to overall composition decreases markedly while the number of particles increases. Microscopically, the various plant fragments, maize fibres, pollen and starch grains can be identified in these fractions.

As shown in Figure 1 for the successively cleared litter traps, harvest by-product deposition shows a clear distance-related gradient. The total mean deposition rates of harvest residuals are about 26 g DW/m² at the edge of the maize field and decline to 0.17 g DW/m² at a distance of 133 m. Hereby, CP predominates mass inputs in the vicinity to the source (21.8 g DW/m²), but its mass proportion declines rapidly after 3–4 m. At greater distances, FP proportion predominates, since small fractions are preferentially transported by wind. In contrast to CP, deposition rates of FP declines rather constantly from about 5 g DW/m² to 3 g DW/m² at a distance of 20 m, than followed by a markedly steeper decrease down to 0.15 g DW/m² at a distance of 133 m.

Tab. 1: Proportion and main constituents of particle size fractions of maize harvest by-products (DW = dry weight).

Particle size	CP > 1 mm	FP < 1 mm total	> 180 µm	> 125 µm	> 63 µm	> 12 µm
[g] DW	40.3	3.54	3.05	0.14	0.021	0.0065
[%]	91.9	8.1	7.0	0.3	0.1	0.1
Main constituents	fragments of leaves, stems, cobs and kernels, 1–2 cm		fragments of plant tissues and elongated maize fibres	plant fragments, elongated maize fibres and grana	maize pollen, diverse plant fragments	plant fragments, grains of maize starch, fungal spores

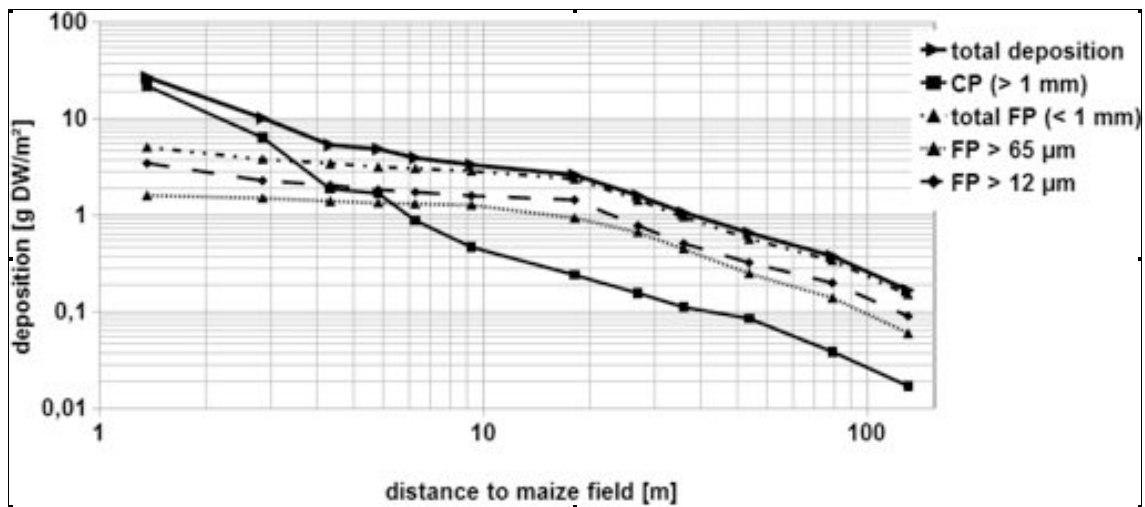


Fig. 1: Deposition of maize harvest by-products measured by metal pans (0.1 m²) in lee-position is still measurable at a distance of 100 m.

Conclusion

Input rates of maize harvest by-products show distinct gradients in relation to distance. Our results emphasize the increasing relevance of small particle fractions for deposition rates of harvest by-products at greater distances. This particle fraction has neither been evaluated in the risk assessment nor by the measurements of Rosi-Marshall et al. (2007) nor Jensen et al. (2010) and its importance has been underestimated until today. Especially, small particles have a greater surface-volume-ratio, thus are more rapidly biodegradable and might be more biological available for smaller non-target organisms in the food chain. For limiting exposure of harvest by-products to protected aquatic ecosystems in respect to the precautionary principle and minimising potential adverse impacts of Bt-maize on aquatic organisms, buffer zones along protected rivers and lakes seem to be potentially effective measures. The investigation will be carried on in 2010 by further field experiments and modelling of the input.

References

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