Export of neonicotinoids from sugar beet seed dressings via tile drains

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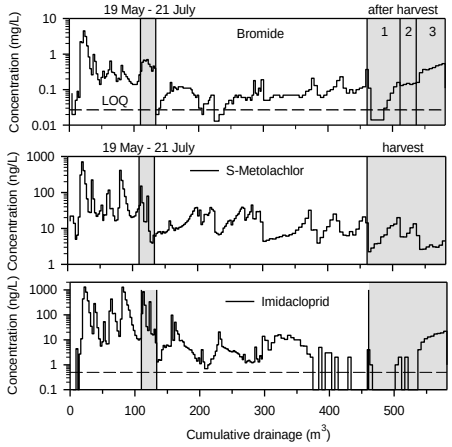
Neonicotinoids in surface waters

Neonicotinoids have found widespread application as seed dressings, due to their systemic properties and relative persistence. Various studies showed that neonicotinoids frequently occur in surface waters worldwide at concentrations well above the environmental quality standards. Our investigation indicated that subsurface tile drains contribute to surface water contamination with neonicotinoids.

Preferential flow

Thiamethoxam and imidacloprid from sugar beet seed dressings were monitored in drainage water together with the tracer bromide and the herbicide S-metolachlor, applied by spraying at the same time. Event-driven, high first concentration maxima up to 2830 and 1290 ng/L for thiamethoxam and imidacloprid, respectively, were followed by an extended period of tailing and suggested preferential flow.



Breaktrough curves of the tracer bromide, the herbicide S-metolachlor (sprayed) and imidacloprid (seed dressing), the grey areas highlight a two-month period with only minor drainage events and the periods after harvest with three distinct drainage events.

Target substance	Max. conc. [µg/L]	Flux-averaged concentration [µg/L] 19.3-21.7	Flux-averaged concentration [µg/L] until 9.10	Field DT50 [days]	K_{FOC} [mL/g]	GUS-Index[1]	Mass recovery [% of applied]
Thiamethoxam	2.83	0.29	0.089	32	68.4	3.3	1.19
Imidacloprid	1.29	0.17	0.054	71	225	3.1	0.482
S-metolachlor	0.71	0.08	0.033	30	189	2.5	0.032

[1]groundwater ubiquity score (GUS) = $\log_{10}(DT50)\,(4 - \log_{10}(K_{OC}))$

Mass balance

Total mass recoveries in the drainage water were 4.9% of the applied mass for bromide, 1.2% for thiamethoxam, 0.48% for imidacloprid and 0.032% for S-metolachlor. The major mass fraction was captured after the first flush, in a manner that was determined by the degradation and sorption properties of the compounds as collated in the groundwater ubiquity score (GUS).

Seed dressings *vs.* spray application

Leaching behaviour of the pesticides cannot solely be explained by the different substance properties. Flux averaged concentrations for the first period (March – July) were reduced by factors of 41 and 31 for thiamethoxam and imidacloprid, respectively, for the second period (until October), compared to a factor of only 5.3 for S-metolachlor. These factors were not correlated with literature field DT50s. We assume that the mode of application (seed dressing vs. spray application) may affect both, degradation and sorption of these compounds:

(1) Biodegradation of neonicotinoids initially may be delayed by the coating of the seed pill and thus preventing contact between the target compound and the soil water.

(2) After the seed pill is fractured, mobility of the neonicotinoid potentially may be higher due to initially higher local concentration (sorption non-linearity).

Soil sample, soil profile of the test field, sampler for flow proportional sampling, drainage manhole.

Abstract

Thiamethoxam and imidacloprid were measured in tile drain water in concentrations up to 2830 and 1290 ng/L, respectively, indicating that leaching from seed dressings contribute to the contamination of surface waters with neonicotinoids. Compared to other pesticides the total mass recoveries of the neonicotinoids were higher than expected on the basis of their physico-chemical properties. We assume that the mode of application (seed dressing vs. spray application) may affect both, degradation and sorption of these compounds. However, pesticide transport from seed dressings is still poorly understood and deserves further attention.

Reference: Felix E. Wettstein et al. Leaching of the Neonicotinoids Thiamethoxam and Imidacloprid from Sugar Beet Seed Dressings to Subsurface Tile Drains. J. Agric. Food Chem., 2016, 64 (33) pp 6407-6415. DOI: 10.1021/acs.jafc.6b02619

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