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Agricultural non-point source pollution of glyphosate and AMPA at a catchment scale

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Information on the actual input of pesticides into the environment is crucial for proper risk assessment and the design of risk reduction measures. The Crespo basin is found within the Balcarce County, located south-east of the Buenos Aires Province. The whole basin has an area of approximately 490 km2 and the river has a length of 65 km. This study focuses on the upper basin of the Crespo stream, covering an area of 226 km2 in which 94.7% of the land is under agricultural production representing a highly productive area, characteristic of the Austral Pampas region. In this study we evaluated the levels of glyphosate and its metabolite aminomethylphosphonic acid (AMPA) in soils; and the non-point source pollution of surface waters, stream sediments and groundwater, over a period of one year. Stream water samples were taken monthly using propylene bottles, from the center of the bridge. If present, sediment samples from the first 5 cm were collected using cylinder samplers. Groundwater samples were taken from windmills or electric pumps from different farms every two months. At the same time, composite soil samples (at 5 cm depth) were taken from an agricultural plot of each farm. Samples were analyzed for detection and quantification of glyphosate and AMPA using ultra-performance liquid chromatography coupled to a mass spectrometer (UPLC-MS/MS). The limit of detection (LD) in the soil samples was 0.5 μg Kg-1 and the limit of quantification (LQ) was 3 μg Kg-1, both for glyphosate and AMPA. In water samples the LD was 0.1 μg L-1 and the LQ was 0.5 μg L-1. The results showed that the herbicide dispersed into all the studied environmental compartments. Glyphosate and AMPA residues were detected in 34 and 54% of the stream water samples, respectively. Sediment samples had a higher detection frequency (>96%) than water samples, and there was no relationship between the presence in surface water with the detection in sediment samples. The presence in sediment samples can be attributed to deposition of soil particles that are washed from the field. On the other hand, more than 90 % of the soil samples had glyphosate and AMPA. The highest concentrations were found in the month of June, corresponding to the fallow period were glyphosate is applied as a chemical weed controller in no-till systems. Glyphosate and AMPA detection in groundwater samples was 24% and 35%, respectively. The highest glyphosate levels in groundwater also corresponded to the month of June. Glyphosate occurrence in groundwater was transient, that is, in most of the cases glyphosate was not detected in the subsequent sampling months. The contamination of shallow groundwater (<20 m) by glyphosate is likely relatively short-term in duration due to its fast degradation. These results indicate that there is a higher risk of agricultural non-point source pollution in the months of herbicide application, that may contribute to groundwater contamination. This is of extreme relevance in the southeast of the Buenos Aires Province, since the main source of drinking water and irrigation is from groundwater resources