Fate of plastic residues in soils after urban compost applications: identification of pyrolysis molecular markers in the soil size fractions

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Plastics are made of inert organic polymers that may reside for long periods in terrestrial and aquatic environments. Despite the improvement of waste selective collection and of waste sorting before composting, plastic residues may be present in final composts. For that purpose, the agricultural use of municipal solid waste composts (MSW), made of the organic matter fraction of MSW obtained after collection of recyclable materials and the sorting of impurities, is regulated by a standard defining maximum thresholds in impurities and more specifically in glass, metals and plastic residues (NFU 44-051, AFNOR, 2006).

Composts are often applied on cultivated soils as organic amendments in order to recycle their large contents of stabilized organic matter (OM). However and even for standardized MSW composts, the use of composts might add to the soil some contaminants, amongst which plastic residues. In order to evidence the fate of plastics in soils, we studied soil samples collected in a long-term experimental field in Feucherolles (Houot et al., 2005), where different standardized composts have been applied every 2 years since 10 years. We studied samples from a plot that received MSW since 1998 and compared them to a control plot that did not receive any compost. Particle size fractionation was applied to the soil samples and soil was separated into five size fractions: 200 µm-2 mm, 50-200 µm, 20-50 µm, 2-20 µm, 0-2 µm, in which OM might have increasing residence times in soils. The 20-50 µm fractions were treated with hydrofluoric acid before analysis in order to remove minerals. About 1 mg aliquot was analysed in triplicate with pyrolysis coupled to gas chromatography and mass spectrometry.

We followed several aromatic pyrolysis products that might indicate the presence of plastics. The ratio of the peak areas of toluene and styrene was calculated. Both compounds are present in the pyrolysates of natural organic matter, that generally display a ratio around 4-5. By contrast, in samples containing plastic, the styrene peak might have an additional polystyrene origin and the ratio largely decreases. A ratio below one indicates the presence of plastics (Fabbri et al., 1998). In the bulk soil as well as in the 2-20 µm, 50-200µm and 200µm-2mm fractions the toluene/styrene ratio significantly decreased from the control to the amended sample, indicating the presence of plastics in the amended samples. The methyl-styrene peak was found neither in the bulk control soil nor in any of its fractions. It clearly appeared in the amended soil and in its 20-50µm, 50-200µm and 200µm-2mm fractions, confirming the presence of plastics. Two pyrolysis products specifically deriving from polystyrene, styrene dimer and trimer (Fabbri, 2001) were identified thanks to their specific ion (m/z 208) only in the 200µm-2mm fraction of the amended soil.

Pyrolysis/GC/MS proved to be an efficient method to follow how plastic residues added to the soil through compost application might be incorporated into different size fractions of the soil. The presence of plastic residues down to the 20-50µm fraction could be confirmed in a MSW compost amended soil.