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Influence of the nature and age of cover crop residues on the sorption of three pesticides

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In agricultural fields, soil and water quality preservation is strongly influenced by pesticides use and behavior. To limit the environmental impacts of agricultural activities, best management practices such as the use of cover crops are encouraged. Cover crops during the fallow period were found to be efficient in reducing nitrate leaching, controlling soil erosion, improving soil organic content and enhancing soil biological activity. This technique was also found to modify soil water dynamics in the following crop. According to these effects, modifications on pesticide behavior in soil, such as sorption, degradation and transport, are expected (Alletto et al., 2012 ; 2013).

In this study, the impact of the nature and level of decomposition of cover crop was studied on the sorption characteristics of three pesticides. These pesticides differed in their physicochemical characteristics (hydrophobicity, solubility, persistence) and were two herbicides, S-metolachlor and glyphosate, which are largely used in maize production and predominantly found as pollutants in water; and one fungicide, epoxiconazole. Correlations between pesticide sorption and physicochemical characteristics of the cover crop residues were studied. Residues of oat, turnip rape, red clover and phacelia were collected in March 2011 and incubated at 28°C and at the water holding capacity during 0, 6, 28 or 56 days. For each date, adsorption of the three radiolabeled pesticides was measured in batch on the different cover crop residues, and their biochemical composition (Van Soest fractionation), hydrophobicity (contact angle measurement) and C/N ratio were determined.

Results showed that the adsorption of the pesticides differed significantly according to (i) the pesticide, (ii) the nature of cover crop, (iii) the decomposition level of the cover crop and the interaction cover crop x decomposition time. Epoxiconazole was the most adsorbed molecule, with Kd values ranging from 161 $\pm$ 30 L/Kg (oat, turnip rape, phacelia) to 206 $\pm$ 45 L/Kg (red clover); and glyphosate was the less adsorbed, with Kd values ranging from 1 $\pm$ 1 L/Kg (oat, red clover) to 9 $\pm$ 1 L/Kg (phacelia) at day 0. Differences between pesticides were expected considering the hydrophobicity of these molecules. Adsorption of the three pesticides increased with decomposition time (up to sevenfold for glyphosate on oat), and was negatively correlated with C/N ratio ($-0.73 << -0.89$, $p<0.001$) and positively with the lignin fraction of the residue in decomposition ($0.54 << 0.85$, $p<0.05$). The correlation between adsorption and wettability was slight and not significant, except for glyphosate on oat and turnip rape ($=-0.99$ and $=-0.62$, $p<0.05$ respectively), leading to the assumption of the contribution of other factors than biochemical composition in wettability. This study highlighted that the nature and level of decomposition of cover crop at the soil surface influenced the mobility of pesticides as it was observed in decomposing mulch of crop residues (Aslam et al., 2013). As a result, the type of cover crop and the changes of cover crop residues composition during decomposition in field may control differently the movement of non-ionic pesticides compared to ionic compounds such as glyphosate, largely used in conservation agriculture practices.

Keywords : Cover crops ; Glyphosate ; S-metolachlor ; Epoxiconazole ; Mulch; Sorption ; Biochemical composition

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