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Effect of mulch quality and decomposition on dynamics of glyphosate in mulch amended soil systems

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Conservation practices are characterized by presence of crop residues (mulch) on the soil surface. Fate of pesticides in such systems is important to study where most of the applied pesticide is intercepted by mulch before passing into soil. Glyphosate is one of the most important herbicide used in such practices because of its non persistent behavior and due to its rapid degradation in soil. This study was conducted to see the effect of mulch carbon quality on the mineralization and sorption of glyphosate. It was hypothesized that glyphosate fate in mulch amended soil may vary depending on the degree of decomposition of plant residues in the mulch. A laboratory incubation experiment was conducted for 49 days in control conditions of temperature (28°C) and humidity (pF=2.5) with three types of mulch made from maize residues i.e. fresh (0 day), and decomposed (for "20-days" and "49-days" during a pre-incubation step). The mineralization of radiolabeled 14C glyphosate, applied to these three types of mulch residues, was monitored along with mulch decomposition. The dynamic of mulch decomposition was followed through total respiration and the quantification of ergosterol used as a fungal biomass indicator. Bio-chemical characterization of mulch residues collected during incubation was also carried out by Van Soest fractionation method. Glyphosate adsorption was also studied on mulch residues having different level of decomposition. Significant differences of mulch carbon mineralization were obtained between the treatments. Fresh mulch mineralized up to 45.6 % of its initial carbon whereas pre-incubated mulch ("20 days" and "49 days") mineralized 25.4 % and 14.5 % respectively. Van Soest fractionation showed loss of hemicellulose and cellulose and increase of lignin and cutin like fractions of mulch organic matter as decomposition proceeds. The ergosterol quantification showed that fungal biomass evolution during incubation was quite different in the three treatments. In 0-day treatment, fungal population increased rapidly and reached maximum in the first seven days, after it started decreasing. While in pre-incubated residues where it was already evolved during pre-incubation, fungal population did not increase during incubation. Glyphosate was dissipated more rapidly in fresh mulch than in pre-incubated mulch residues. Its mineralization in 0-day mulch was (61.1 % of 14C activity) significantly greater than in the other two treatments, while pre-incubated much residues had no significant differences (52.6 % and 51.4 % of 14C activity for 20 day for 49 day, respectively). Non mineralized 14C was quantified in water extracts, ammonia extracts and non extractable (NER) fractions. At the end of incubation, the distribution of these fractions did not differ according to mulch type. Adsorption coefficients (Kd) were also not significantly different among the three treatments. We can conclude that mineralization of glyphosate in maize mulch and its sorption were not affected by the degree of mulch decomposition. However, further experimentations with other pesticide molecules having different chemical properties may show more differences between treatments.

Keywords: mulch; soil tillage, decomposition; glyphosate; mineralization; adsorption