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Modelling the impact of climatic conditions and plant species on the nitrogen release from mulch of legumes at the soil surface

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Cover crops provide multiple services to the agro ecosystem. Among them, the use of legumes as cover crop is one of the solutions for limiting the use of herbicides, mineral fertilizers, and insecticides. However, the dynamic of mineralization is difficult to understand because of the difficulty of measuring nitrogen release from mulch in field. Indeed, residues are degraded at the soil surface as mulch, while the nitrogen uptake by the main crop occurred simultaneously in the soil. This work aims to study the dynamics of nitrogen mineralization from legume residues through i) the use of a model able to describe the physical and biological dynamic of mulch and ii) a data set from a field experiment of intercropping systems “oilseed rape-legumes” from different species (grass pea, lentil, Berseem clover, field pea, vetch). The objective of the simulations is to identify the variations of expected quantities of nitrogen from different legumes.

The soil-plant model of mulch decomposition PASTIS-Mulch was used to determine the nitrogen supply from mulch available for rapeseed. These simulation results were compared to the data collected in the experimental field of Grignon (France). We performed analyzes of biochemical and physical characteristics of legume residues and monitored the evolution of mulches (moisture, density, cover surface, biomass) in fields. PASTIS simulations of soil temperature, soil moisture, mulch humidity and mulch decomposition were close to the experimental results. The PASTIS model was suitable to simulate the dynamic of legume mulches in the case of "rape - legume" associations. The model simulated nitrogen restitution of aerial and root parts. We found a more rapid nitrogen release by grass pea than other species. Vetch released less nitrogen than the other species. The scenarios for climate conditions were : i) a freezing in December that causes the destruction of plants, or a destruction by herbicide in March, ii) a strong or a weak rainy spring. Climatic conditions had a strong impact on the simulated release of nitrogen. Nitrogen supply was higher when degradation begun early with a rainy spring. Conversely, the degradation was lower when the degradation started late with a dry spring. Root release was less sensitive to climate and most of the nitrogen in the roots returned to the soil in a few weeks. The impact of "species" on the decomposition was explained not only by their chemical properties but also by their physical properties. The climatic conditions had different effects according to the species.