Dynamics of soil available carbon, nitrogen and phosphorus pools after burying innovative bio-based mulching films

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The use of plastic mulching films is rapidly increasing in agriculture to enhance crop productivity and control weeds. However, their non-biodegradability and long-lasting presence in soil have raised serious concerns regarding their environmental impact. Typically composed of non-biodegradable materials like polyethylene, these films can persist in the soil for several years after use, enhancing the plastic pollution and posing challenges for sustainable agricultural practices. Consequently, there is a pressing need to explore alternative materials that are both biodegradable and environment-friendly.

In this context, the PRIN mulching+ project aims to make innovative mulching films based on carboxymethyl cellulose, chitosan, and sodium alginate, enriched with N and P salts acting as slow-release fertilizers in the soil. Thus, the purpose of this study is to evaluate the effects of the degradation of these innovative films after burial in the soil on the dynamics of available N and P and on the microbial biomass C (MBC) and N (MBN)for assessing their suitability as sustainable alternatives to conventional plastic mulch films.

Four types of mulch films were used in the study. They were prepared with either 1:1 or 17:3 mass ratio of chitosan to cellulose, both with and without the addition of 90% by weight of $NH_4H_2PO_4$, in order to investigate the influence of material ratios and nutrient addition on the biodegradation processes and soil microbial component. The experiment involved burying 0.1% by weight of the film in pre-wetted soil, to simulate the field conditions.

Soil samples were collected 30, 60, 90 and 120 days after burial to evaluate as variables MBC and MBN, available ammonium, nitrate and phosphate, but also the composition and abundance of major microbial groups in the soil. The results showed significant changes in soil parameters, with ammonium, nitrate and phosphate levels influenced by the presence of $NH_4H_2PO_4$. Moreover, an increase in soil MBC and MBN over time occurred, suggesting the assimilation of film organic matter by soil microorganisms. Overall, results were promising for the use of these innovative bio-based films in agriculture. Ongoing activities include the use of 13C- and 15N-labeled films to track the fate of film-derived C and N in soil and to identify which main microbial groups are responsible for their degradation.