Effect of iron-porphyrin treatment on soil microbial communities

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Intensive agricultural management have led to an increasing transfer of carbon from soil organic matter (SOM) to atmospheric CO_2. It is noteworthy that the flux of CO_2 from the soil is ten times greater than fossil fuel emission from industrial and automotive activities.
Piccolo and co-workers (1999) suggested that hydrophobic humic components in soil exerted hydrophobic protection towards easily degradable compounds. They postulated that associations of apolar molecules deriving from plant degradation and microbial activity incorporate more polar molecules, thus preventing their otherwise rapid microbial degradation and enhancing their persistence in soil. Moreover, synthetic metal-porphyrins were shown to significantly decrease CO_2 emission from soil due to an in-situ catalysis of oxidative polymerization of soil OM (Piccolo *et al*., 2002).
The present work was conducted to investigate the effect of iron-porphyrin amendments on soil microbial communities in agricultural soils. Field experiments took place at three Italian locations strongly differing in pedological, chemical and climatic characteristics: Naples, Turin and Piacenza. Soils were treated with synthetic iron-porphyrins (POR) for three consecutive years. Soil and rhizosphere samples from plots under wheat and maize cropping were sampled at different time and the composition of microbial groups directly implicated in OM mineralization, such as actinobacteria, fungi and cellulosolytic bacteria, as well as microbial groups involved in key bio-geochemical processes (e.g. aerobic free-living N_2-fixing bacteria and ammonia-oxidizing bacteria) was estimated and the structure of cultivable populations was examined.
The iron-porphyrin treatment showed a different effect on microbial populations in bulk soil, wheat rhizosphere, and maize rhizosphere, but in all cases this was a long term effect. Indeed, during the first two years of treatment there was no significant difference between POR treatment and control without porphyrin (NO POR) in experimental fields.
The effect on bulk soil in the three different Italian locations was found to be the same. However, results were different from expected. In fact, POR treatment showed a significant increase in microbial groups directly implicated in OM mineralization if compared with NO POR control.
By contrast, the effect on rhizosphere communities was different. In maize rhizosphere (site location Piacenza) POR treatment showed a significant decrease in microbial populations involved in the turn-over of OM comparing with NO POR control. While, in wheat rhizosphere (site locations Naples and Turin) there was no significant difference between POR and NO POR treatments. Finally, POR treatments did not significantly influenced the aerobic free-living N_2-fixing and ammonia-oxidizing bacteria populations in all experimental fields. In conclusion, the influence of iron-porphyrin treatments on microbial communities depended on crop, but not on pedological, chemical, and climatic characteristics of experimental soils.

Keywords: microorganisms, soil carbon sequestration, iron-porphyrins.

References:

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