Organic-complexed superphosphate (CSP) and soil biological properties

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The positive effect of the humic substances (HS) on soil phosphate (Pi) bioavailability is well known. Infact, HS are efficient in protecting P from retention on Ca, Al and Fe oxides, in increasing the soil labile P fraction and in improving the utilization efficiency of P fertilizers. As a consequence, a variety of fertilizers consisting of a mixture of superphosphate and humic substances or organic matter has been produced. However, often, the methodology employed in the production of these organo-mineral fertilizers (a mixture during the granulation process) did not involve the real formation of organic-calcium-phosphate complexes, which can more efficiently protect phosphate from soil retrogradation. Recently, a new methodology for the production of an organic-complexed superphosphate (CSP) has been developed (Roullier Group; **FR 1050009** ; 2010). This methodology involves the real formation of organic-calcium-phosphate complexes during the manufacture of CSP.

In principle, CSP could be able to protect Pi from insolubilization and retention processes through chemical and/or physical stabilization (Roullier Group; **FR 1050009** ; 2010). However, CSP compounds, in particular their organic component, could play a key role in the soil Pi bioavailability also influencing some soil biological processes. Up to date no information are available about that.

For this purpose, we examine the effect of two CSPs, CSP-1 and CSP-2, characterized by a different quality and content of organic C, respect to a mineral superphosphate (SP) on: i) Pi bioavailability in a calcareous soil (measured as Olsen-P); ii) the mineralization of soil organic C ($C\text{-}CO_2$ soil emission); iii) the hydrolysis of fluorescein diacetate; iv) on some specific soil enzymatic activities linked with the principal nutrient cicles.

Our results have shown that: i) CSP-1 and CSP-2 were able to protect Pi from insolubilization in a calcareous soil at different humidity levels. As well known, higher levels of soil humidity, in a calcareous soil, influencing the Ca activity in the soil solution, promote Pi insolubilization as Ca-phosphates. In all the tested humidity conditions, we were able to recovery from CSP-1 and CSP-2 treated soil a Olsen-P fraction significant higher than from SP treated soil. In particular CSP-2 seemed to be the most effective product. In general, Olsen-P measured in CSP-2 treatment was 40 % higher respect to SP treated soil; ii) mineralization of the soil organic C, was significantly higher in the soil treated with CSP-2 and CSP-1 respect to SP treated soil; ìii) the dynamic of fluorescein diacetate hydrolysis was in agreement with the mineralization of soil organic C. Infact, in CSP-2 treated soil the hydrolysis level was all the time higher than CSP-1 and SP treated soil; iv) The trend of alkaline phosphatase and urease seemed to confirm the stimulative effect of CSPs, in particular CSP-2.

In conclusion, our results showed that CSP products, added to a calcareous soil at agronomical doses, were able to protect Pi from insolubilization processes and to act as a real biostimulant of soil microbial activities. These effects seem correlated with type and amount of organic C present into the CSP product.