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Nitrogen and carbon pools in an agricultural soil amended with natural and NH4-enriched K-Chabazite zeolitite

Giacomo Ferretti (1), Barbara Faccini (1), Livia Vittori Antisari (2), Dario Di Giuseppe (1), and Coltorti Massimo (1)

(1) University Of Ferrara, Department of Physics and Earth Sciences, Ferrara, Italy , (2) University Of Bologna, Department of Agricultural Sciences, Bologna, Italy

Nitrogen and Carbon pools in a reclaimed agricultural soil amended with 5 to 15 Kg m-2 of natural and NH4-enriched (K-Chabazite) zeolitites have been investigated. Zeolitites were enriched by means of static exchange with a swine slurry in a prototype (ZeoLIFE Project, www.zeolife.it). The experimental field is located in the Po Delta plain near Codigoro (Ferrara, Italy), it extends over an area of about 6 ha and it was divided in six parcels. The field has been heavily fertilized with chemical fertilizers and livestock sewage since 1960. Nowadays the area is part of the Nitrate Vulnerable Zones (Nitrate Directive 91/676/CEE) and a maximum annual input of 170 Kg-N ha-1 must be respected.

With respect to the control parcels, at the end of the agronomic year, sorghum yield was 4% and 14% higher in the parcels treated with natural zeolitite and in that treated with NH4-enriched zeolitite, respectively. This notwithstanding the N fertilizers reduction from 30% in the former to 50% in the latter.

Beside the yield improvement, N and C pools are affected by the use of zeolitite and relevant changes have been noticed. i) δ15N ratios in both soil (total and fixed N-NH4 inside the clay interlayer and zeolite exchange sites) and different organs of the sorghum crops show that the N-NH4 stocked in the enriched zeolitite has been transferred to the crops and preferentially stocked in the leaves with respect to the N-NH4 provided by chemical fertilizer. ii) The active role of fixed N-NH4 pool in mineral nutrition of the crops and its replacement can be due to inorganic N fertilizers (Urea and Diammonium Phosphate). This pool in fact decreased during the crops growth, suggesting that it represented an important contribution to the active N pool in the soil. iii) Due to the high N content in this agricultural field, no significant total N decrease was observed during the growing season, which is also responsible for the low C/N ratio in the soil. After the N input from NH4-enriched zeolitite, the lowest C/N ratio is detected and the mineralization of organic C was enhanced as evidenced by the decrease of Humic Acids (HA) and the increase of Fulvic Acids (FA) contents; a total organic C depletion was also observed. iv) In the first month, after the enriched-zeolitite spreading, a reduction in the exchangeable NH4 was noticed. At the same time no significant NO_3 loss was observed in the porewaters and drainage waters, suggesting that the microbial biomass played a crucial role in the immobilization of the NH4 contained in the zeolitite. v) A significant increase of Cation Exchangeable Capacity and OC content in the soil treated with zeolitite at the end of the agronomic year was also evidenced.

In summary, this study emphasizes that notwithstanding the fertilization reduction the crop yield can be maintained adding natural and NH4-enriched K-Chabazite zeolitite in an agricultural field. This addition contributes also to improve the soil properties and the porewater and superficial water qualities.