The effect of cover crops on the humification of organic material in a built soil after coal mining

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Introduction

While the coal is being mined, layers of soil are removed which need to be replaced, and afterward vegetated, seeking the recovery of mined areas. This study evaluated the rate of humification of organic matter (OM) of rebuilt soil, after the coal mining, under different cover crops, using indices obtained through fluorescence spectroscopy analyzes. The experiment has been conduced since 2003 in an area of built soil of the Riograndense Mining Company (CRM) in partnership with the Federal University of Pelotas (UFPEL). In Sept/2009, samples from 0.00 to 0.03 m soil's layers were taken in four treatments: T1-grass limpograss (*Hemarthria altissima* (Poir.) Stapf & CE Hubbard); T2-Pensacola (*Paspalum notatum* Flüggé); T3-Bermuda grass (*Cynodon dactilon* (L.) Pers.) T4-Brachiaria (*Brachiaria brizantha* (Hochst.) Stapf). Samples were also collected in an area adjacent to this experiment; with built soil without ground vegetation cover (T8) and in a natural soil with native vegetation (T9). The laser-induced fluorescence spectroscopy (LIF) is relatively easy to implement and is usually non-invasive, and it is very useful for environmental applications [1]. The soil samples, passed through a sieve of 9.52 mm, were ground; and soil pellets were obtained by pressing them at 8 tons. The fluorescence analysis was performed by using in a portable LIF system. It was used four measurements per sample and the data was used to calculate the humification index (HLIF) [2].

Results and Discussions

The areas under the curves, normalized by the carbon content, provide the HLIF (Table 1), which can be directly related to the humification degree of OM. The LIF spectra of the soil samples indicate that the greatest HLIF was presented by the uncovered built soil (Table 1). This may have occurred due to mining processes, which involve the mixing of surface horizons, the soil disaggregation and the decrease of plant biomass; reducing the physical protection of more labile soil organic matter and accelerating the process of decomposition.

Table 1. Area under the curve of fluorescence (ACF) weighted by the content of organic carbon as the humification degree (HLIF) of the organic matter of a built soil after the mining of coal.

Treatments	HLIF
T1 - Limpograss	5120
T2 - Pensacola	5075
T3 - Tifton	7579
T4 - Brachiaria	6274
T8 - Bare soil	8905
T9 - Natural soil	3845

The natural soil had the lowest humification degree. This is probably due to higher input of plant's residues over this ground and the non-revolving of the same, resulting in a slower decomposition of the organic matter [3]. A lower rate of humification of a natural soil in comparison to a soil under cultivation was also detected by this same author. Favoretto & Gonçalves et al [4] found a lower humification degree for soil under no-tillage than for soil under conventional tillage, using the technique of LIF, and they justified the incident by the major input of organic residues existing in the surface layer of soil under no-tillage. The soil built under the cover crop showed an intermediary humification index, between T8 and T9. Among the cover crops evaluated, the Tifton and Brachiaria were those that resulted in a more recalcitrant soil OM. The most humified OM is rich in functional groups with unsaturated bonds. Thus, when samples are illuminated with near ultraviolet or blue lights, it excites preferentially the most recalcitrant structures, which concentration increases in the humification process [1]. The Limpograss' and Pensacola's hedges were the ones that showed the lowest HLIF (Table 1). According Pulrolnik et al. [5], when the plant's components are more lignified and aromatic, it decomposes more slowly, favoring the maintenance of organic substances in soil. Milori et al [6], obtained positive correlations as they compared methods, already described in literature, to obtain the humification degree with the technique of LIF in intact soil, index of Zsolnay et al. [7] for humic acid solution (r = 0.85), index of Kalbitz et al. [8] (r = 0.76) and index of Milori et al. [9] (r = 0.77), showing that the technique used in this work has great potential for application.

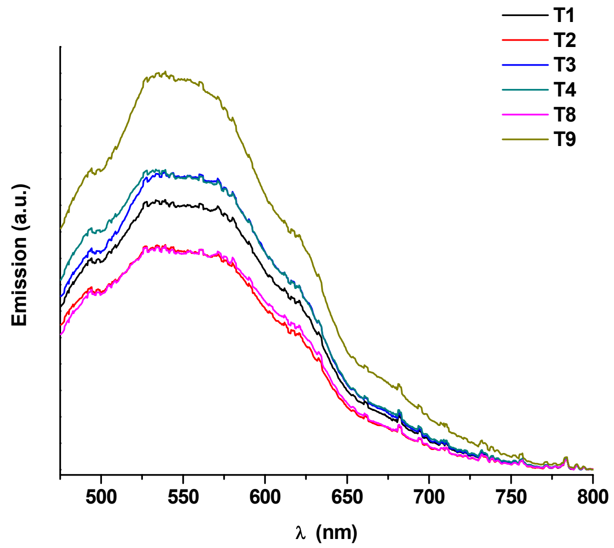

Figure 1. Fluorescence emission of the organic matter from a built soil after the coal mining under different vegetation cover.

Conclusions

The data indicate a higher rate of organic matter humification for soil under Tifton and Brachiaria.

The soil under Pensacola and Limpograss had the lowest indices of organic matter humification, indicating greater potential to recovery of built soils. The covering of the soil with plant species resulted in an intermediate humification degree, higher than the one in natural soil and lower than the one in uncovered built soil, indicating the recovery process of degraded soil.

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