Effect of tillage and slurry application on soil quality and CO_2 emissions

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Introduction Agricultural ecosystems generally contain less soil organic carbon (SOC) pool than their potential capacity because of the low return and high rate of mineralization of biosolids, and severe losses due to accelerated erosion and leaching. The depletion of SOC pool leads to decline in soil biological quality and resilience with attendant reduction in biomass productivity, decreased capacity to degrade and filter pollutants, increased risks of soil degradation by erosion and other processes, and increase in emission of greenhouse gases (GHGs). Some farming practices, such as organic fertilization, no-tillage and legume-based rotations can mitigate these problems. The main objective of the current work was to study the effects of the utilization of cow slurry and no-tillage on soil quality and CO_2 emission. We also intend to study the potential of soil microbial activity to assess the effect of these agricultural practices.

Materials and methods In Spring 2005, a 2-year field assay was established in Basque Country (northern Spain), in an acid (pH = 5.1) silty clay loam soil. The field assay consisted of an intensive crop rotation (cereal-legume mixture in winter/forage corn in summer). The following treatments were applied in a randomized complete block design with 3 replicates: (i) convencional tillage + mineral fertilization, (ii) convencional tillage + cow slurry, (iii) no-tillage + mineral fertilization, and (iv) no-tillage + cow slurry. An absolute control (v), consisting of a contiguous native meadow, was also studied. Mineral fertilization consisted of 150 kg N ha^{-1}, 100 kg P ha^{-1}, and 150 kg K^+ ha^{-1} and similar doses were used for the organic fertilization treatment with fresh cow slurry. For the conventional tillage, soil was ploughed to 25 cm with a mouldboard plough and then rotavated. Direct sowing for the no-tillage treatment was carried out with a Semeato machine. Soil OM content (MAPA, 1994), dehydrogenase activity (Dick *et al*., 1996) and CO_2 emission (PP-Systems EGM-4/SRC-1) were measured. Data were analysed using ANOVA and Fisher test.

Results and discussion The highest value of soil OM content was found in no-tilled and organically (cow slurry) fertilized plots, although the differences were statistically significant only when compared to those conventionally tilled plots treated with mineral fertilizer. Soil dehydrogenase activity, which apparently plays a role in oxidation of organic matter, also showed the highest value in no-tilled and organically fertilized plots, but in this case it was significantly higher than all the rest of the treatments. Dehydrogenase activity can be more sensitive to treatments most likely due to its being associated with viable microbial populations (Dick *et al*., 1996). Within each tillage system, plots amended with cow slurry showed higher values of dehydrogenase activity. Regarding CO_2 emission, conventional tillage seemed to increase CO_2 flux to atmosphere.

Table 1 *Effect of treatments in summer 2007. Different letters within each line indicate significant differences ($p<0.1$).*

	Till+Mineral	Till+Slurry	No-till+Mineral	No-till+slurry
OM content (%)	2.71 ± 0.05^a	2.92 ± 0.07^{ab}	2.88 ± 0.09^{ab}	2.99 ± 0.09^b
Dehydrogenase (mg INTF kg^{-1} dry soil h^{-1})	0.33 ± 0.09^a	1.23 ± 0.18^a	0.37 ± 0.13^a	3.77 ± 1.35^b
CO_2 emission (g CO_2 m^{-2} h^{-1})	0.46 ± 0.16^a	0.50 ± 0.02^a	0.23 ± 0.03^a	0.39 ± 0.02^a

Conclusions Cow slurry application increases soil OM content and dehydrogenase activity, particularly when is combined with no-tillage. Dehydrogenase activity has a great value as early and sensitive indicator of changes in soil properties induced by different systems of tillage and fertilization. No-tillage can contribute to reduce CO_2 emission form soil.

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