Geophysical Research Abstracts
Vol. 19, EGU2017-1687, 2017
EGU General Assembly 2017

Differences in soil quality between organic and conventional farming over a maize crop season

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Land degradation in agricultural areas is a major concern. The large number of mechanical interventions and the amount of inputs used to assure high crop productivity, such as fertilizers and pesticides, have negative impacts on soil quality and threaten crop productivity and environmental sustainability. Organic farming is an alternative agriculture system, based on organic fertilizers, biological pest control and crop rotation, in order to mitigate soil degradation. Maize is the third most important cereal worldwide, with 2008 million tons produced in 2013 (IGN, 2016). In Portugal, 120000 ha of arable land is devoted to maize production, leading to annual yields of about 930000 ton (INE, 2015). This study investigates soil quality differences in maize farms under organic and conventional systems.

The study was carried out in Coimbra Agrarian Technical School (ESAC), in central region of Portugal. ESAC campus comprises maize fields managed under conventional farming - Vagem Grande (32 ha), and organic fields - Caldeirão (12 ha), distancing 2.8 km. Vagem Grande has been intensively used for grain maize production for more than 20 years, whereas Caldeirão was converted to organic farming in 2008, and is being used to select regional maize varieties. The region has a Mediterranean climate. The maize fields have Eutric Fluvisols, with gentle slopes ($<3\%$).

In order to assess soil quality, three plots per farm were installed in May 2006, immediately after sowing, and monitored until October 2016, before harvesting, in order to cover all the crop season. Each plot comprises 5 plant lines ($\sim$4 m width) with 20 m length. In order to assure the comparison between both farms, the same maize variety was used (*Pigarro*) in both fields, with the same compass. Soil samples were collected immediately after sowing. In Vagem Grande distinct soil samples were taken: (i) within plant lines, and (ii) between plant lines, since mineral fertilizers were spread over the field before sowing, and addition fertilizer was applied together with seeds, in plant lines. In Caldeirão, since fertilization was not performed due to weather constrains, soil samples were collected randomly within the plots. Additional soil samples were collected before harvest, in plant lines and between plant lines, in both farms. Surface (0-15 cm) and subsurface (15-30 cm) soil samples were taken. Soil samples were used for texture, pH, organic carbon, Kjeldhal nitrogen, nitrates, ammonia nitrogen, plant available phosphorus and potassium, and exchangeable cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}) analyses. Additional soil samples were also collected with soil ring samplers (137 cm^3) for bulk density analyses after sowing. Surface water infiltration was also measured with tension infiltrometer (membrane of 20cm), using different tensions (0 cm, -3cm, -6 cm e -15cm). Decomposition rate and litter stabilisation was assessed over a 3-month period through the Tea Bag Index (Keuskamp et al., 2013). The number and diversity of earthworms were also measured at the surface (0-20cm), through extraction, and at the subsurface ($>$20cm), using mustard solution.