Modelling of soil carbon sequestration by use of rice-straw mulching in two citrus orchards in Valencia (Spain)

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In the context of sustainable development, agriculture holds a promising potential for CO_2 sequestration and, accordingly, for the mitigation of climate change. This potential capacity can be developed through the adoption of less conventional farming techniques, such as the mulching of the topsoil with agricultural by-products where they are available, e.g., rice straw in the semiarid Valencia province (Eastern Spain). In general, the use of straw as mulching material has been found beneficial for soil quality as it reduces temperature excursions both daily and yearly, increases soil water content overall, and increases the activity of microbes. Moreover, it encourages the binding of organic matter and mineral particles into macro and micro aggregates, leading to: enhancement of the aggregate stability, restoration of stable C, and increase in the soil organic carbon (SOC) content and, thus, soil carbon sequestration. SOC dynamic models, like the widely used RothC, are useful to assess the soil carbon sequestration potential of different agricultural practices and to project their effects on the long term. However, there is a lack of studies focusing on the modelling of straw mulch effects on SOC dynamics.

Our work aimed at modelling the rice straw mulch degradation and its effects on the SOC dynamics in two citrus orchards, as observed during a short-term field experiment (2 years). In the orchards, the straw mulch was applied to the inter-rows once a year, and its effects on soil water content, temperature, respiration rate, and SOC contents (amidst other chemical and biological parameters) were compared with bare soil and natural grass formation

The RothC carbon dynamics model was modified by including the straw mulch effects on SOC dynamics as observed on the field and, additionally, by modelling the soil water dynamics with the HYDRUS1D model. The SOC pools for the RothC simulations were assessed following the fractionation of Zimmerman et al. (2007). The model parameters were calibrated with the soil respiration data.

The straw mulch model can be used for the estimation of the effects of the rice straw on the SOC in the short term. By changing the soil, climatic and agricultural practices inputs, the model can be applied to different fields in semiarid conditions, allowing the assessment of the soil carbon sequestration potential of different agricultural practices. However, the model still needs to be verified on long term field studies to deliver reliable long term sequestration projections.