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Soil CO_2 emissions in terms of irrigation management in an agricultural soil

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Irrigation water restrictions in the Mediterranean area are reaching worrying proportions and represent a serious threat to traditional crops and encourage the movement of people who choose to work in other activities. This situation has created a growing interest in water conservation, particularly among practitioners of irrigated agriculture, the main recipient of water resources (>80%). For these and other reasons, the scientific and technical irrigation scheduling of water use to maintain and even improve harvest yield and quality has been and will remain a major challenge for irrigated agriculture. Apart from environmental and economic benefits by water savings, deficit irrigation may contribute to reduce soil CO_2 emissions and enhance C sequestration in soils. The reduction of soil moisture levels decreases microbial activity, with the resulting slowing down of organic matter mineralization. Besides, the application of water by irrigation may increment the precipitation rate of carbonates, favoring the storage of C, but depending on the source of calcium or bicarbonate, the net reaction can be either storage or release of C. Thus, the objective of this study was to assess if deficit irrigation, besides contributing to water savings, can reduce soil CO_2 emissions and favor the accumulation of C in soils in stable forms. The experiment was carried out along 2012 in a commercial orchard from southeast Spain cultivated with nectarine trees (Prunus persica cv. 'Viowhite'). The irrigation system was drip localized. Three irrigation treatments were assayed: a control (CT), irrigated to satisfy the total hydric needs of the crop; a first deficit irrigation (DI1), irrigated as CT except for postharvest period (16 June – 28 October) were 50% of CT was applied; and a second deficit irrigation (DI2), irrigated as DI1, except for two periods in which irrigation was suppressed (16 June-6 July and 21 July-17 August). Each treatment was setup in triplicate, randomly distributed in blocks. Each repetition had 15 rows with 15 trees per row. Soil CO_2 emissions, moisture and temperature were monitored every 15 days. A soil sampling (0-30 cm) was carried out every three months, to determine the evolution of organic carbon, recalcitrant carbon, labile and soluble carbon, inorganic carbon, microbial biomass carbon, β-glucosidase and arylesterase enzyme activities, and organic functional groups measured by Fourier transform infrared spectroscopy (FTIR). A soil fractionation was carried out in all samples (<50, 50-250, 250-850, >2000 μm) to assess the weight and carbon content of each particles fraction in terms of irrigation treatments. Results showed that the application of deficit caused a significant decrease in CO_2 emission rates, mainly in DI2, with rates 10 μg CO_2-C m-2 s-1 lower than CT during this deficit period. When cumulative CO_2-C released during one year was estimated, it was verified that water deficit contributed to decreases in the release of CO_2, with a total release of 410 g CO_2-C m-2 in CT, 355 g CO_2-C m-2 in DI1, and 251 g CO_2-C m-2 in DI2. This last treatment has supposed an annual reduction of 159 g CO_2-C m-2 regarding CT. Soil properties, contrarily, showed no significant differences among treatments, with similar values in the C fractions and organic carbon quality, with an average organic C content of 4.5 kg m-2, 30 kg m-2 of inorganic C, a recalcitrance index of 57%, 1.40% of organic compounds solubility index and 160 g m-2 of microbial biomass C. There were no differences among particle sizes weigh and organic or inorganic carbon contents either. Thus, since no differences in quantity and quality of organic carbon was assess in soil with regard to irrigation treatment, it seems that longer periods are needed to assess shifts in soil properties related to carbon sequestration.

Key words: carbon sequestration, CO_2 emissions, organic carbon quality, irrigation