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Optimizing biochars to mitigate N2O emissions in Mediterranean areas

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Some of the most productive agricultural soils stand in Mediterranean-type climate areas of the world (e.g. California's Central Valley, Andalucia region in South Spain, and Lombardy region in Italy). Many of these soils are under intensive agricultural production, bearing the addition of substantial amounts of N fertilizers, which are known to promote soil N2O emissions. Laboratory studies have shown the potential of biochar to decrease N2O emissions in soils from Mediterranean areas. These soils generally have alkaline pH and low concentrations of organic C and several laboratory experiments found that applying biochar at a rate of 2% in weight could decrease N2O emissions up to 90%. However, field studies carried out in areas of California, Italy and Spain (all under Mediterranean climate) showed none or very limited N2O mitigation with biochar. We postulate that this discrepancy may be because biochar-soil combinations were not optimal in field studies and that developing biochars adjusted to specific soil properties is crucial for their successful application to mitigate N2O emissions. Thus, in this study we aimed at (i) collecting and characterizing a variety of the most representative Mediterranean agricultural residues (olive tree, almond and orange tree pruning, olive mill waste, rice straw, horticultural residues, etc.), (ii) exploring their suitability as feedstocks for biochar production and (iii) analyzing their impact on N2O emissions in a Mediterranean agricultural soil. Biochars were produced by slow pyrolysis with a heating rate of 5˚C min-1 at two pyrolysis temperatures (400 and 600˚C) and a retention time of two hours. Soil incubations were set up simulating conditions of highly intensive crop production (high N fertilization, high moisture) to test how the biochars produced from different feedstocks and under two pyrolysis temperatures influence N2O emissions. Our starting hypothesis was that it is possible to optimize biochar characteristics (by appropriately selecting original feedstocks and pyrolysis conditions) in order to mitigate N2O emissions in Mediterranean agricultural soils.
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