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Soil carbon sequestration in semi-arid soil through the addition of fuel gas desulfurization gypsum (FGDG)

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This study investigated a new strategy for increasing carbon retention in slightly alkaline soils through addition of fuel gas desulfurization gypsum (FGDG, $CaSO4•2H_2O$). FGDG is moderately soluble and thus the FGDG amendment may be effective to reduce microbial respiration, to accelerate calcite ($CaCO_3$) precipitation, and to promote soil organic carbon (SOC) complexation on mineral surfaces, but rates of these processes need to be understood. The effects of FGDG addition were tested in laboratory soil columns with and without FGDG-amended layers, and in greenhouse soil columns planted with switchgrass, a biofuel crop. The results of laboratory column experiments demonstrated that additions of FGDG promote soil carbon sequestration through suppressing microbial respiration to the extent of ∼200 g per m2 soil per m of supplied water, and promoting calcite precipitation at similar rates. The greenhouse experiments showed that the FGDG treatments did not adversely affect biomass yield (∼600 g dry biomass/m2/harvest) at the higher irrigation rate (50 cm/year), but substantially reduced recoverable biomass under the more water-limited conditions (irrigation rate = 20 cm/year). The main achievements of this study are (1) the identification of conditions in which inorganic and organic carbon sequestration is practical in semi-arid and arid soils, (2) development of a method for measuring the total carbon balance in unsaturated soil columns, and (3) the quantification of different pathways for soil carbon sequestration in response to FGDG amendments. These findings provide information for evaluating land use practices for increased soil carbon sequestration under semi-arid region biofuel crop production.