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Could biochar and green manure be a substitute for synthetic nitrogen fertilization to guarantee rice grain yield and decrease greenhouse gas emissions?

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Hunger, poverty, climate change, health, soil quality and clean water are all connected by the agriculture sector. In the world, there are about 815 million people who are undernourished, and 663 million do not have access to clean water. More than 33% of the soils are degraded, largely due to intensively mechanized agriculture, and excessive pesticides and mineral fertilizer use. Rice is a staple food for most of the world population, and improving the nitrogen use efficiency (NUE) and reducing greenhouse gas (GHG) emissions is fundamental for the sustainability of this crop. Within this context, the objective of this study was to find a feasible alternative to the use of nitrogen fertilizers for smallholders and commercial farming in tropical flooded rice systems. The cultivation of rice (BRS Catiana) was assessed in a flooded system on a Latossolo Amarelo (Ferralsol, FAO, 2014), throughout the 2016/2017 growing season. The field experiment was carried out in strips without (0 char +0 N [control], 0 char+ green manure (GM), 0 char + synthetic nitrogen (N)), and with application of biochar (char +0 N, char+ GM, char + N) made of rice husks (21 Mg ha^{-1}, composition: 8% total C, 0.08% N, 63.6 g kg^{-1} organic C, 1482 mg dm^{-3} K and 10.9 mg dm^{-3} P), incorporated into 10 cm soil depth using a harrow, about six months before sowing rice. Within each strip, N sources treatments were added: green manure (*Crotalaria juncea*), cultivated for 60 days and incorporated into the 10 cm soil depth using a harrow at 10 days before sowing rice; and synthetic N (urea, 115 kg ha^{-1} N) applied at sowing rice (15 kg ha^{-1} N), and twice during rice growth (24 days after sowing [DAS] and 60 DAS). Fluxes of N_2O and CH_4 were quantified using manual static chambers throughout the rice growing season. The highest fluxes of N_2O were observed in the treatment with green manure. The treatments with synthetic N, without or associated with biochar, and the treatment with green manure only, increased N2O emissions. Similarly, synthetic N and green manure associated with biochar promoted higher total CH_4 emissions than the treatments with biochar only and the treatments with synthetic N and green manure only. The total emissions of N2O and CH4 per unit of grain produced were higher in treatments with biochar. Grain yield by the use of green manure and N synthetic fertilizer had no statistical diferences, with or without biochar. However, rice grain yield was lower in treatments with biochar.

Keywords: flooding, tropic, yield, Oxisol, NUE

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