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Assessing impacts of alternative fertilizer management practices on both nitrogen loading and greenhouse gas emissions in rice cultivation

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HIGHLIGHTS

- N loss and GHG emissions were measured from a paddy field in Shanghai.
- N loss associated to different precipitation patterns.
- GHG emissions related to different fertilizer and water management.
- Application of urea increased N losses and N_2O emissions.
- Application of organic manure enhanced CH_4 emissions and net GWP.

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ABSTRACT

Nitrogen (N) losses and greenhouse gas (GHG) emissions from paddy rice fields contaminate water bodies and atmospheric environment. A 2-year (2012–2013) field experiment was conducted at a typical paddy rice field in a rural suburb of Shanghai, China. N losses and GHG emissions from the paddy field with alternative fertilizer management practices were simultaneously measured. Four treatments were tested in the experiment: applications of only chemical synthetic fertilizer urea (CT), only organic manure (OT), a combination of the two types of fertilizers (MT) and a control (CK). Results from the field study indicated that CT produced the highest seasonal N loading rate (18.79 kg N/ha) and N_2O emissions (1.81 kg N_2O/ha) but with the lowest seasonal CH_4 emissions (69.09 kg CH_4/ha). With organic manure applied, MT and OT respectively reduced N loading by 21.86% and 30.41%, reduced N_2O emissions by 28.34% and 69.41%, but increased CH_4 emissions by 137% and 310% in comparison with CT. However, the net impact of CH_4 and N_2O emissions on global warming was enhanced when organic manure was applied. In addition, CT and MT produced the optimal rice yield during the experimental period, while OT treatment led to a yield reduction by 9.29% compared with CT. In conclusion, the impacts of alternative fertilizer management practices on ecosystem services ought to be assessed specifically due to the great variations across rice yields, N loss and GHG emissions.

1. Introduction

Paddy rice is one of the most important staple crops in the world and widely cultivated in Asia. Chinese rice planting area accounts for approximately 20% of global total and produces nearly 30% of world's total rice production quantity, that has made China as the largest rice producer in the world (Frolking et al., 2002). In order to meet the increasing food demand of the rapidly growing population in China, the country's rice production has been substantially improved in the past decades. The high application rates of synthetic nitrogen (N) fertilizer have contributed to the substantial increase in the rice production in China (Peng et al., 2009). The

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