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Methodology of fertilizer recommendation based on yield response and agronomic efficiency for rice in China

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ABSTRACT

A science-based, reliable, and cost-effective fertilizer recommendation method is needed to solve problems of low nutrient use efficiency and yield brought about by inappropriate fertilization practices in rice (*Oryza sativa* L.). We collated results from 2218 on-farm experiments conducted between 2000 and 2013 in major rice-producing regions of China to establish scientific principles and develop a methodology that would support fertilizer recommendations for rice. The study analyzed the relationships among yield response, agronomic efficiency (AE), relative yield (the ratio of the yield without N or P or K to the yield of the full NPK), and soil indigenous nutrient supply. On average, yield responses to nitrogen (N), phosphorus (P), and potassium (K) fertilizer applications were 2.4, 0.9, and 1.0 t ha^{-1}, and the AE of N, P, and K application were 13.0, 12.7, and 8.4 kg kg^{-1}, respectively. Relative yield was used to classify the soil indigenous nutrient supply; average relative yields related to N, P, and K were 0.71, 0.89, and 0.89, respectively. A significant negative linear correlation was observed between yield response and relative yield, and a significant quadratic relationship was seen between yield response and AE. These findings allowed us to build the *Nutrient Expert (NE) for Rice* decision support system. With continuous optimization of the NE system in each cropping season, results confirmed the effectiveness of this method in improving rice yields and profits. Compared with farmers' practices (FP), NE significantly increased grain yield in early, middle, and late rice and increased gross profit in middle and late rice during the third year (2015) of field validation. In addition, with NE, there was greater improvement in the recovery efficiency of N (REN) in early, middle, and late rice and the AE of N and partial factor productivity of N (PFPN) in middle rice as compared with FP and soil testing (ST). Results of this study showed good agreement between simulated and observed AE of N application, indicating that NE is a promising nutrient decision support tool that can be used in China.

1. Introduction

Rice is one of the most important staple food worldwide, playing a crucial role in world food security. Improved rice varieties, soil and fertilizer management, water use efficiency, and weed and pest control have increased world rice yield by 59% from 1984 to 2014 (FAOSTAT, 2014). However, there remains an urgent need to maintain and increase crop yield to meet the demand of the growing population—world rice production must increase to 771.1 million tons by 2030 to meet food requirements (Van Nguyen and Ferrero, 2006). The challenge of increasing agricultural production in an economically viable way while maintaining the ecological

Abbreviations: AEN, agronomic efficiency of applied N; FP, farmers' fertilizer practice; IKS, indigenous potassium supply; INS, indigenous nitrogen supply; IPS, indigenous phosphorus supply; NE, Nutrient Expert; ST, soil testing; PFPN, partial factor productivity of applied N; REN, recovery efficiency of applied N.

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