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Spatial variation of attainable yield and fertilizer requirements for maize at the regional scale in China

Xinpeng Xu[a,b], Ping He[b,c,*], Jiajia Zhang[b], Mirasol F. Pampolino[d], Adrian M. Johnston[e], Wei Zhou[b,*]

[a] Institute of Plant Nutrition and Resources, Beijing Academy of Agriculture and Forestry Sciences, Beijing Engineering Technology Research Center for Slow/Controlled-Release Fertilizer, Beijing 100097, PR China
[b] Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences (CAAS), Beijing 100081, PR China
[c] International Plant Nutrition Institute (IPNI) China Program, CAAS-IPNI Joint Lab for Plant Nutrition Innovation Research, Beijing 100081, PR China
[d] International Plant Nutrition Institute (IPNI), Southeast Asia Program, c/o IRRI, Los Baños, Laguna, Philippines
[e] International Plant Nutrition Institute (IPNI), 102-411 Downey Road, Saskatoon, SK S7N4L8, Canada

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ABSTRACT

Understanding attainable yield, soil nutrient supply capacity and fertilizer requirements in current intensive maize (*Zea mays* L.) production at regional and national scales in China is essential in making informed decisions on policy, research and investment. In this study, results of a large number of on-farm experiments (n = 5893) were collected for the period 2001–2015 from the main maize production areas in China to study the spatial variability of attainable yield, relative yield (RY) and fertilizer requirements by coupling geographical information system with the Nutrient Expert for Hybrid Maize system. We found strong spatial variation in attainable yield across all sites, with a coefficient of variation (CV) of 25.5%. Mapping the spatial variability of RY indicated that 85.3%, 79.3% and 72.5% of RY for nitrogen (N), phosphorus (P) and potassium (K) of the study areas ranged from 0.68 to 0.87, from 0.83 to 0.95 and from 0.84 to 0.94, respectively. The RY was higher in North Central China than other regions. The RY can reveal the spatial heterogeneity of soil nutrient supply capacity, and has been integrated into crop management strategies for calculating fertilizer requirements using the Nutrient Expert for Hybrid Maize decision support system. Overall, there were large variations in N, P and K fertilizer requirements across all sites with CVs of 19.5%, 31.6% and 35.0%, respectively, and the ranges of 150–210 kg N ha^{-1}, 50–90 kg P_2O_5 ha^{-1} and 50–110 kg K_2O ha^{-1} accounted for 72.0%, 81.7% and 81.5% of the study areas, respectively. The results of 605 field experiments in 10 provinces during 2010–2014 showed that the Nutrient Expert for Hybrid Maize system not only reduced N and P fertilizer application rates by 31.6% and 15.5%, respectively, but also increased maize yield by 3.3% compared with farmers' current practices. The combination of the fertilizer recommendation system and geographical information system with a large database of field trials provides a useful tool to identify spatial variation in fertilizer requirements in fields and regions, and contributes towards more efficient and effective fertilizer management.

1. Introduction

Crop yields have substantially increased over the past two decades, driven by the increasing use of chemical fertilizer, improved crop varieties and agronomic management (Mueller et al., 2012; Chen et al., 2014). However, the challenges for further potential yield increases are heightened by the increasing costs of inorganic fertilizer, soil degradation, decreasing arable land and increasing water and air pollution (Ju et al., 2009; Guo et al., 2010). Low nutrient use efficiency and environmental pollution are caused

Abbreviations: AY, attainable yield; K, potassium; MLYR, the Middle and Lower reaches of the Yangtze River; N, nitrogen; NC, north-central China; NE, northeast China; NW, northwest China; P, phosphorus; RY, relative yield; SW, southwest China.

* Corresponding authors at: Ministry of Agriculture Key Laboratory of Plant Nutrition and Fertilizer, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences (CAAS), Beijing 100081, PR China.
E-mail addresses: phe@ipni.net, phe@caas.ac.cn (P. He), zhouwei02@caas.cn (W. Zhou).

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