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# Spatial variation of soybean seed yield and nutrient requirement in Northeast China

**Shicheng Zhao**[1] | **Rai Schwalbert**[2] | **Xiaomao Lin**[2] | **Xinpeng Xu**[1] | **Ignacio Ciampitti**[2]

[1] Ministry of Agriculture Key Laboratory of Plant Nutrition and Fertilizer, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, PR China

[2] Department of Agronomy, Kansas State University, Manhattan, KS 66506, USA

**Correspondence**
Shicheng Zhao, Ministry of Agriculture Key Laboratory of Plant Nutrition and Fertilizer, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, PR China.
Email: zhaoshicheng@caas.cn
Ignacio Ciampitti, Department of Agronomy, Kansas State University, Manhattan, KS 66506, USA.
Email: ciampitti@ksu.edu

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**Abstract**

Soils and climate influence soil nutrient supply, crop nutrient demand, and potential yield. We collected soybean [*Glycine max* (L.) Merr.] data of seed yield and nutrient uptake from field students ($n = 657$) in Northeast China (2001–2017) to study spatial distribution of attainable yield, yield response to fertilizer, and crop nutrient requirements at regional scale. The study area was divided in four weather regions based on daily average temperature and cumulative precipitation during the soybean growth season. Average attainable yield was 3.2, 3.1, 2.9, and 2.6 Mg ha$^{-1}$ in warm-wet, warm-dry, cold-wet, and cold-dry regions, respectively. Soybean yield response to N, P, and K fertilizers and requirement of these nutrients presented the following order for each region from high to low: cold-wet > warm-dry > cold-dry > warm-wet regions, with exception for K requirement. In overall, spatial correlation in yield response to fertilizer and nutrient requirement ranked in the following order: P > K > N across all the climate regions. Based on the variation in attainable yield, balanced fertilization should be pursued to more sustainable higher soybean yields in the warm-dry and cold-wet regions with favorable weather conditions; while for the cold-dry region, fertilization needs to address the topic of improving P use efficiency, as future research prioritizes from both environmental and productivity standpoints.

## 1 | INTRODUCTION

Soybean [*Glycine max* (L.) Merr] is an important field crop globally grown as a source of both protein and oil for animal and human consumption. For its contribution of N to the system via the biological nitrogen fixation (BNF), soybean (as a legume) is a relevant crop for the rotational system (Varvel & Wilhelm, 2003). Although global soybean production was 306 million Mg in 2016 (FAOSTAT, 2019), this production level cannot meet the demand of the overgrowing human population. From a biophysical standpoint, the main factors limiting soybean yield at the farm-scale are related to genotype, environment, management practices (including fertilization), and

**Abbreviations:** AE, agronomic efficiency; BNF, biological nitrogen fixation; HI, harvest index; QUEFTS, Quantitative Evaluation of the Fertility of Tropical Soils; RE, nutrient recovery use efficiency; RIE, nutrient requirement per Mg of seed yield.