Modelling crop yield, soil organic C and P under various long-term fertilizer management in China

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Introduction

Phosphorus (P) is a major limiting nutrient for plant growth and thus essential for food security. P is a nonrenewable resource and it controls freshwater eutrophication..

It is thus essential to find an integrated and effective approach to optimize phosphorous fertilizer application in the agro-ecosystem while maintaining crop yield and minimizing environmental impacts.

Many models have been developed to simulate soil C and N, but few consider the long-term dynamics of soil P. Hitherto, calibration/validation of soil P models with long-term field experimental data to study the dynamics of soil P is rare and has not been reported in China .

Objective

The objectives of this study are to:

- calibrate and validate the Environmental Policy Integrated Climate (EPIC) model (crop yield, soil organic carbon and soil P dynamics)
- test the sensitivity of crop yield, soil organic carbon (SOC) and soil available P (SAP) to varying fertilizer P application rates and meteorological conditions.

Method

The Environmental Policy Integrated Climate (EPIC) process-based model was employed to simulate grain yield, SOC and SAP based on 8 field experiments in China with 11 years of data, for 4 treatments: control (CK), NPK fertilizer, NK fertilizer and NPK+manure (NPKM). The sensitivity of soil P to variation of fertilizer P application rates and climate (humid, dry) was also conducted.

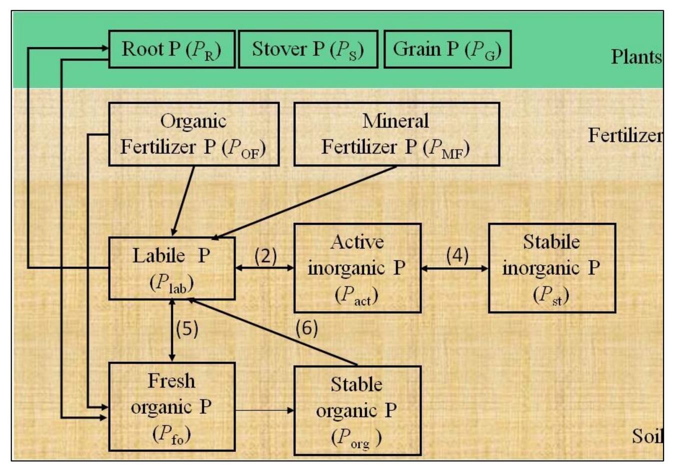

Fig 1. Phosphorus pools and flows of EPIC model

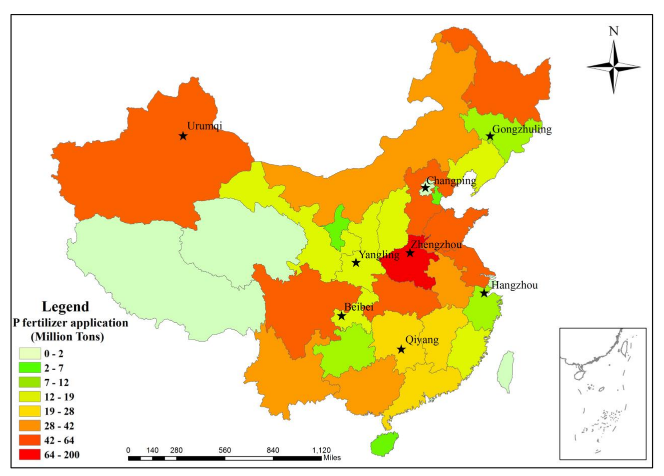

Fig 2. Sampling locations of ***the National Soil Fertility and Fertilizer Effects Long-term Monitoring Network*** *and the P fertilizer application of every province in China in 2013*

Table 1. Data used in this work

Data set	Description
Climate	Daily meteorological data
Soil	Soil physical and chemical data
Crop management	Crop rotation, planting/harvest, tillage, fertilization, irrigation etc.
Crop yield, SOC and SAP	Field observed yield, SOC and SAP

Results

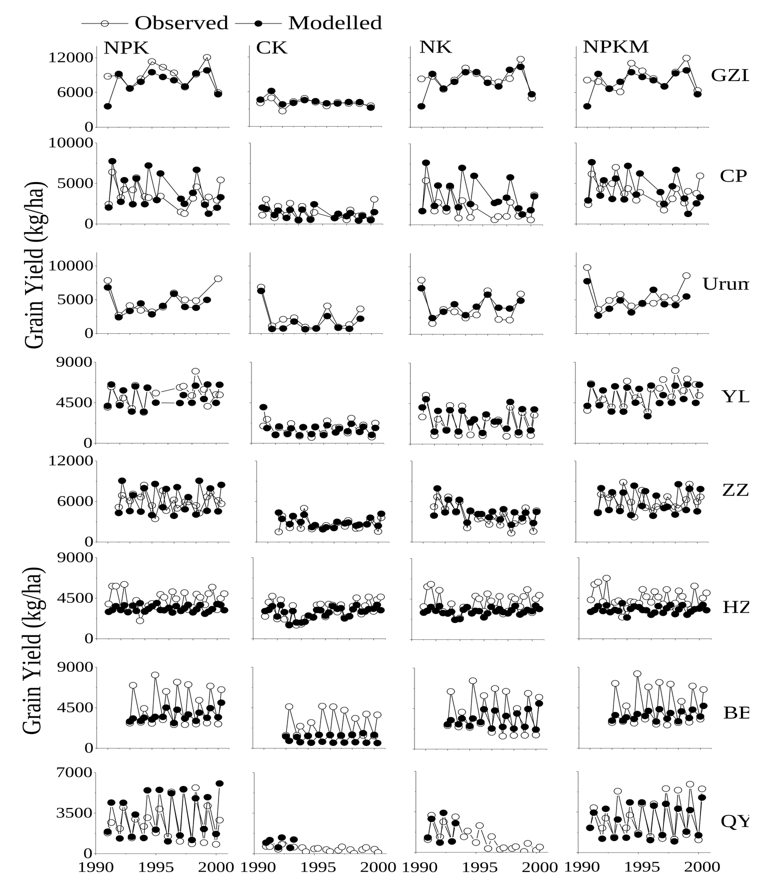

Fig 3. Temporal variation of grain yields: measure values and model simulation

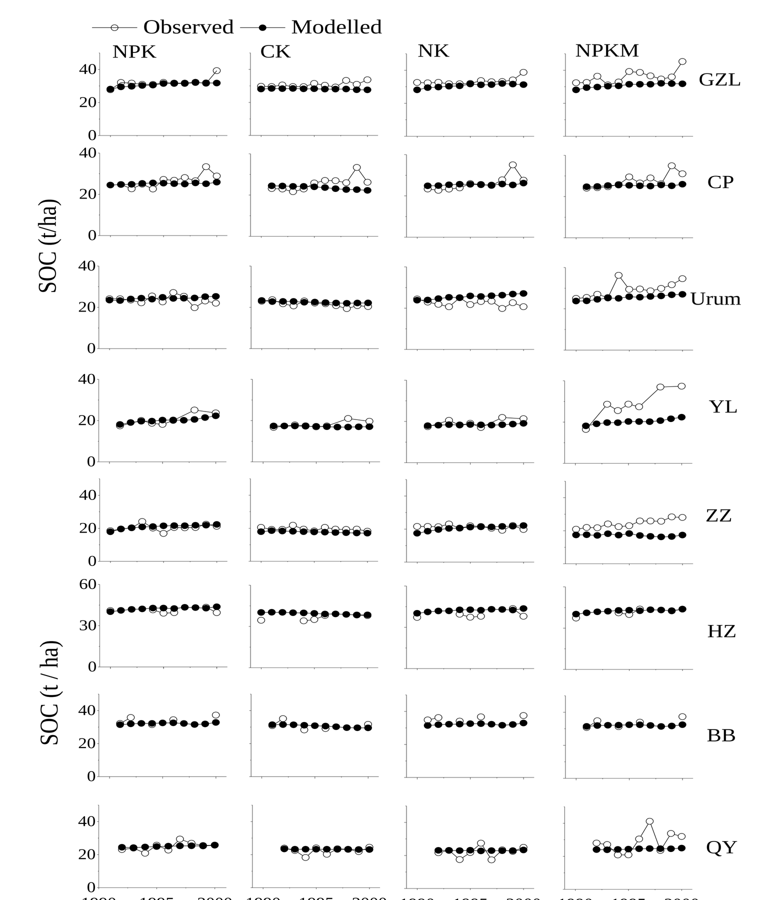

Fig 4. Temporal variation of grain SOC: measure values and model simulation

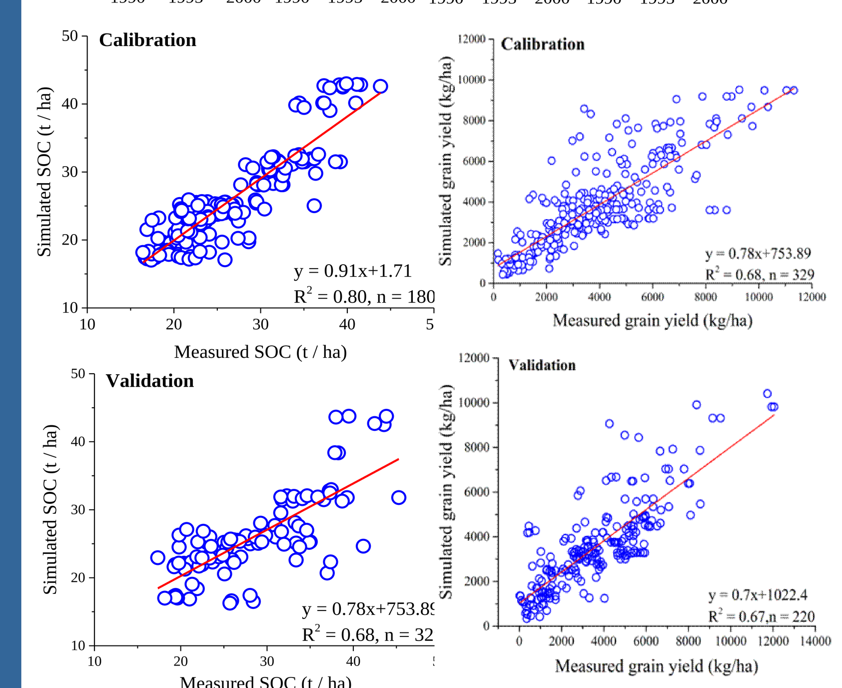

Fig 5. The correlation of the simulated and measured SOC and grain yields of all treatments

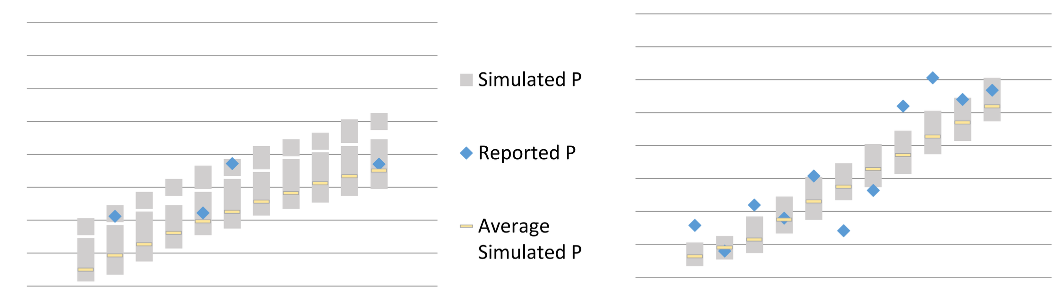

Fig 6. Temporal variation of soil available P (mg/kg) : measurements and simulation for site Yangling (NPK) and Zhengzhou (NPK)

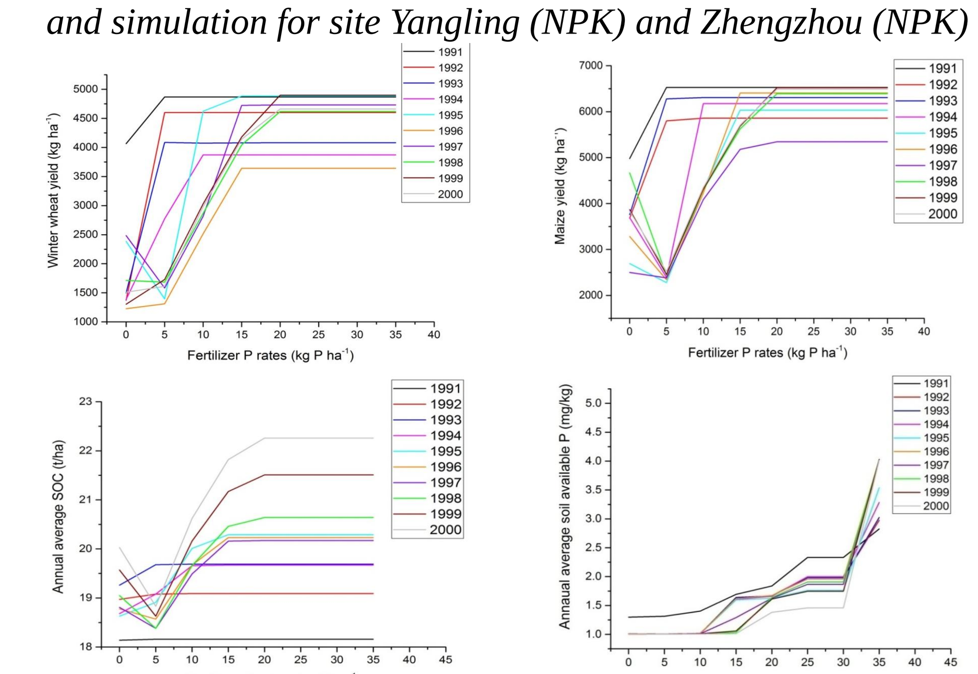

Fig 7. Sensitivity of grain yield, annual average SOC and soil available P to sequential P fertilizer

Conclusion

- EPIC performed well in simulating grain yields, SOC and SAP of different crops under various long-term fertilizer management in China.
- Crop yields, SOC and SAP are sensitive to P fertilizer input and show linear increase followed by reaching plateau. Interestingly, SAP will accumulate in soil finally.
- EPIC has great potential to simulate crop growth, SOC and soil P dynamics in China.

Acknowledgements

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