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Tillage practices improve rice yield and soil phosphorus fractions in two typical paddy soils

Waqas Ahmed[1] · Muhammad Qaswar[1] · Huang Jing[1,2] · Dong Wenjun[3] · Sun Geng[4] · Liu Kailou[5] · Meng Ying[3] · Tang Ao[3] · Sun Mei[4] · Li Chao[4] · Xu Yongmei[6] · Sehrish Ali[1] · Yodgar Normatov[7] · Sajid Mehmood[8] · Muhammad Numan Khan[1] · Zhang Huimin[1,2]

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Abstract

Purpose This research was undertaken (I) to evaluate the status of phosphorus fractions in paddy soils in response to different tillage management practices under different rice-based cropping systems and environments in order to better understand phosphorus behavior in paddy soils and (II) to assess the effects of various tillage practices on crop yield in different soil types and climatic conditions.

Materials and methods We selected four tillage treatments, i.e., conventional tillage (T1), conventional tillage with straw return (T2), rotary tillage with straw return (T3), and no-tillage with straw return and autumn plowing with straw return (T4) at Ningxiang and Haerbin, respectively. Soil samples were collected from 20 cm depth, and we investigated soil pH, total P, Olsen P, SOM content, phosphatase activities, phosphorus fractions, and grain yield at the two experimental sites.

Results and discussion The results showed that the T4 tillage system led to significantly higher soil organic matter (SOM) content, total P, and Olsen P concentrations at both sites compared with T1. Regardless of the tillage system, the average rice grain yield at Haerbin was 50.3% greater than that at Ningxiang. Phosphomonoesterase (AcP) and phosphodiesterase (DP) enzyme activities were significantly higher, by 39.8% and 62.1% and by 40.3% and 54.6%, under T4 compared to under T1 at Haerbin and Ningxiang, respectively. The organic and inorganic fractions of P were significantly affected by the different tillage systems. Labile and moderately labile P pools were 29.3% and 19.2% higher in Ningxiang and 64.7% and 33.8% higher in Haerbin under T4 compared to T1, and the non-labile P pools were 10.6% and 18.5% lower, respectively. The labile and moderately labile organic P fractions and phosphatase activities showed a significant correlation with SOM and total P concentrations in RDA analysis. Variance partitioning analysis (VPA) showed that different soil properties, climate factors, phosphatase activities, and their interactions were responsible for 7.1%, 6.8%, 1.3%, and 53.7%, respectively, of the variation in grain yield.

Conclusions Different tillage management practices revealed varied effects at both sites for grain yield, P fractions, and phosphatase activities. Tillage management and climatic variations could be the driving factors that influence grain yield in northern and southern parts of China.

Keywords Paddy soils · Phosphatase activities · Phosphorous fractions · Rice grain yield · Tillage systems

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✉ Zhang Huimin
zhanghuimin@caas.cn

[1] National Engineering Laboratory for Improving Quality of Arable Land, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China

[2] National Observation Station of Qiyang Agri-Ecology System, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Qiyang 426182, Hunan, China

[3] Institute of Crop Cultivation and Tillage, Heilongjiang Academy of Agricultural Sciences, Haerbin 150000, China

[4] Hunan Institute of Soil and Fertilizer, Changsha 410125, China

[5] National Engineering and Technology Research Center for Red Soil Improvement, Jiangxi Institute of Red Soil, Nanchang 331717, China

[6] Institute of Soil, Fertilizer and Agricultural Water Conservation, Xinjiang Academy of Agricultural Sciences, Urumqi 830091, China

[7] Department of Soil Science, Gulistan State University, Gulistan City, Uzbekistan 120100

[8] Guangdong Provincial Key Laboratory for Radionuclides, Pollution Control and Resources, School of Environmental Science and Engineering, Guangzhou University, Guangzhou 510006, China

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