Agronomic and Environmental Effects of Reducing P Fertilization for Four-Year Rice-Wheat Rotation Field Experiment in the Taihu Lake Region of Southern China

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The need for efficient use of phosphorus (P) in agriculture has been highlighted recently by concerns about the finite amount of P fertilizer resources (USGS, 2016). However, in the Taihu Lake Region (TLR) of China, farmers' injudicious and excessive use of P fertilizer has led to a dramatic spike in P accumulation in the lake (Figure 1) (Wang et al., 2012). To validate the feasibility of omitting phosphorus (P) fertilizer applications in the rice season for a rice-wheat rotation on a typical paddy soils in TLR, a four-year field experiment encompassing eight rice–wheat-growing seasons was conducted. Four different P regimes, including P fertilization only for wheat season (PW), P fertilization only for rice season (PR), P fertilization for both rice and wheat seasons (PR+W), and no P fertilization for either crop (Pzero) as a control (Figure 2, Table 1) were used as treatments. The results showed that compared to the PR+W treatment, the PW treatment had no significant difference in rice or wheat yields over the 4 years; but Olsen-P concentration in soil and total P contents in runoff declined by 10.5~36.7% and 12.0%, respectively (P<0.05), and the utilization efficiency of P fertilizer increased by 3.54% (P<0.05) (Figure 3, Figure 4). According to the current price of superphosphate, 3.06 billion RMB could be saved in TLR in just a single year. Therefore, the regime of omitting P fertilizer in rice for a rice-wheat rotation has positive effects on agriculture, environment and economy, and is feasible in the TLR. The results of field conditions were comparable to those from our previous soil pot laboratory experiments, and this was the first field test of omitting P fertilization of flooded rice in rice–wheat rotations.

References

USGS – United States Geological Survey. 2016. Mineral Commodity Summaries, Phosphate Rock. U.S. Department of the Interior, Washington, D.C., USA. Available online at: http://minerals.usgs.gov/minerals/pubs/commodity/phosphate_rock/.

Wang, S., X. Zhao, G. Xing, Y. Gu, T. Shi, and L. Yang. 2014. Phosphorus pool in paddy soil and scientific fertilization in typical areas of Taihu Lake watershed, China. Soils 44(1): 158-162.

Table 1. Basic average properties of soil from experimental field plots.

TN (g/kg)	TP (g/kg)	TK (g/kg)	OM (g/kg)	Olsen-P (mg/kg)	CEC (cmol/kg)	pH
0.957	0.371	12.33	16.7	16.28	8.57	5.95

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Figure 1. Taihu Lake and field site location.

Figure 2. Field experiment plots.

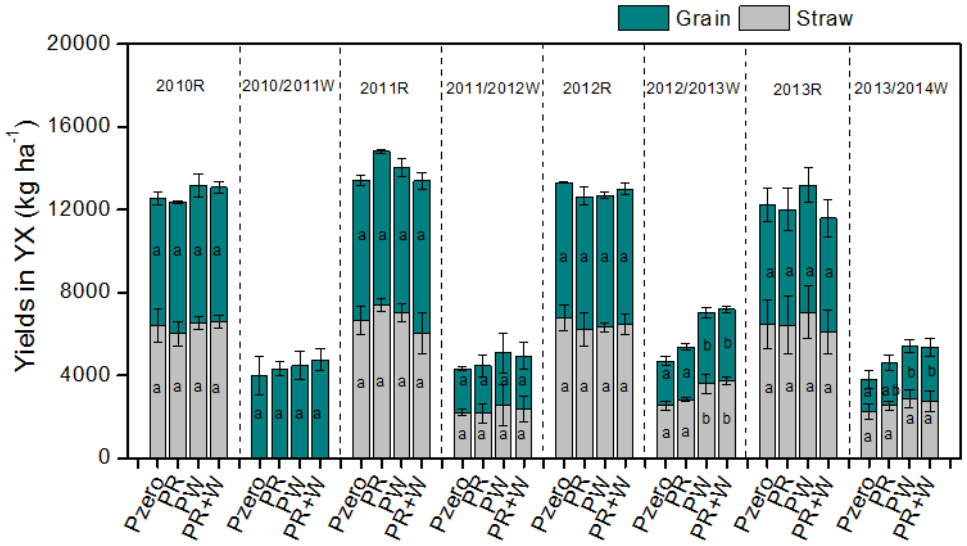

Figure 3. Yields of Grain/Straw during four entire rice/wheat rotations from 2010 to 2014.

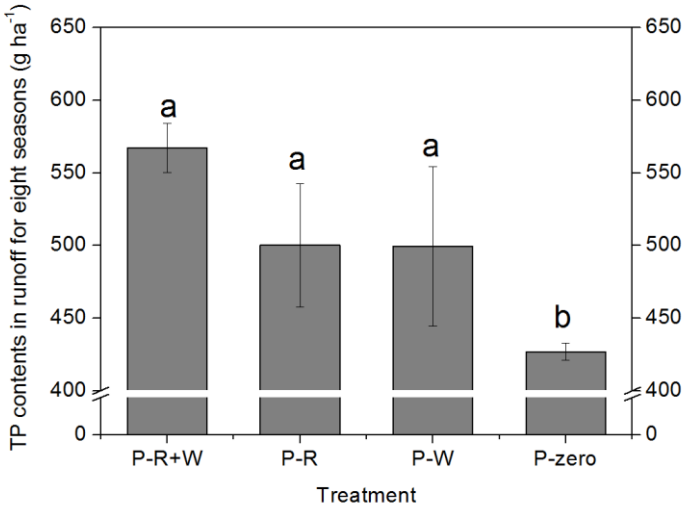

Figure 4. Total phosphorus content in runoff from 2010 to 2014. Bars with same lower case letter at top are not significantly different (Tukey test was used at a significance level of $P<0.05$).