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Manipulation of nitrogen and phosphorus fertilization to improve wheat grain zinc for human health

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Background

- **Human Zn deficiency is a widespread health problem for humans in developing countries, due to a large consumption of cereal-based foods with low Zn concentration.**
- **Wheat, as one of the stable food crops, has low zinc (Zn) concentration in grain generally, thus increasing Zn concentration of wheat grain has attracted specific and wide attentions in recent years.**
- **Agronomic biofortification is considered to be an effective strategy for improving Zn concentration in crop grain, such as increasing nitrogen (N) and Zn fertilization and decreasing phosphorus (P) fertilization are able to increase Zn concentration in wheat grain.**
- **Nowadays, how to manipulate N, P and Zn fertilization for achieving high yield with high Zn concentration in grain is still lacking in wheat production.**

Materials and Methods

- **Nitrogen, P and Zn fertilization rate, and wheat yield and grain Zn concentration given in figures was from: (i) "field experiments", which conducted on N and P fertilization rates and Zn fertilization to soil and foliage by our research team; (ii) "literatures", that is published during 1980~2019 in China National Knowledge Internet (CNKI) and the Web of Science with search topics including "wheat" and "zinc or Zn".**
- **Specific criteria for the data selection were as follows: data from literatures was obtained through experiments carried out under field conditions; (2) available soil Zn concentration was investigated when the field experiments started; (3) the datasets were not from particularly high-yielding cultivation conditions or high fertility fields used for high-or super high-yielding purposes.**

Results

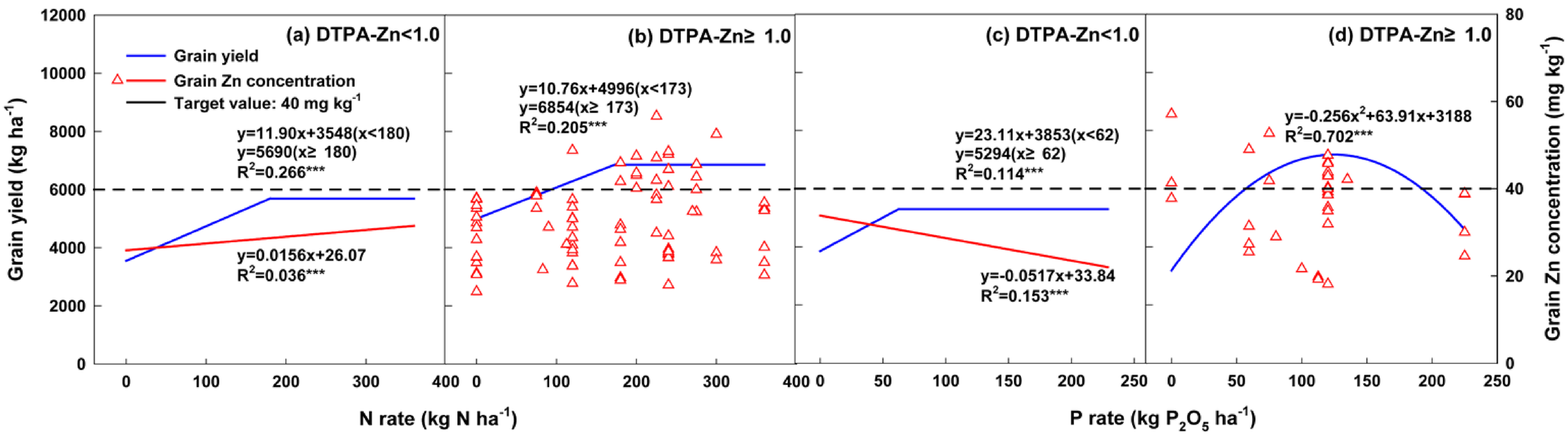

Fig. 1 Grain yield and Zn concentration of wheat affected by N and P application rates. DPTA-Zn<1.0 and DPTA-Zn≥1.0 indicate available Zn concentrations in soil that are <1.0 mg kg^{-1} and ≥1.0 mg kg^{-1}, respectively. Black lines represent a desired Zn concentration of 40 mg kg^{-1} in wheat grain. Triangular symbols indicate grain yield that is not fitted by a curve. * denotes regressions that are significant at $P < 0.001$.**

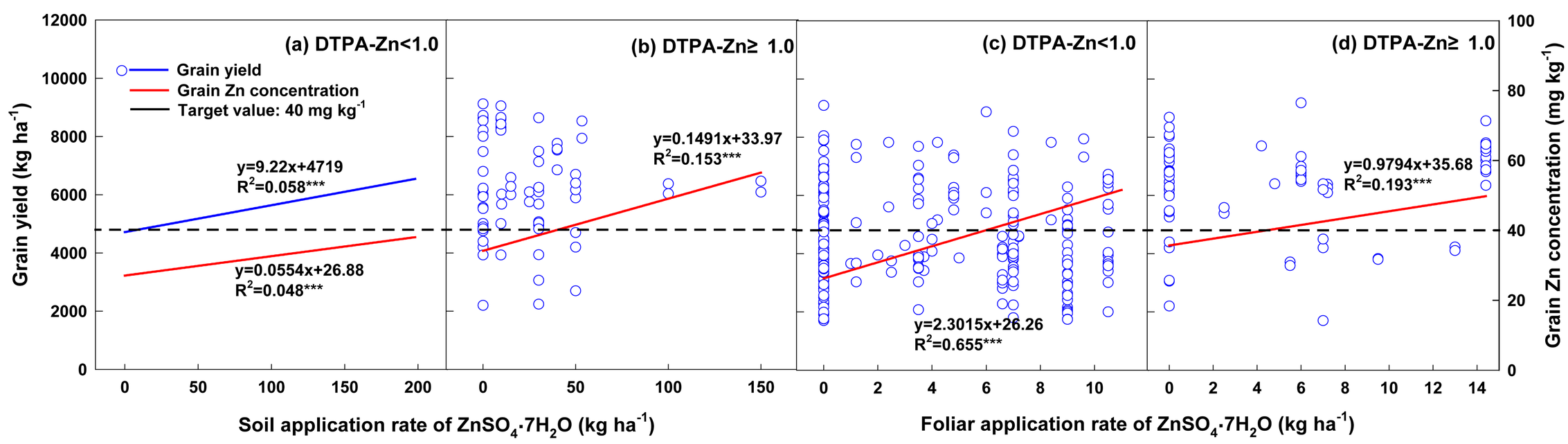

Fig. 2 Grain yield and Zn concentration of wheat affected Zn application to soil and foliage. DPTA-Zn<1.0 and DPTA-Zn≥1.0 indicate available Zn concentrations in soil that are <1.0 mg kg^{-1} and ≥1.0 mg kg^{-1}, respectively. Black lines represent a desired Zn concentration of 40 mg kg^{-1} in wheat grain. Circle symbols indicate grain Zn concentration that is not fitted by a curve. * denotes that regressions are significant at $P < 0.001$.**

Conclusions

- **Regulation of N and P fertilization did not achieve the target Zn concentration in wheat grain grown on the soil with Zn deficiency and no Zn applied. The grain Zn concentration increased by 1.6 mg kg^{-1} for each 100 kg N ha^{-1} increase, but for each 100 kg P_2O_5 ha^{-1} increase, it decreased by 5.2 mg kg^{-1}.**
- **The increase in wheat grain Zn concentration with Zn application to foliage was much higher than to soil. On Zn-deficient and non Zn-deficient soil, the Zn concentration in grain increased by 0.6 and 1.5 mg kg^{-1} with each 10 kg $ZnSO_4 \cdot 7H_2O$ ha^{-1} applied to soil, and with each 10 kg $ZnSO_4 \cdot 7H_2O$ ha^{-1} applied to foliage, it increased by 23.0 and 9.8 mg kg^{-1}, respectively.**

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