Phosphorus fertilizer management on grain quality and seed phytic concentrations of black rice for consumption and production

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Introduction

- Black rice: a superfood high in antioxidants for human health.
- Generally grown in fragile ecosystems and thus soil nutrient status would affect yield and nutritional quality of black rice.
- This study evaluated

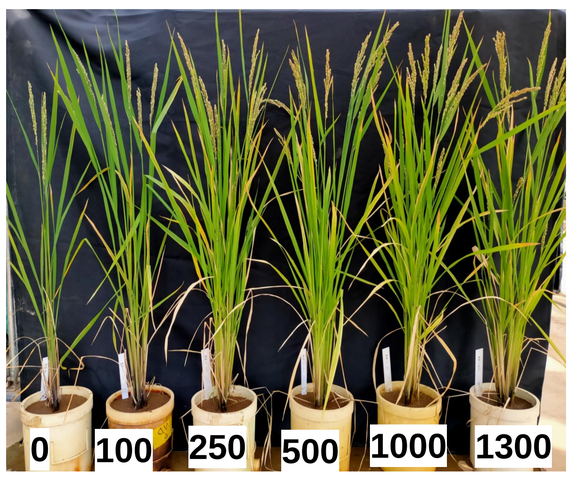
(1) how phosphorus (P) fertilization affected grain yield and quality of black rice.

(2) Seed phytic acid concentrations on early seedling vigor of black rice.

Materials and methods

Experiment 1:

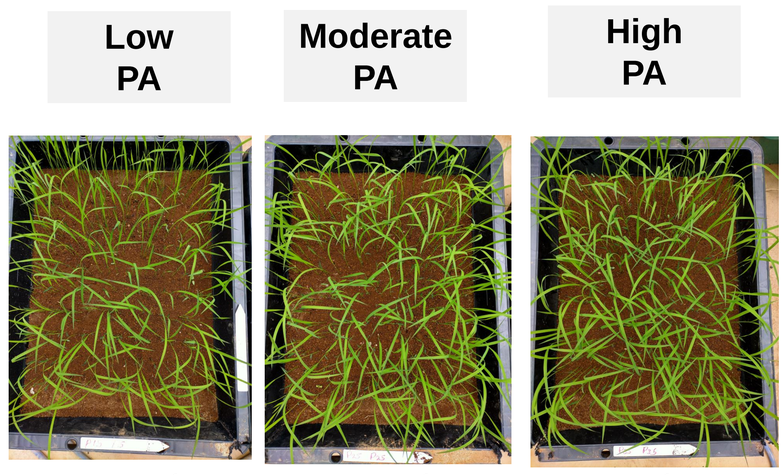
Different P doses on grain yield and quality



P application rates (mg P_2O_5/pot)

Experiment 2:

Seed phytic acid (PA) concentration on early seedling vigor



Seed PA concentrations

Results

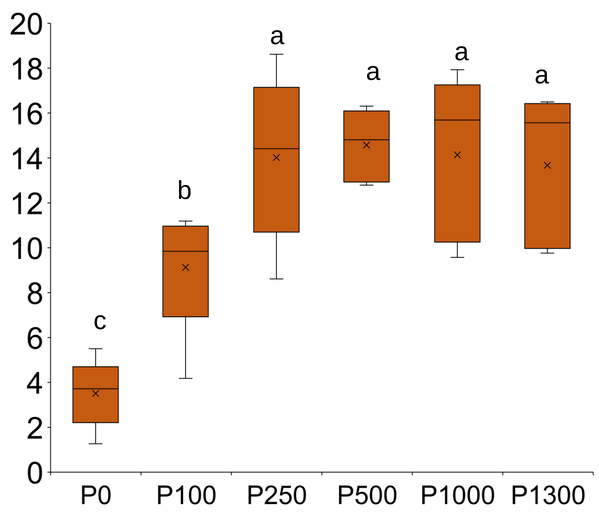


Fig. 1 Grain yield response of rice to P applications (mg P_2O_5/pot)

- Black rice requires less P to achieve optimal grain yield and high P rates have no effect on yield increase (Fig. 1)
- Under stressful and low P conditions, the grain color stability is improved (Fig. 4)

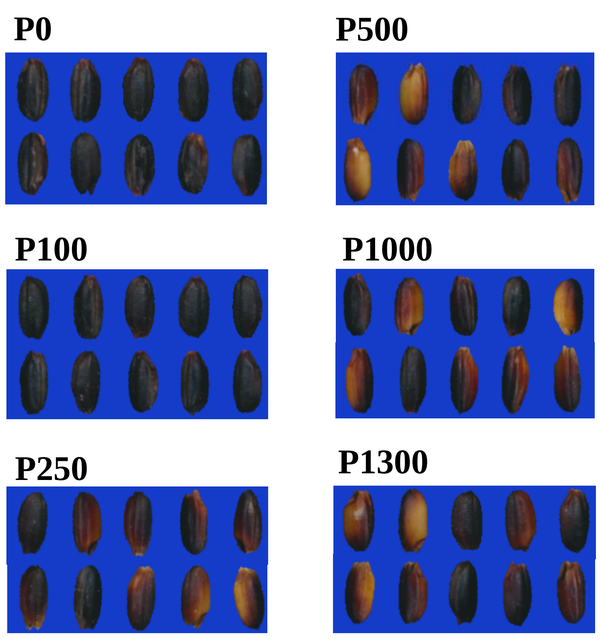


Fig. 4 Grain color stability in black rice under different soil P conditions.

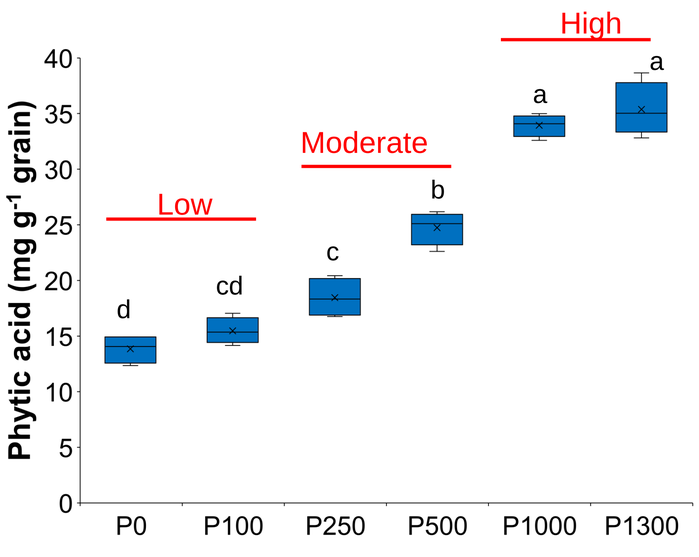


Fig. 2 P applications on grain phytic acid (PA) concentrations

- Increasing P levels led to higher grain PA levels, which acts as an anti-nutritive agent) (Fig. 2).
- However, high levels of seed PA are necessary to enhance early seedling vigor (Fig. 5).
- Phytohormone ethylene is produced in response to P stress and high ethylene production in LPA inhibits early vigor (Fig. 5).

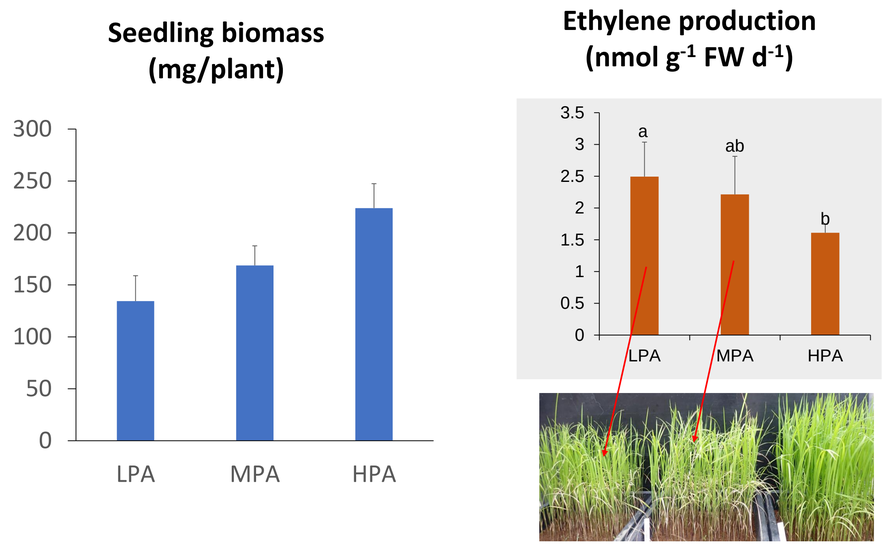


Fig. 5 Effect of seed phytic acid on early rice growth and ethylene production by seedlings

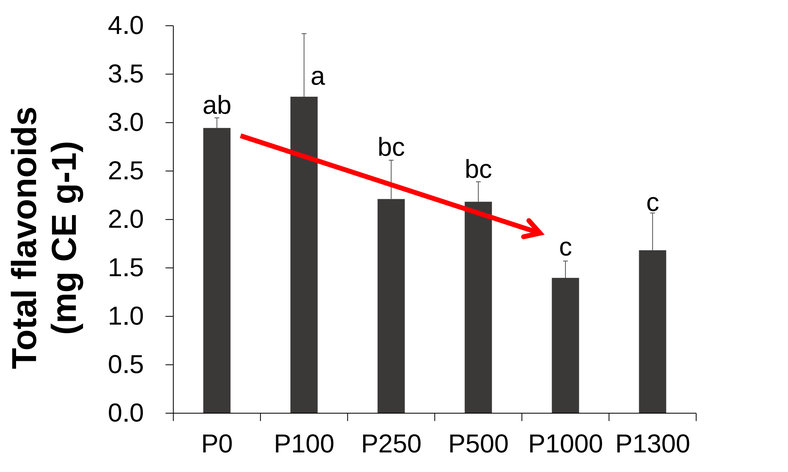


Fig. 3 P applications on grain total flavonoid content

- Total flavonoid content in the grains decreased with P applications.
- Black rice produced under low P enhances grain anthocyanin, thus further improving grain nutritional quality (Fig. 3 and 4).
- A positive effect of seed PA on early rice growth was observed, regardless of soil P bioavailability (Fig. 6).

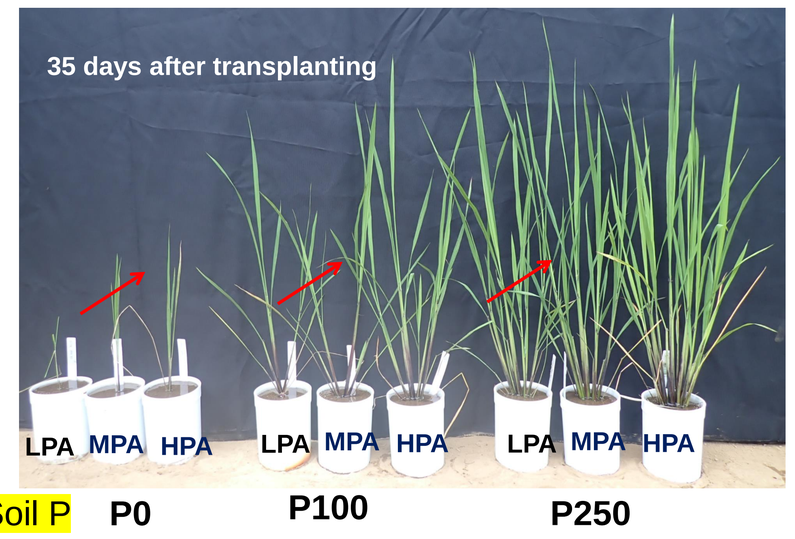


Fig. 6Seed phytic acid and P application (mg P_2O_5/pot) showed an additive effect on early rice growth

Conclusions

- Black rice is sensitive to P stress, but low levels of P can improve the quality of the grains.
- Black rice requires a lower amount of P to achieve high yields with high antioxidants and low phytic acid.
- While a high supply of P can increase the concentration of phytic acid in the grains and affect their quality, it is necessary to enhance the vigor of early rice seedlings.
- As a result, it is crucial to optimize P fertilizer management based on the intended use of the seeds.

Acknowledgements

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