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

Aung Zaw Oo, Hidetoshi Asai, Junichiro Marui, Toshiyuki Takai, Hiroki Saito

Japan International Research Center for Agricultural Sciences, Japan

Abstract

Black rice, known for its antioxidant properties, is becoming increasingly popular due to its nutritional value, especially in Asian tropical regions. It is known for its antioxidant properties, but its productivity is often limited by soil infertility, particularly by soil phosphorus (P) deficiency. However, the effect of soil P availability on grain quality has not been fully understood.

A recent trial was conducted in which different rates of P fertiliser (ranging from 0–1300 mg pot^{-1}) were applied to P-deficient soils. The results showed that soil P deficiency reduced grain yield, which increased with higher soil P availability until it plateaued at an optimal P rate of 250 mg pot^{-1}. Conversely, reduced soil P availability enhanced the grain quality, resulting in increased mineral content (Fe and Zn) and total flavonoid content. As soil P availability increased beyond the optimal P rate, these nutritional parameters declined. Similarly, seed phytic acid (PA) content, which is an antinutritive agent that inhibits the absorption of essential minerals, increased from 16 mg g^{-1} to 35 mg g^{-1} as soil P availability increased. This increase persisted even beyond the optimal P rate. Therefore, it is essential to manage soil P optimally to maximise yield while maintaining nutritional quality and mitigating seed PA accumulation in black rice for human consumption. Moreover, seed PA serves as a P source for initial growth and plays a crucial role in early seedling vigour. However, low PA seed had reduced seedling vigour and increased ethylene production in response to P stress, a key mechanism modulating seedling growth. Conversely, high PA seeds had improved root development and physiological processes, leading to increased seedling vigour and P uptake. Furthermore, a combination of high PA seed and external P supply significantly improved seedling growth. In conclusion, optimal P management enhances the nutritional quality of black rice and maintains optimal yield with low PA levels. This study also emphasises the importance of seeds with high PA in enhancing early vigour and subsequent rice growth, providing useful insights for rice growers and consumers who seek to obtain the maximum nutritional value from black rice while maintaining its high yield.

Keywords: Antioxidants, black rice, mineral content, phosphorus

Contact Address: Aung Zaw Oo, Japan International Research Center for Agricultural Sciences, Crop, Livestock and Environment, 1-1 ohwashi, 3058686 Tsukuba, Japan, e-mail: aungzawoo@affrc.go.jp