Impact of abiotic stress on grain yield, antioxidant activity, and nutritional quality of black rice

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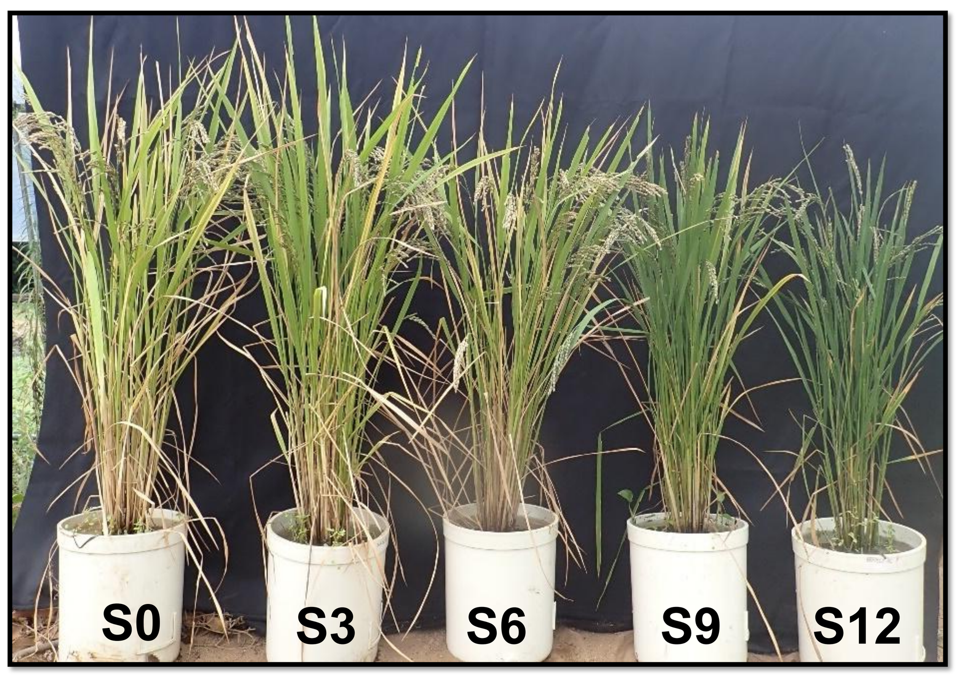
Introduction

- Abiotic stresses pose significant challenges to crop growth, yield, and nutritional quality.
- Black rice, renowned for its high antioxidant content, is particularly vulnerable to abiotic stresses, which can affect both grain quality and antioxidant activity
- This study examines the effects of salinity, water and temperature stresses on grain yield, antioxidant compounds (flavonoids and phenolics), phytic acid content, and grain color appearance.

Materials and methods

Pot experiment 1



Salt stress (dS m^{-1})

Pot experiment 2

Black rice varieties
- Asamurasaki,
- Minenomurasaki, and
- Etsunanmochi191

Water management
- continuous flooding (CF)
- alternate wetting and drying (AWD)
- aerobic rice system (ARS)

Temperature treatment
- Normal temperature
- Elevated temperature

Results

Pot experiment 1

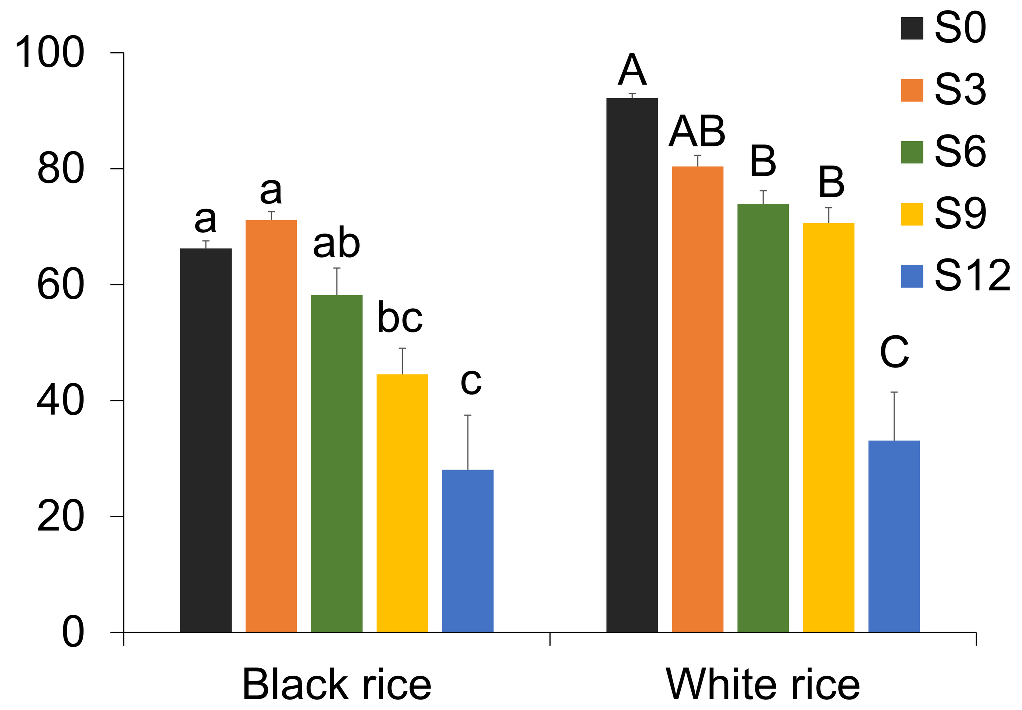


Fig. 1 Salt stress on rice grain yield.

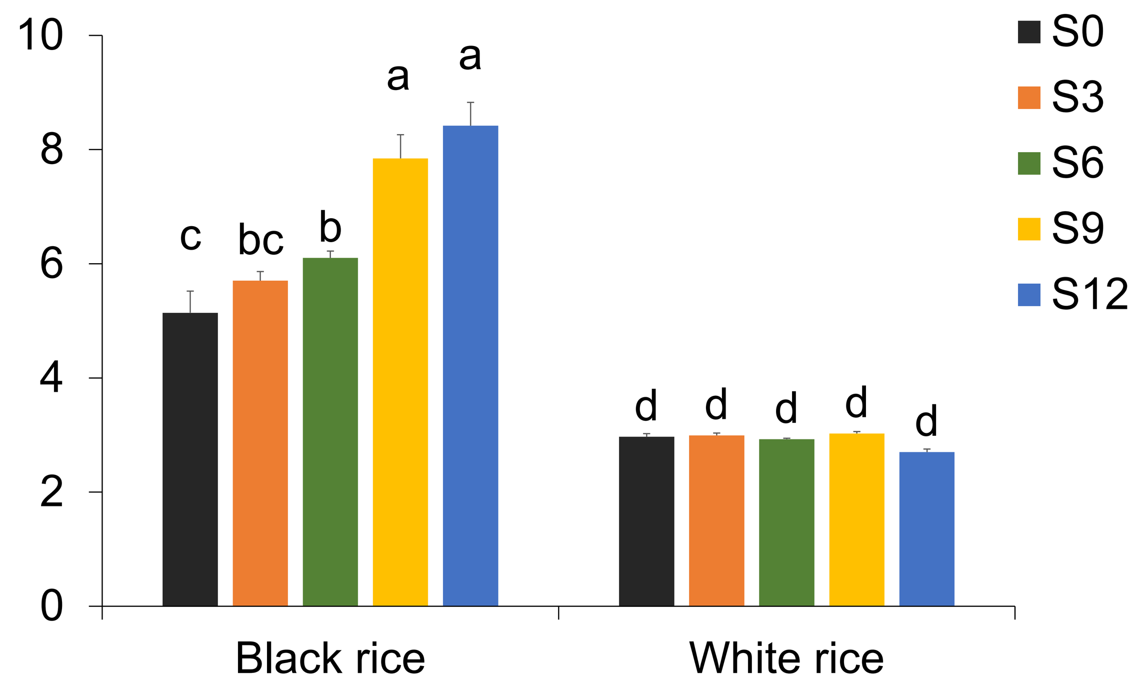


Fig. 2 Salt stress on grain antioxidant.

Gallic acid equivalents (GAE)

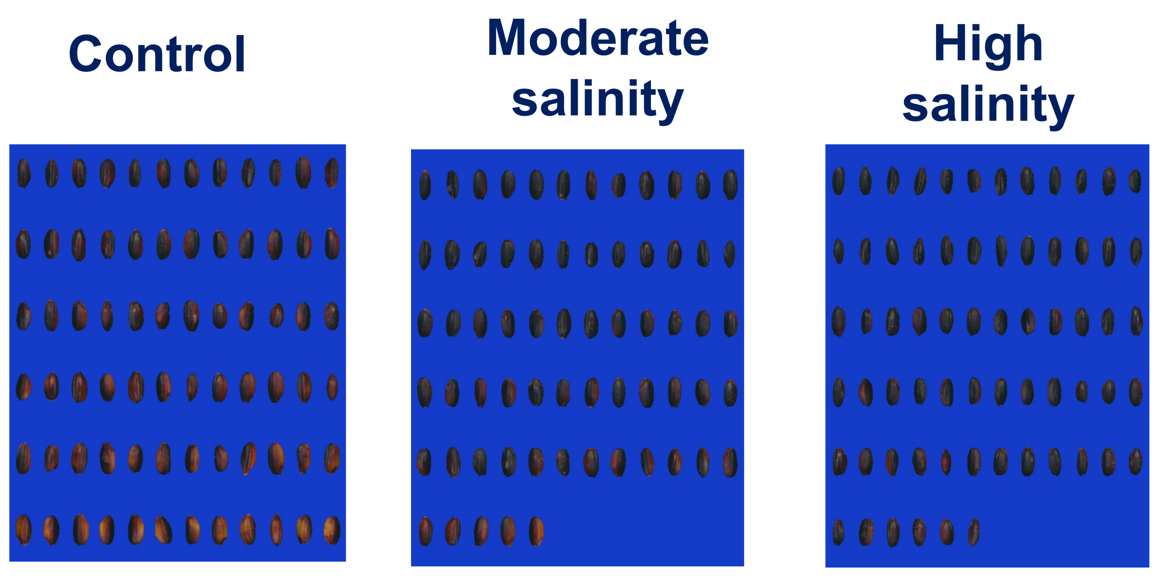


Fig. 3 Black rice grains become darker under salt stress

- Under salt stress, both rice varieties decreased rice yield, but with less reduction under moderate stress: (Fig. 1).
- Salt stress increases phenolic content in black rice but does not affect white rice. (Fig. 2)
- A trade-off between grain yield and grain color stability was observed: an increase in salinity level, an improvement in grain color, but a low yield. (Fig. 3)

Pot experiment 2

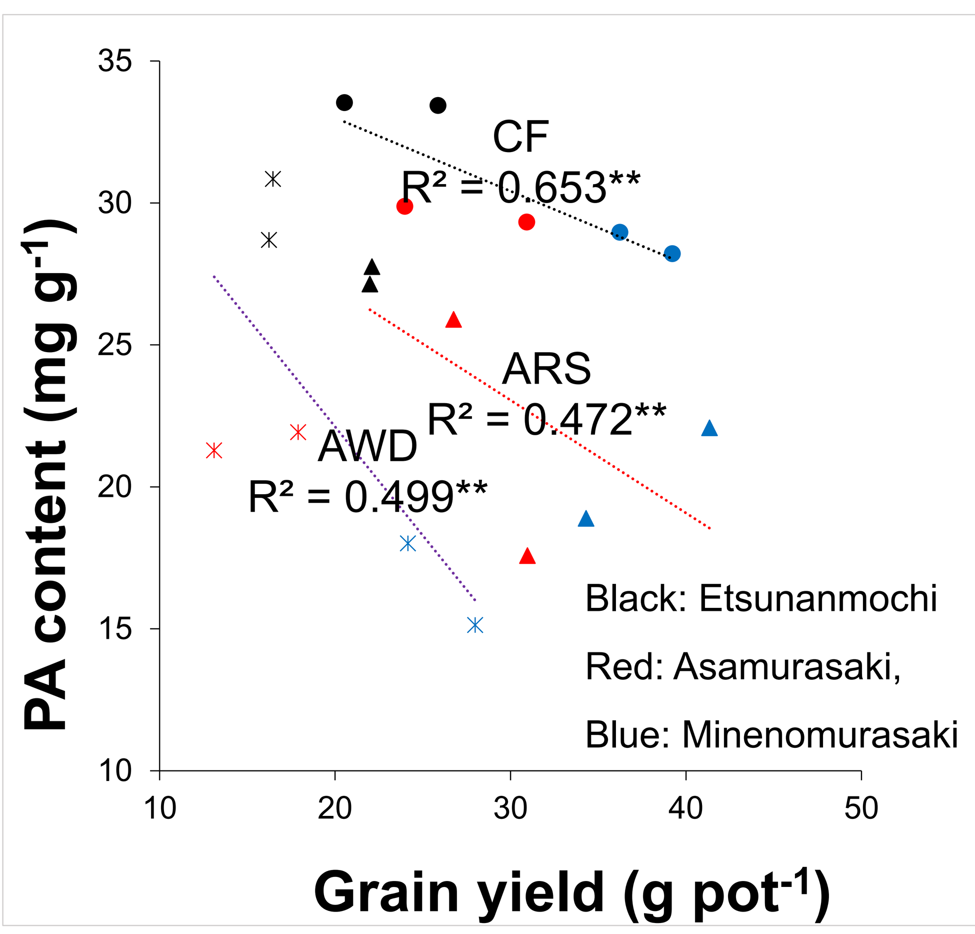


Fig. 4 Grain yield and PA correlation.

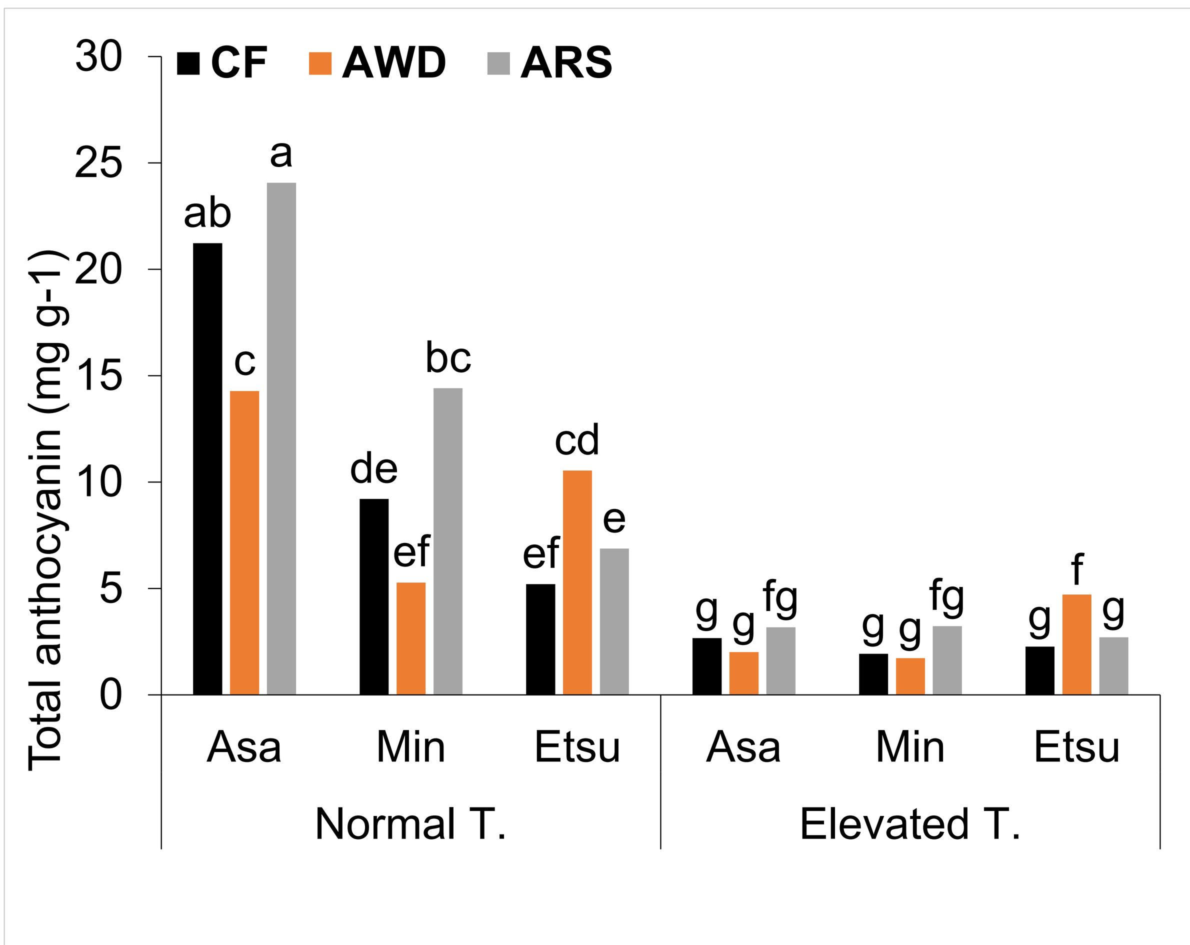


Fig. 5 Grain anthocyanin content.

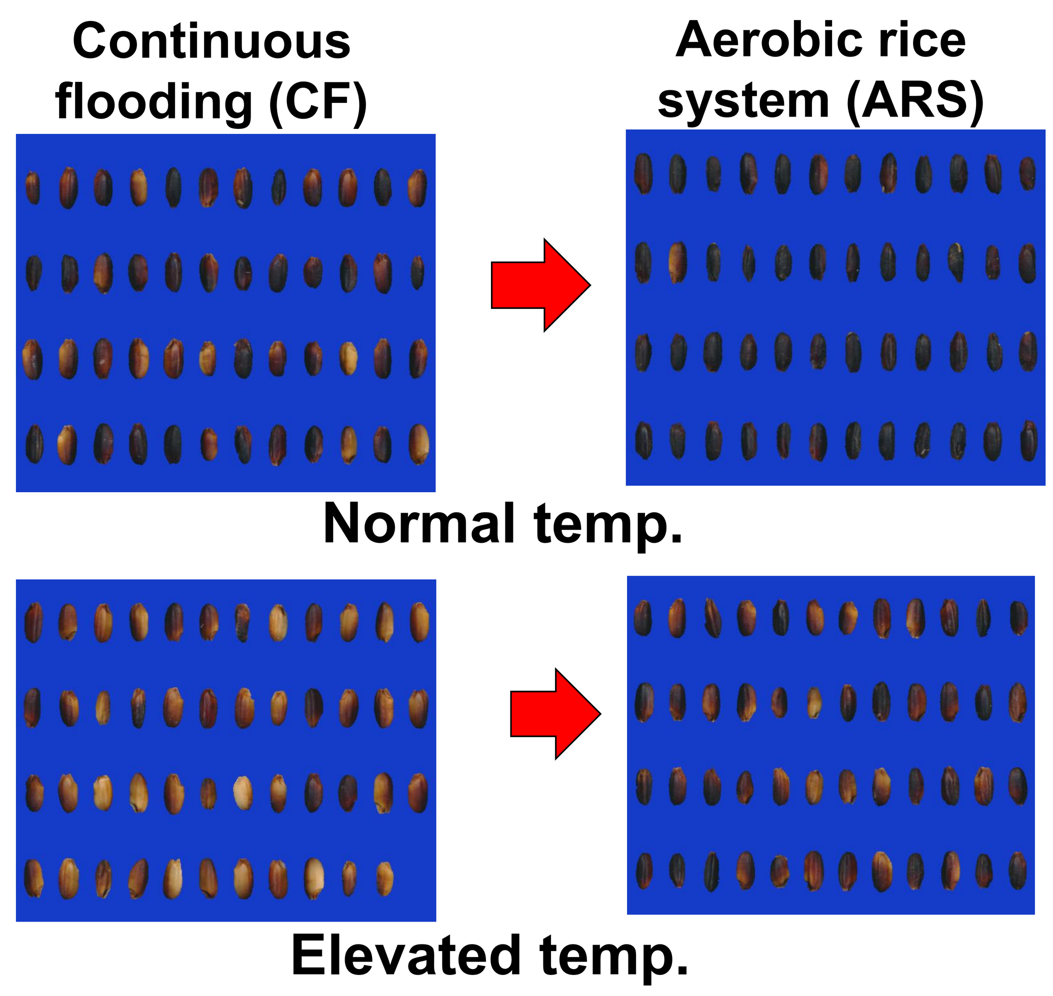


Fig. 6 Grain anthocyanin content of variety Minenomurasaki.

- Aerobic rice maintained high yield while reducing PA content in Minenomurasaki (Fig. 4)
- Aerobic rice increased anthocyanin content, but elevated temperature negatively affected (Fig. 5)
- Aerobic rice improved grain color stability even under elevated temperature conditions (Fig. 6)

Conclusions

- **A trade-off relationship between grain yield and quality in black rice under abiotic stress.**
- **Salt stress enhanced grain anthocyanin and improved grain appearance, while temperature stress had a negative effect.**
- **Black rice grown under the aerobic rice system not only maintains grain yield but also increases anthocyanin and reduces PA content.**
- **Effective exploitation of abiotic stress will be key to balancing grain yield and nutritional quality of black rice.**

Acknowledgements

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