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Mutualistic fungal endophytes produce phytohormones and organic acids that promote japonica rice plant growth under prolonged heat stress

Key words: *Paecilomyces formosus* LWL1, Plant-growth promotion, Heat-stress mitigation, Phytohormones, Organic acids, Endophytes

Research Summary

This study identifies the potential role in heat-stress mitigation of phytohormones and other secondary metabolites produced by the endophytic fungus *Paecilomyces formosus* LWL1 in japonica rice cultivar Dongjin.

Innovation points

- Endophytic association in Heat Stress significantly improved plant growth parameters

Table 1. Plant growth response of japonica rice (*Oryza sativa* L.) cv. Dongjin under no stress (NS) and prolonged heat stress (HS) with or without endophytic *Paecilomyces formosus* LWL1

Treatment	Plant Height (cm)	Fresh Weight (gm)[1]	Dry Weight (gm)[2]	Chlorophyll Content
No Stress (NS)¶				
Control	21.85±1.00	26.89±1.24	1.43±0.08	31.61±1.63
P. formosus LWL1	25.57±0.88*	40.78±0.89*	1.93±0.05*	36.03±1.08*
Heat stress (HS)				
Control	19.86±1.55	18.56±1.29	1.01±0.02	34.09±1.20
P. formosus LWL1	23.43±1.48*	27.90±1.03*	1.49±0.03*	43.23±0.89*

[1] Fresh weight per 30 plants (shoot and root). [2] Dry weight per 30 plants (shoot and root).
¶The effect of *P. formosus* LWL1 on the growth of Dongjin (GAs normal) rice cultivars under normal environmental conditions (no stress) have been previously reported in Waqas *et al.* (2014).
*Significant differences between plants treated with and without *P. formosus* at the $p < 0.05$ level by the Student's *t* test.
The experiment was independently repeated three times and values of respective treatments were pooled together to calculate the means.
In each experimental repetition 30 plants were randomly selected per treatment from three replicates.

Innovation points

- Plants had low abscisic acid (25.71%) and jasmonic acid (34.57%) during endophyte and heat stress

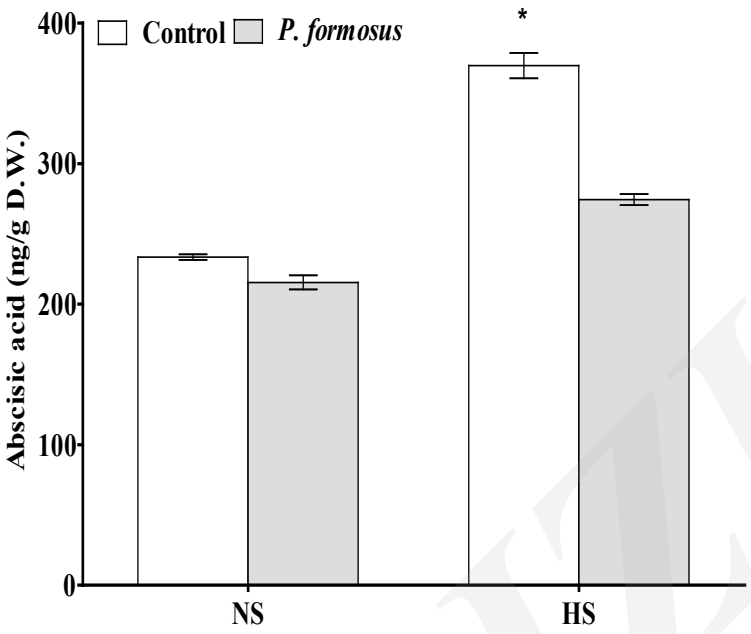

Figure 2.
The major abiotic stress signaling phytohormone abscisic acid (ABA) in japonica rice (*Oryza sativa* L.) cv. Dongjin with or without endophytic *Paecilomyces formosus* LWL1 under no stress (NS) and prolonged heat stress (HS). The ABA was analyzed in freeze-dried samples of 30 randomly collected plants from each of three treatment replicates from three independently conducted experiments. Values of ABA analysis in respective treatments were pooled together to calculate the means± SD. For each set of treatments, the asterisk on error bars indicates significant differences between plants treated with and without *P. formosus* at the $p < 0.05$ level by the Student's *t* test.

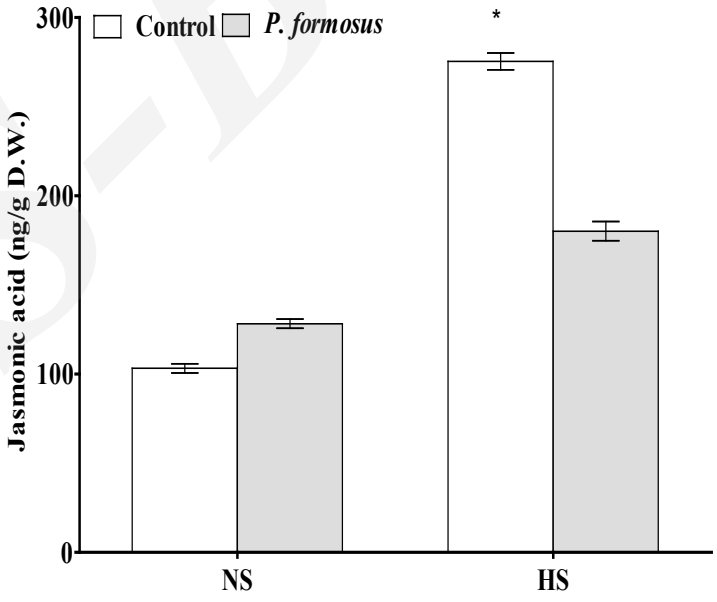

Figure 3.
The phytohormone jasmonic acid (JA) in japonica rice (*Oryza sativa* L.) cv. Dongjin with or without endophytic *Paecilomyces formosus* LWL1 under no stress (NS) and prolonged heat stress (HS). The JA was analyzed in freeze dried samples of 30 randomly collected plants from each of treatments three times replicated in three independently conducted experiments. Values of JA analysis in respective treatments were pooled together to calculate the means± SD. For each set of treatments, the asterisk on error bars indicates significant differences between plants treated with and without *P. formosus* at the $p < 0.05$ level by the Student's *t* test.

Innovation points

Conclusion

- Fungal endophytes can helpful for sustainable crop production under high environmental temperatures.