Fungal Endophyte Infection in Tall Fescue Results in Changes in Root System Architecture in Responses to Phosphorus Availability

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Introduction

Grass-fungal endophyte associations are thought to be based primarily on protection of the host from biotic and abiotic stress (Clay and Schardl 2002). Compared with other major nutrients such as nitrogen (N) and potassium (K), phosphorus (P) is the least mobile and available to plants in soils (Hinsinger 2001). The aim of this work was to determine how endophyte status, including novel and common toxic endophyte varieties, influenced P uptake under high and low P availability in tall fescue. Further, we also focus on the responses of root system architecture (total root length, root surface area, root diameter, number of root hairs and lateral roots) to P deficiency, in an effort to improve our understanding of the endophyte-induced mechanisms of tall fescue survival under abiotic stresses.

Methods

Plants were growing for 3-weeks post germination and then petri dishes containing plants were screened using WinRhizo (Regent Instruments Inc., Ontario, CA) root image analysis software. Root length, surface area, average diameter were recorded using this system.

Results

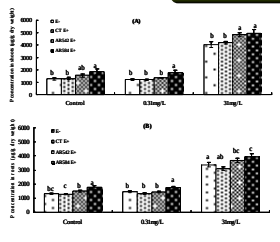

Fig.1. P concentration (μg/mg dry weight) in shoot (A) and root (B) of tall fescue with different endophyte infection statuses (E-, CTE+, AR542E+ and AR584 E+)

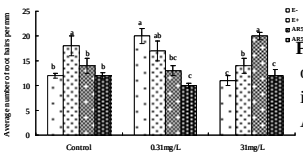

Fig.2. Unit root hair numbers of different endophyte infection statuses (E-, CTE+, AR542E+ and AR584E+)

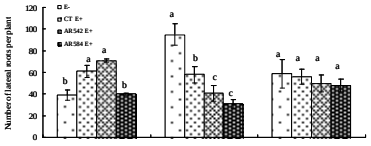

Fig.3. Unit lateral root numbers (value per plant) of different endophyte infection statuses (E-, CTE+, AR542E+ and AR584E+)

Fig.4. Comparison of tall fescue growth under control, low P and High P treatments

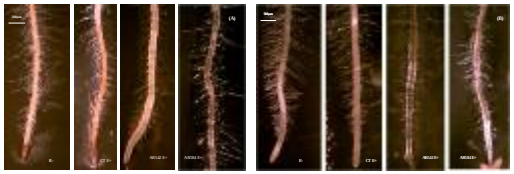

Fig.5. Comparison of root hairs of different endophyte infection statuses (E-, CTE+, AR542E+ and AR584E+) under control (A), low P (B) and high P treatments (C).

Table 1. Shoot and root dry weight (mg) of tall fescue with different endophyte infection statuses (E-, CTE+, AR542 E+ and AR584 E+) under three P treatments (control, 0.31mg/L and 31mg/L)

P level	Endophyte	Shoot (mg)	Root (mg)	Total (mg)	Root:shoot
Control	E-	11.9±1.52 ab	5.3±0.29 b	17.2±2.20 a	0.53 ±0.012a
	CTE+	12.3±0.51 a	7.5±0.40 a	19.8±1.28 a	0.59±0.031 a
	AR542E+	8.3±0.69 b	4.8±0.51 b	13.1±1.98 a	0.55±0.023 a
	AR584E+	15.6±2.18 a	4.9±0.89 b	20.5±5.01 a	0.58±0.012 a
0.31mg/L	E-	15.8±1.02 ab	7.6±0.78 a	23.4±2.23 a	0.58±0.035 ab
	CTE+	16.3±1.53 ab	7.3±0.40 a	23.6±3.53 a	0.50±0.030 a
	AR542E+	12.2±1.43 b	7.7±0.86 a	19.9±2.32 a	0.52±0.036 a
	AR584E+	19.9±1.94 a	9.3±0.66 a	29.2±3.34 a	0.51±0.017 a
31mg/L	E-	22.2±1.94 a	8.4±0.45 a	30.6±1.74 a	0.36±0.025 a
	CTE+	18.7±1.69 a	7.9±0.68 a	26.6±1.91 a	0.40±0.023 ab
	AR542E+	14.9±1.03 b	5.9±0.49 b	20.8±3.65 a	0.39±0.006 a
	AR584E+	11.9±1.75 b	4.8±0.54 b	16.7±3.28 a	0.37±0.013 a
Significance (*P* value)					
P level		0.000**	0.118	0.000**	0.000**
Endophyte		0.288	0.220	0.036*	0.211
P level ×Endophyte		0.306	0.683	0.539	0.073

Conclusions

- In 0.31and 31mg/L P treatments, E- had greater root length, root surface area and lateral roots densities, lower P uptake compared to CTE+, AR542E+ and AR584E+ at the same P concentration.
- Less dry mass (shoot and root dry mass) but greater P uptake occurred in AR584E+ grown compared to E-,CTE+ and AR542E+ in P 31mg/L treatment.
- Endophyte infection status did not affect root average diameter, regardless of P levels.

References

Clay, K., and C. Schardl, 2002: Evolutionary origins and ecological consequences of endophyte symbioses with grasses. Am. Naturalist. 160, 99-127.

Hinsinger, P., 2001: Bioavailability of soil inorganic P in the rhizosphere as affected by root-induced chemical changes: a review. Plant Soil. 237(2), 173-195.

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