Endophyte Effects on Antioxidants and Membrane Leakage in Tall Fescue During Drought

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Introduction Tall fescue [*Festuca arundinacea* (Schreb.)=*Lolium arundinaceum* (Schreb.) S.J. Darbyshire] infected (E+) by its fungal endophyte [(*Neotyphodium coenphialum* Morgan-Jones & Gams.) Glenn, Bacon & Hanlin] often shows greater persistence during summer drought than endophyte-free (E-) plants (Malinowski *et al*., 2005). Survival of the apical meristem and growing zone of vegetative tillers likely involves biochemical adaptations whose benefits to the host are enhanced by endophyte presence. Antioxidant enzymes may scavenge free radicals during heat and drought, and thereby reduce membrane damage. Their roles in endophyte-mediated drought tolerance in tall fescue have not been tested. Our objective was to determine the endophyte influence on antioxidant enzyme activities, membrane leakage, and tiller survival in tall fescue during water deficit.

Materials and methods Two contrasting genotypes of tall fescue, 60 and 330, each with its respective wild-type endophyte genotype, were grown separately in glasshouse trials. In Trial 1, E+ and E- ramets were grown together in replicated plastic dishpans containing sandy-loam soil, and subjected to well-watered or drought-stress treatments. Vegetative tiller bases (2 cm) were sampled at six stages of progressive water deficit (early leaf rolling to complete sheath desiccation) and analysed for activities of ascorbate peroxidase, peroxidase, glutathione reductase, and superoxide dismutase (SOD) activities. In Trial 2, E+ and E- plants were grown in 60-cm deep PVC tubes. Water was withheld, and tiller bases were assayed for membrane leakage, expressed as membrane damage coefficient (Howarth *et al*., 1997), at three stress stages. After complete desiccation, tubes were rewatered, and surviving tillers were counted after one week to quantify percentage tiller survival.

Results There were no effects of water deficit or endophyte infection status on the activities of ascorbate peroxidase, peroxidase, or glutathione reductase. In contrast, SOD activity in both genotypes increased faster in E+ than in E- plants in the stress treatment as water deficit intensified (Figure 1). As expected, membrane leakage was enhanced by withholding water (data not shown). In genotype 60, membrane damage was greater in E- than in E+ stressed plants at the intermediate stress stage (leaf blades severely rolled); however, there was no significant endophyte effect in genotype 330. Tiller survival rates for E+ and E- plants were 32% and 16% (P<0.05), respectively, for genotype 60, and 42% and 20% (P<0.05), respectively, for genotype 330.

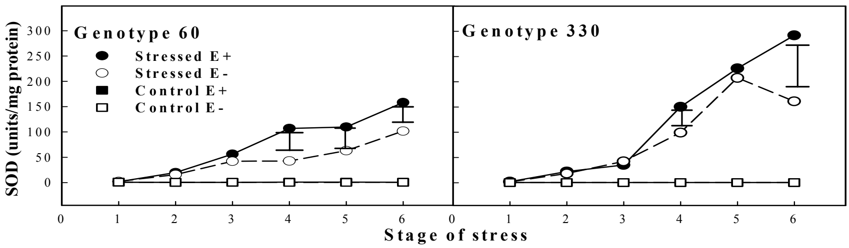

Figure 1 Superoxide dismutase (SOD) activity in (A) genotype 60 and (B) genotype 330. Bars indicate $LSD_{0.05}$. Symbols for control E+ data are under those of the control E- data.

Conclusions Stimulation of SOD activity by endophyte infection was associated with endophyte-enhanced tiller survival across host genotypes, supporting the hypothesis that SOD enhancement serves as a mechanism for endophyte-mediated drought tolerance in tall fescue. Some protection against membrane leakage was observed in one genotype, suggesting involvement of membrane protection in some endophyte-grass associations.

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References

Howarth, C.J., C.J. Pollock, and J.M. Peacock. (1997). Development of laboratory-based methods for assessing seedling thermotolerance in pearl millet. *New Phytologist* 137, 129-139.

Malinowski, D.P., D.P. Belesky, & G.C. Lewis. (2005). Abiotic stresses in endophytic grasses. In: C.A. Roberts, C.P. West, & D. Spiers (eds.) *Neotyphodium* in Cool-Season Grasses. Blackwell Publ., Ames, Iowa, 187-199.