Ecophysiological Responses of Tall Fescue Genotypes to Endophyte Infection and Climate Change

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1 Background

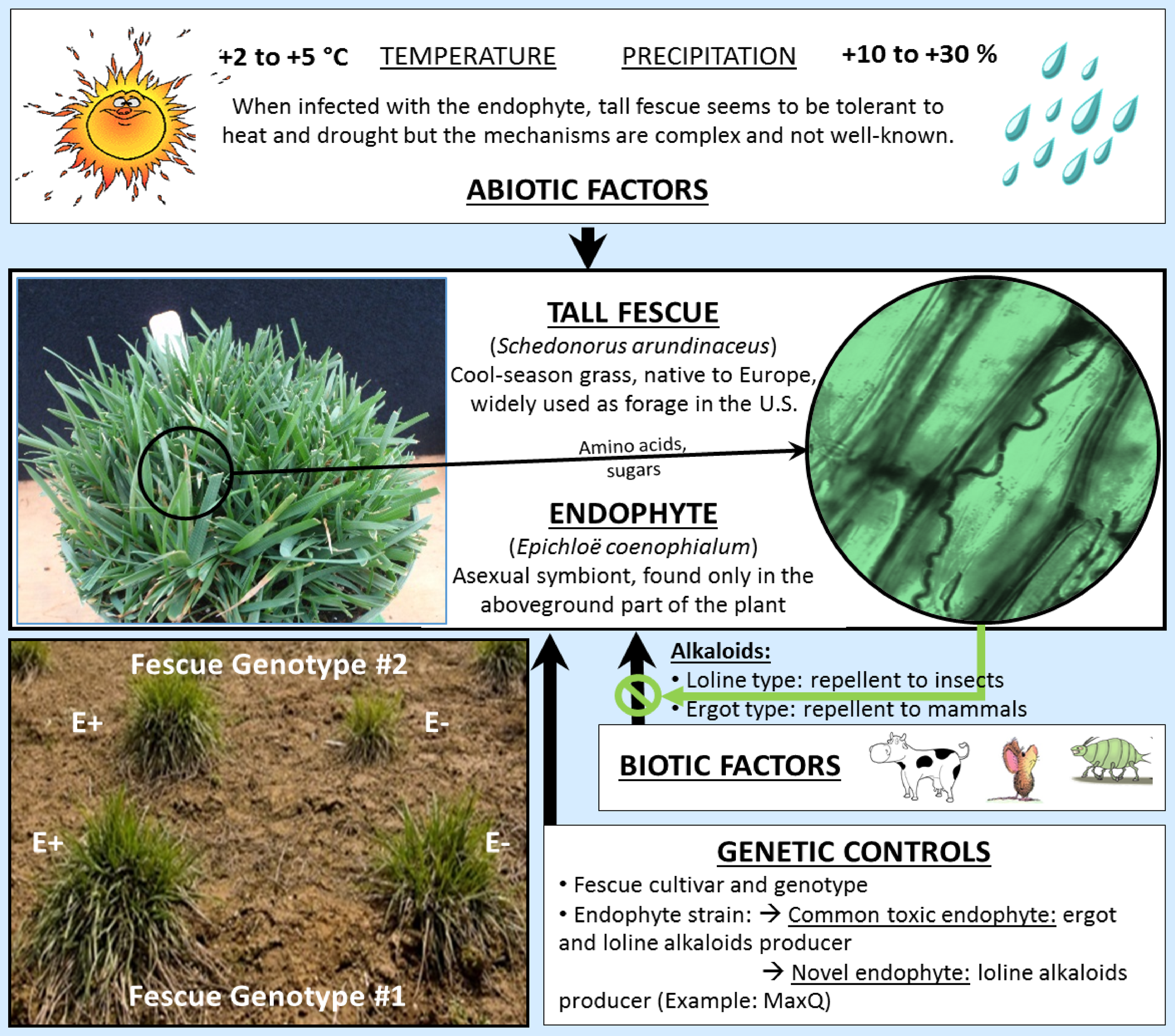

Figure 1: Abiotic, biotic factors and genetic controls on the tall fescue – E. coenophialum symbiosis.

Tall fescue (*Schedonorus arundinaceus*) can form a symbiosis with the fungal endophyte, *Epichloë coenophialum*, whose presence can benefit the plant, depending on plant and fungal genetics and prevailing environmental conditions.

Despite having agricultural, economic and ecological importance, relatively little is known regarding how the symbiosis will respond to predicted climate change. **We evaluated how plant genetics and endophyte presence altered fescue response to predicted changes in climate.**

2 Methods

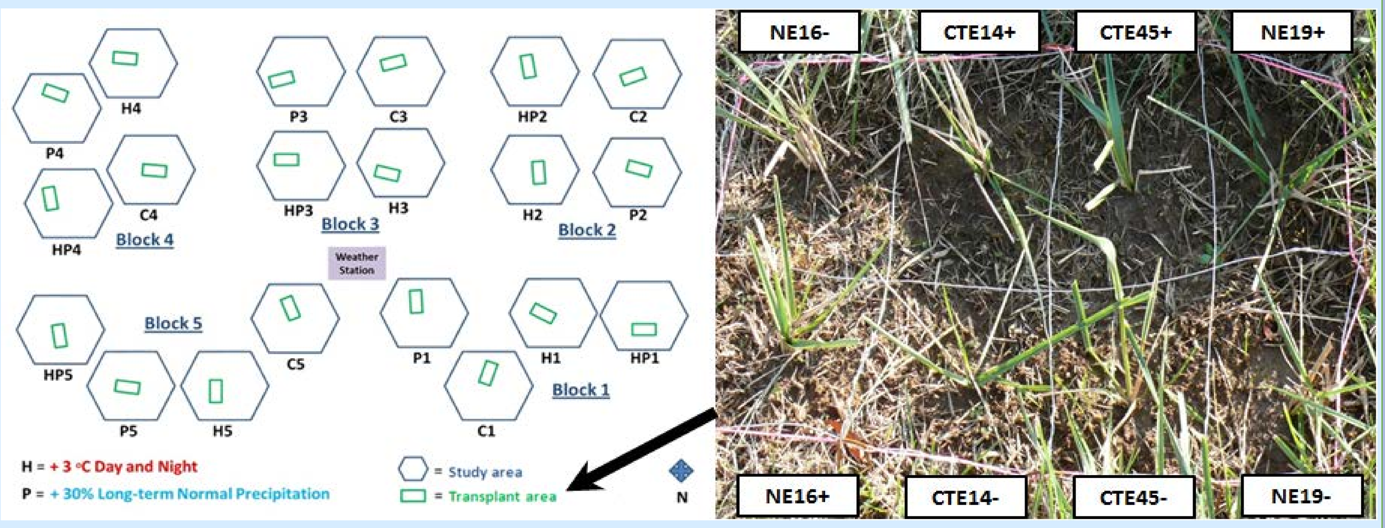

Figure 2: Experiment layout, UKY Research Farm, Lexington, KY.

Genetic clones of four KY-31 derived tall fescue individuals infected with different common toxic (CTE14, CTE45) or novel endophyte (NE16, NE19) strains were developed. Half of the material was treated with Folicur 3.6F to produce genetically identical endophyte-free individuals. Endophyte-infected (E+) and -free (E-) genetic clones were transplanted into an existing 2 x 2 factorial climate change experiment: Control, +Heat (+3°C), +Precip (+30%), +Heat+Precip (+3°C, +30%). The study was a randomized complete block design with five replications. **Photosynthesis, leaf water potential, tiller number, aboveground biomass and ergot and loline alkaloid concentrations** were measured from March to November 2012.

3 Results

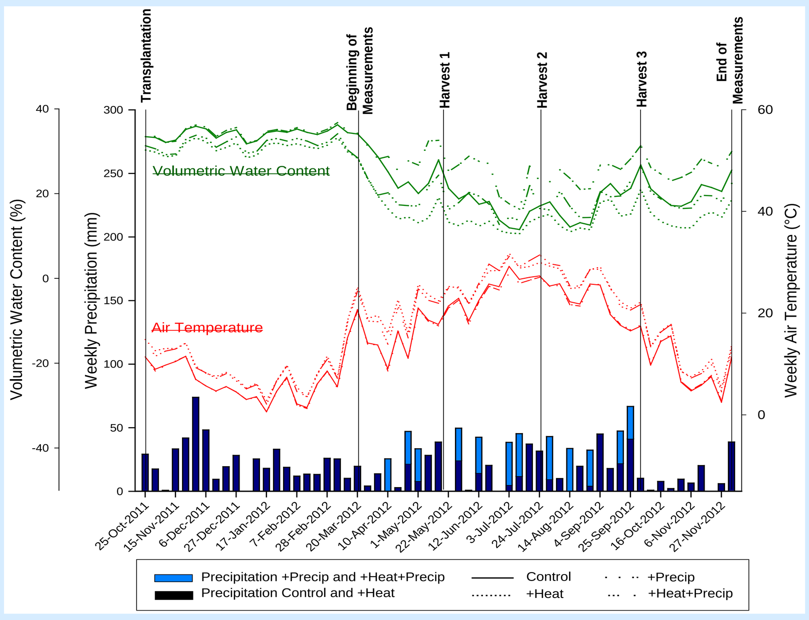

Figure 3: Weekly average air temperature, precipitation, and average volumetric water content for the four climate treatments.

In 2012, environmental conditions were much hotter and drier than usual, affecting water availability. All measured fescue responses, except alkaloid concentrations, were negatively impacted by additional heat, especially in the summer.

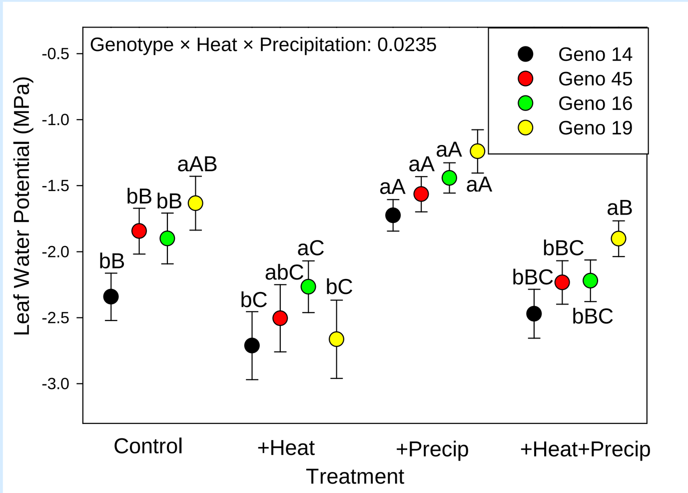

Figure 4: Averaged across the study leaf water potential of endophyte-free fescue for each genotype and each climate treatment. Within a climate treatment, points with different lower case letters are statistically different across genotypes; whereas capital letters denote significant differences between treatments within the same genotype

Plant Genetic Controls:

- Genotype 19 was more responsive to the climate change treatments than the other fescue genotypes. The response of leaf water potentials and tiller production to climate change varied across studied genotypes (Fig. 4).
- Elevated heat and additional precipitation tended to reduce tiller production, but the degree varied by genotype (not shown).

Fescue Genotype Variability:

- Endophyte infection greatly stimulated aboveground biomass production in CTE14, but had no significant effect on the other genotypes (Fig. 5-A).
- For tiller production, the same endophyte-associated stimulation was observed for both symbiotic genotypes CTE14 & NE19 (Fig. 5-B).

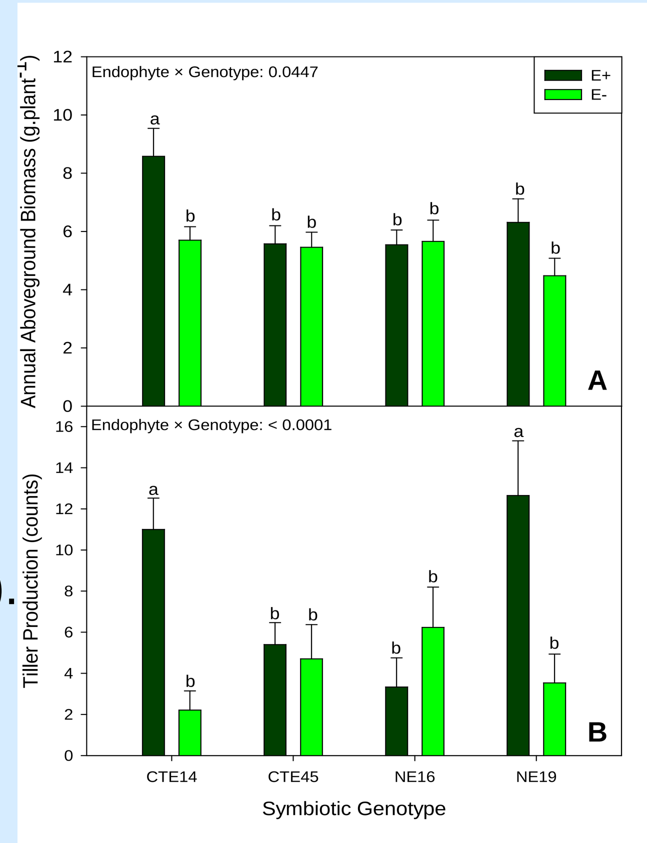

Figure 5: Aboveground biomass (A) and tiller production (B) for E+ and E- fescue, averaged across fescue genotypes, averaged across climate treatments. Letters indicate significant differences within a panel.

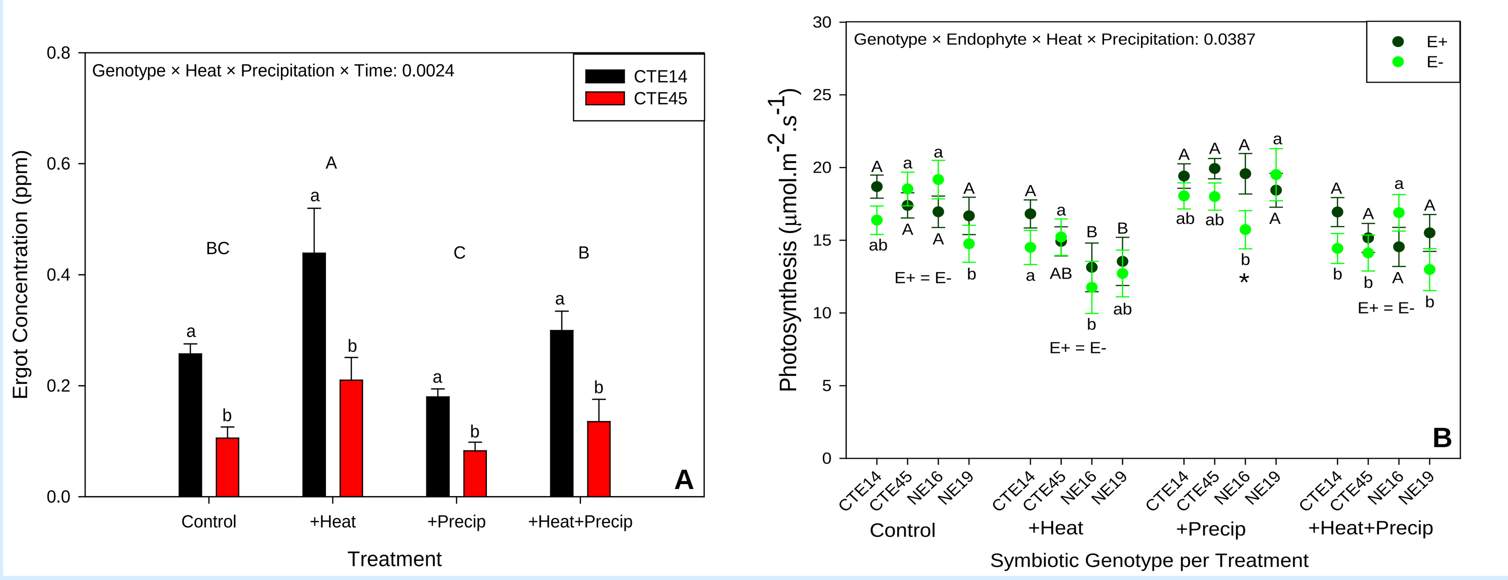

Figure 6: Ergot alkaloids or two fescue genotypes infected with a common toxic strain of endophyte (A) and photosynthesis rates of E+ and E- fescue for all four genotypes (B) in each climate treatment and averaged across the year, 2012. Lower case letters indicate significant differences between genotypes (A) or endophyte status (B) within a climate treatment; whereas capital letters illustrate differences across climate treatments (A) or genotypes (B).

Fescue-Endophyte Symbiosis Variability:

- Ergot alkaloid concentrations were stimulated by elevated heat for genotypes infected with a common toxic form of the endophyte (Fig. 6-A). Effects of the +Heat and +Precip treatments appeared to be additive.
- Photosynthesis was the most sensitive parameter measured, with all experimental factors significantly affecting it (Fig. 6-B). Elevated precipitation and endophyte presence increased overall photosynthesis, whereas warming conditions negatively affected it, but these responses were genotype dependent.

4 Conclusion

We hypothesized that fescue ecophysiological responses to climate change factors would vary across plant genotypes and depend on *Epichloë* presence. We predicted that endophyte infection would not confer the same degree of environmental stress tolerance to all fescue genotypes. Our results support these suppositions.

When averaged across the growing season, photosynthesis rates were significantly impacted by elevated heat and increased precipitation but in contrasting ways depending on the fescue genotype and endophyte status. Often, E+ individuals performed better than E-, except for leaf water potential, which was never influenced by endophyte presence. Endophyte infection conferred different levels of environmental stress tolerance to the different fescue genotypes.

Overall, this study suggests that choice of plant and endophyte genetic material will be important in determining the productivity and resilience of fescue pastures under future climate conditions.

5 Acknowledgements

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DOE National Institute for Climatic Change Research