Physiological Characteristics and Molecular Basis of Heat Tolerance in Agrostis *species*

Bingru Huang
Rutgers University

Objectives:

1. To determine the physiological characteristics of thermal *Agrostis rossiae* and *A. scabra* exposed to high soil temperatures.
2. To compare the portfolios of heat-inducible proteins expressed in the thermal species, non-thermal species, and commercial cultivars, and advanced breeding lines of creeping bentgrass, and to identify potential candidates for proteins involved in the thermotolerant phenotype.
3. Identify and isolate heat-inducible genes responsible for heat tolerance in the thermal bentgrass species. The genes expressed to a greater extent in thermotolerant grass may be used for transformation of creeping bentgrass.

Start Date: 2003
Project Duration: three years
Total Funding: $90,000

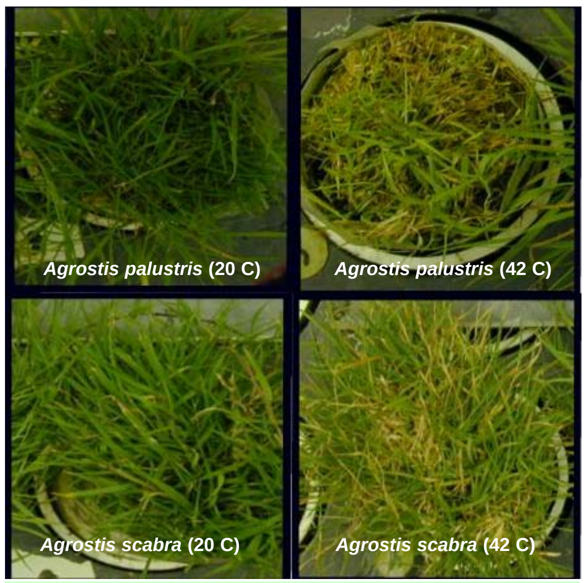
We conducted a growth chamber study to address the first objective in 2003. Specifically we aimed to 1) compare heat tolerance of two geothermal *Agrostis* species with creeping bentgrass, widely used species on golf courses and 2) determine physiological factors associated with tolerance to elevated soil temperature.

The study examined thermal *Agrostis scabra*, non-thermal *Agrostis scabra*, *A. rossiae*, and *Agrostis palustris* cv. L-93. Grasses were grown in sand in plastic bags, which allowed for proper drainage, and placed in water baths. Soil temperatures were 20 (control), 35, and 40 C, while air temperature was held at 20 C. Treatments were imposed for 70 days.

Plants were measured for quality, canopy temperature, chlorophyll content, chlorophyll fluorescence, photosynthesis, stomatal conductance, transpiration, and root number at 5-, 15-, and 30-cm deep each week. Upon completion of the project, plants were harvested and measured for root dry weight and root activity.

After 10 days, all plants grown at 42 C had lower chlorophyll content than plants grown at 35 and 20 C. Differences in chlorophyll content between 35 and 20 C were not significant. Both ecotypes of thermal *A. scabra* had greater chlorophyll content than other *Agrostis* species at 35 C. Canopy temperature for all species at 35 and 42 C increased over time as much as 6 and 8 C, respectively.

Thermal *Agrostis scabra* ecotypes had lower canopy temperatures than other *Agrostis* species after 25 days of 42 C. Photosynthesis rate, transpiration rate, and stomatal conductance decreased for all species and ecotypes over the course of the study. This decrease was most pronounced in a non-thermal *A. scabra* ecotype. This ecotype had the highest photosynthesis rate at 20 C.



Plants after 55 days of soil treatment. Agrostis palustris *at 20 (top left) and 42 C (top right) and* A. scabra *at 20 (bottom left) and 42 C (bottom right).*

Differences between species were most pronounced early in the treatment period at 35 C. One ecotype of thermal *A. scabra* had the greatest conductance and transpiration rate early in the study at 35 C. The non-thermal *A. scabra* ecotype had the greatest photosynthesis rate over the first 25 days, but decreased rapidly thereafter.

Total root number for all species decreased over time at 35 and 42 C. Both non-thermal and thermal ecotypes of *A. scabra* had greater root number than other *Agrostis* species. Root distribution in thermal *A. scabra* ecotypes changed during the treatment period at 35 C. New roots were produced 5 cm below the crowns, while roots at 15 and 30 cm below crowns decreased dramatically. High root numbers for non-thermal *A. scabra* were relics of inactive roots as evidenced by root activity data. Root activity was greatest in both thermal ecotypes of *A. scabra* and *A. rossie*. Root dry weight data showed the same trends as root number data, which indicates many of the remaining roots in non-thermal species of *Agrostis* were not functioning.

These physiological measurements showed that thermal *Agrostis scabra* species had superior tolerance to elevated soil temperatures. These species had a better cooling mechanisms and produced large numbers of roots at 5 cm at 35 C soil temperature, while root growth declined for creeping bentgrass.

Summary Points

- The study examined thermal *Agrostis scabra*, non-thermal *Agrostis scabra*, *A. rossiae*, and *Agrostis palustris* cv. L-93.
- After 10 days, all plants grown at 42 C had lower chlorophyll content than plants grown at 35 and 20 C. Both ecotypes of thermal *A. scabra* had greater chlorophyll content than other *Agrostis* species at 35 C.
- Photosynthesis rate, transpiration rate, and stomatal conductance decreased for all species and ecotypes over the course of the study. This decrease was most pronounced in a non-thermal *A. scabra* ecotype.
- Total root number for all species decreased over time at 35 and 42 C. Both non-thermal and thermal ecotypes of *A. scabra* had greater root number than other *Agrostis* species. Root dry weight data showed the same trends as root number data.