Investigations into the Cause and Management of Etiolation on Creeping Bentgrass Putting Greens

David Ritchie and Joseph A. Roberts
North Carolina University

Start Date: 2012
Project Duration: 3 years
Total Funding: $69,600

Turfgrass and Environmental Research Online
Volume 14, Number 2 | March—April 2015

Objectives:

1. *Isolate and identify bacteria and other microorganisms associated with etiolated creeping bentgrass.*
2. *Determine if bacteria associated with etiolated bentgrass produce gibberellic acid or modulate its production by turf plants.*
3. *Investigate the influence of biostimulant and growth regulator programs on bentgrass etiolation.*

Bacterial etiolation has developed into a significant problem on creeping bentgrass putting greens in the U.S. and research has implicated bacteria, *Acidovorax avenae* and *Xanthomonas translucens*, as causal agents. Symptoms often coincide with changing weather conditions and are more prevalent with frequent rainfall. In rare cases, bacterial etiolation can develop into a decline that causes severe necrosis and thinning of turfgrass stands.

To combat this growing phenomenon, we initiated a comprehensive research program to determine the cause and to develop management programs for etiolation on creeping bentgrass. Since 2010, we have isolated 228 bacteria from 64 locations representing numerous bacteria genera including several species of *Acidovorax, Bacillus, Enterobacter, Microbacterium, Pantoea, Pseudomonas, Stenotrophomonas and Xanthomonas* (Figure 1). Out of all submitted samples, plant pathogenic bacteria (i.e., *Acidovorax* and *Xanthomonas*) have been present in less than 30% of samples. The wide range of bacteria genera isolated suggests that additional bacteria are involved. Initial research examining *Pantoea* sp. has shown some isolates to cause chlorosis and dieback, thus reducing turf quality, but other isolates were not different than the control (Figure 2). *Pantoea* bacteria did not cause bacterial etiolation when compared to A. avenae inoculations. Continued research will explore the diversity of bacteria living within turfgrass ecosystems and evaluate other potential pathogens.

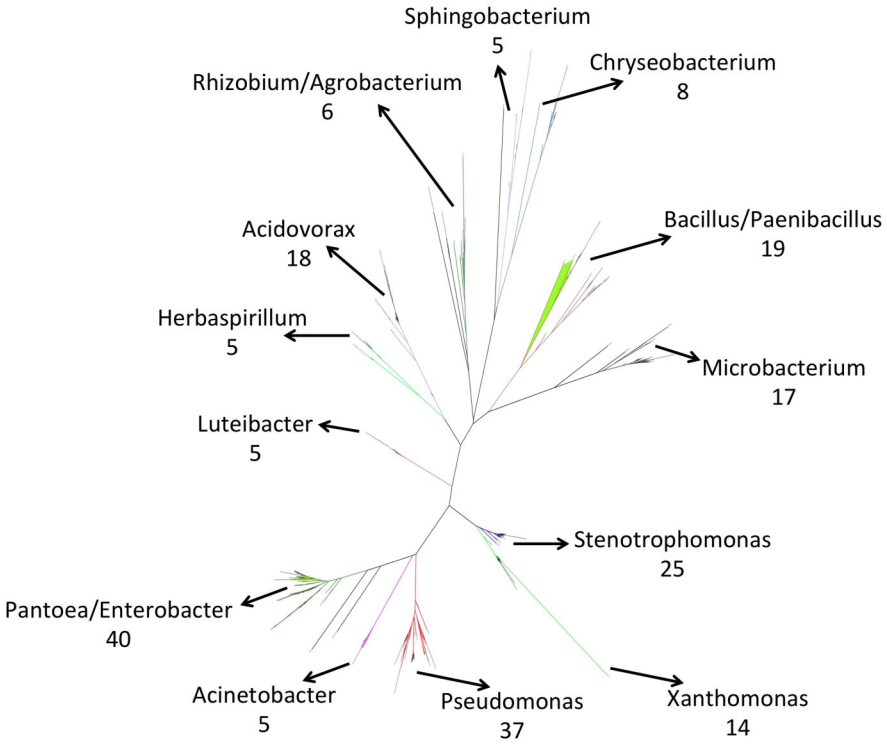

Figure 1. Phylogenetic analysis of isolated bacteria associated with bacterial etiolation and/or decline in creeping bentgrass. Samples represent diverse bacteria genera and number designations refer to the number species isolated within each genera.

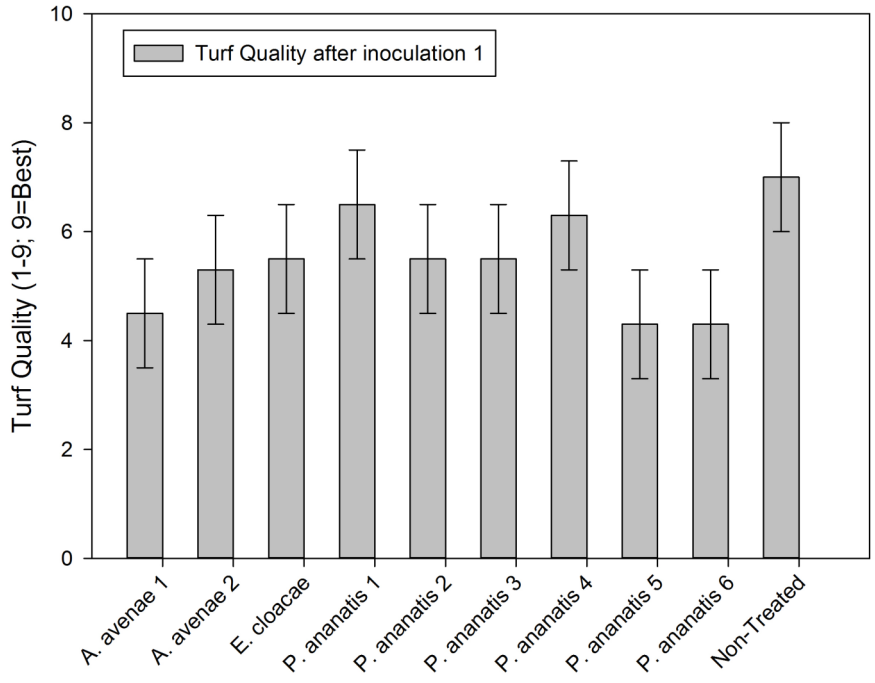

Figure 2. Turf quality of 'A-1' creeping bentgrass 6 d after inoculation with bacterial species. Turf was inoculated with each bacterium and quality was rated on a scale of 1-9 with 9=best. Error bars represent Tukey's Honest Significant Difference at the 0.05 probability level.

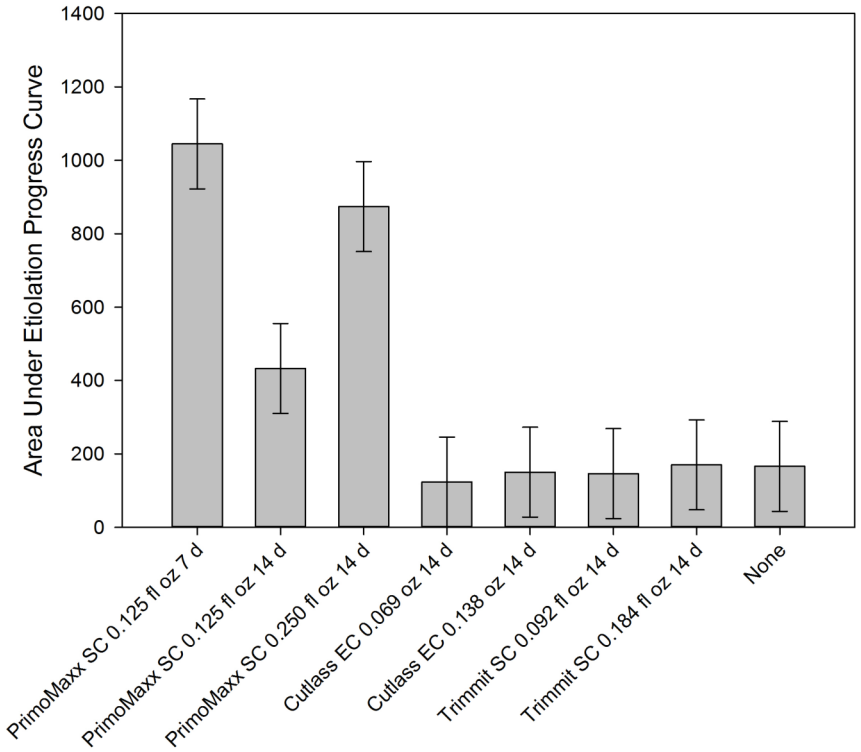

Figure 3. Impact of plant growth regulators on bacterial etiolation caused by Acidovorax avenae in 2013. Etiolation is presented as area under etiolation progress curve values, which represent a season-long measure of etiolation for each treatment. Error bars represent Tukey's Honest Significant Difference at the 0.05 probability level.

Field observations of bacterial etiolation have suggested that biostimulant and plant growth regulator applications could exacerbate symptom development. While our research showed biostimulants to have little effect, frequent applications of trinexapac-ethyl (PrimoMaxx at 0.125 fl oz. 1000 ft-2 every 7 d) increased etiolation caused by *A. avenae*. In 2013, an additional field study was initiated to evaluate the impact of plant growth regulators (trinexapac-ethyl, flurprimidol, and paclobutrazol) on bacterial etiolation caused by A. avenae. Results from the 2-yr trial were similar to previous trials in that trinexapac-ethyl increased symptoms compared to the non-treated control; however, multiple rates of flurprimidol (Cutless EC at 0.069 oz. or 0.138 oz. 1000 ft-2 every 14 d) and paclobutrazol (Trimmit SC at 0.092 fl oz. or 0.184 fl oz. 1000 ft-2 every 14 d) decreased etiolation symptoms compared to trinexapac-ethyl (0.125 fl oz. 1000 ft-2 every 7 d) applications (Figure 3). Trinexapac-ethyl applications still resulted in the highest turf quality, as bacterial decline did not occur as a result of *A. avenae* inoculations. High rates of flurprimidol and paclobutrazol did cause phytotoxicity during periods of low nighttime temperatures, but turf eventually recovered. Based on this research, altering plant growth regulator programs with either chemistry can maintain competitive playing conditions while limiting potential increases in bacterial etiolation.

Figure 5. Close-up of bacterial etiolation caused by *Acidovorax avenae.*

The nature of bacterial etiolation symptoms and the response observed with varying plant growth regulator applications has suggested the involvement of phytohormones (i.e., increased gibberellins that result in elongated plants). Recent research to evaluate bacteria with an enzyme linked immunosorbent assay (ELISA) has shown production of gibberellic acid (GA3) by *A. avenae* in the laboratory (Figure 4). Future research utilizing chemical analysis through chromatography methods will improve our knowledge of phytohormone production by all bacteria capable of causing etiolation symptoms.

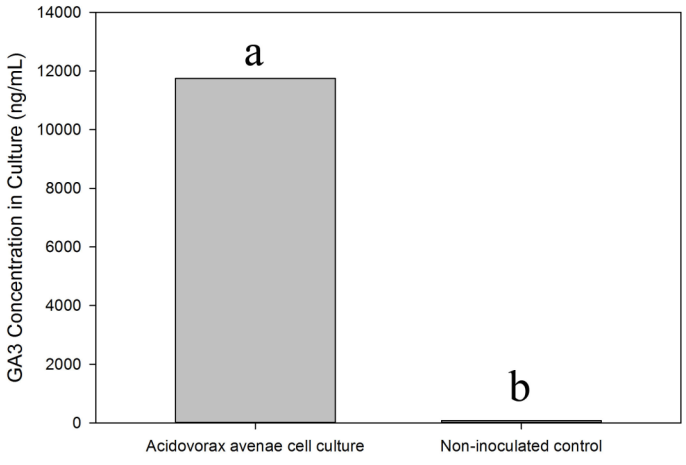

Figure 4. RR_{50}-values (LD_{50} resistant/ LD_{50} susceptible) obtained in the different types of bioassays: Petri dishes assay (PDA), greenhouse assay (GHA) and topical assay (TA).

Summary Points:

- Diverse bacteria have been isolated from creeping bentgrass putting green samples exhibiting symptoms of bacterial etiolation and/or decline
- While previous research has shown *Acidovorax avenae and Xanthomonas translucens* to cause bacterial etiolation, additional screening has shown that some Pantoea sp. can cause chlorosis and tip dieback.
- If etiolation is problematic, reducing the frequency of trinexapac-ethyl applications or altering plant growth regulator programs with flurprimidol or paclobutrazol can maintain competitive playing conditions while limiting etiolation.
- *Acidovorax avenae* has been shown to produce gibberellic acid in culture, which is a possible cause of etiolation symptoms. Further research is necessary to evaluate phytohormone production in bacteria capable of inducing bacterial etiolation symptoms.