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

David Ritchie and Joseph A. Roberts
North Carolina State University

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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.*

Etiolation of creeping bentgrass has recently emerged as a significant problem on golf course putting–green turf. In 2010, Giordano et al. reported etiolation of creeping bentgrass to be caused the bacteria *Acidovorax avenae*. Since then, numerous reports of etiolation have been cited throughout the U.S. Symptoms are often transient and associated with the pervading weather conditions. In some cases, bacterial etiolation has progressed to a chronic problem leading to thinning turf and death during stressful summer periods.

In 2011, we initiated a comprehensive research program to determine the cause and to develop management programs for etiolation on creeping bentgrass. Over the past 3 years, we have isolated 188 bacteria from 64 locations. Identification using 16S and ITS rDNA sequences has successfully identified bacteria representing 16 genera including several species of *Pseudomonas, Microbacterium, Pantoea, Bacillus, Acidovorax,* and *Xanthomonas*. Inoculation tests have shown additional bacteria, such as *Xanthomonas translucens*, to cause etiolation of creeping bentgrass. Further research to examine how bacteria cause etiolation is ongoing. Due to the nature of this phenomenon, it is believed that etiolation could be due to the increased production of plant hormones, such as gibberellic acid. Certain species of bacteria have been shown previously to produce plant hormones. Experiments are underway to evaluate individual bacteria capable of causing etiolation for their ability to produce plant hormones directly and indirectly by altering the plant physiology.

Figure 1. Etiolation on creeping bentgrass, c.v. 'Dominant' caused by *Xanthomonas translucens*.

A field study was initiated in fall 2011 to evaluate the impact of biostimulants and trinexapac–ethyl on etiolation. The trial was arranged as a factorial design with biostimulants (Knife Plus, CytoGro, Astron, and Nitrozyme) applied alone and in combination with weekly or biweekly applications of trinexapac–ethyl (0.125 fl oz 1000 ft–2) and a non–treated control. While biostimulants showed no effect on etiolation during the fall of 2011,

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trinexapac–ethyl significantly reduced etiolation regardless of application frequency (Table 1). However, biweekly trinexapac–ethyl treatments did break down at the end of the 2–wk period. The study was repeated throughout the growing seasons in 2012 and 2013 with treatments applied from early April to October in both years. The entire plot area was inoculated with *Acidovorax avenae* to encourage uniform etiolation. Biostimulants rarely influenced etiolation during the summer months of both years; however, trinexapac–ethyl applied weekly and biweekly increased etiolation compared to control plots and the increase was observed regardless of biostimulant evaluated (Table 1). Trinexapac–ethyl treatments also exhibited the best turf quality on multiple dates throughout the study (data not shown). Etiolation was not observed during September or October in 2012 or 2013. Additional research is underway to examine differences in etiolation observed in the fall and summer months related to growth regulator applications.

Figure 2. Etiolation observed in greenhouse inoculation trials; turf on the right (labeled 10–I–X) was inoculated with *Xanthomonas translucens* while the turf on the left (labeled 10–I) was non–inoculated.

Table 1. Etiolation of creeping bentgrass as influenced by biostimulant and trinexapac–ethyl applications in 2011, 2012, and 2013

	Rate	AUEPC†		
Treatment	oz 1000 ft^{-2}	2011	2012	2013
Biostimulant‡				
Knife Plus	1.0	516.8	316.2	463.8
CytoGro	0.4	352.1	318.1	404.7
Astron	2.0	544.1	443.4	467.2
Nitrozyme	0.4	472.1	353.6	505.6
Non–treated control		440.3	297.5	388.8
Trinexapac–ethyl§				
Weekly	0.125	64.4 b¶	446.9 a	849.0 a
Biweekly	0.125	149.1 b	349.6 b	337.7 b
Non–treated control		1181.8 a	240.7 c	151.1 c
Source of Variation		*Pr* > *F*		
Biostimulant		NS††	NS	NS
Primo Interval		***	***	***
Bio*Primo		NS	NS	NS

***Significant at the 0.001 probability level
†Area under etiolation progress curve calculated using the trapezoidal method
‡Biostimulant treatments were applied every 14 d from early Sept. to late Oct. 2011 and early Apr. to early Oct. 2012 and 2013
§Trinexapac–ethyl was applied at the designated intervals from early Sept. to late Oct. 2011 and early Apr. to late Sept. 2012 and 2013
¶Means followed by the same letter are not significantly different according to Tukey´s HSD (0.05)
††NS, not significant

Summary Points

- Multiple species of bacteria have been associated with etiolation and or general decline of creeping bentgrass putting green turf.
- Inoculation tests have shown both A. avenae and *X. translucens* to cause etiolation in creeping bentgrass.
- Research is underway to determine whether *A. avenae* or *X. translucens* produce plant hormones or plant hormone analogs that may be causing etiolation.
- While trinexapac–ethyl can provide better turf quality, applications can increase and decrease etiolation depending on weather conditions, turfgrass physiological state, or other unknown factors. Further research is needed to determine how trinexapac–ethyl can be used to maintain turf quality without impacting etiolation development.

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