The Use of Microbial Inoculants to Improve Abiotic Stress Tolerance in Warm and Cool-Season Turfgrasses

David Jespersen and Mussie Habteselassie, University of Georgia

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Introduction:

Reducing damage from abiotic stresses is critical for maintaining quality and performance on golf courses. Particularly during summer months, where heat and drought stress can cause damage and reduce performance of high value greens. On potential strategy is the use of microbial products, which promise to improve plant performance and soil health, while reducing inputs. Adaptive Symbiotic Technologies is one such company that has developed microbial products, including fungal endophytes and bacterial suspensions, which have shown some promise to improve plant performance, and a desire to utilize their products in turfgrass systems. There is however a need to test these products to confirm their ability to promote more resilient and sustainable turf areas.

Objectives:

The objectives of this study are to test the ability of microbial inoculant products to improve stress tolerance on fine turf areas. This will be accomplished through multiple sub-objectives including:

1: Testing of products in controlled environments for improvement of (1a) heat tolerance in creeping bentgrass and (1b) drought tolerance in bermudagrass and zoysiagrass

2: Testing of products in field conditions to determine if similar effects are found in real world conditions for both (2a) heat tolerance and summer performance in creeping bentgrass and (2b) improved drought performance on ultradwarf bermudagrass.

3: Understanding mechanisms responsible for improved stress tolerance including (3a) changes in plant physiology and (3b) microbial composition and function

Results and Progress:

Due to timing, the field trial was prioritized in order to complete data collection during the summer months, while controlled environment experiments are less time sensitive due to the ability to adjust growing conditions. Field trials were performed at UGA-Griffin for estimating the ability to reduce heat stress damages on a ‘Pure Eclipse’ creeping bentgrass green, and drought damages on a ‘TifEagle’ ultradwarf bermudagrass green.

Trials were initiated on June 8th, 2023. Applications at the labeled rate for BioEnsure, BioTango, and the combined BioEnsure + BioTango, as well as a water control, were applied every two weeks. The experiments were laid out as a randomized complete block design with

four replicates. Prior to treatment application data collection was performed on both trials. Measurements included: Visual turf quality ratings, Digital image analysis to estimate percent green cover, and NDVI measurements to estimate overall turf performance. Additionally, electrolyte leakage measurements were performed to estimate membrane stability and overall cell damage, as well as relative water content to estimate leaf water status. Soil cores were taken to measure soil microbial communities and activities.

On August 11th, bermudagrass irrigation was reduced by 50% to induce more severe drought damages, with soil water content falling to 5% (VWC). On August 15th the air movement fans were turned off on the bentgrass green to induce more severe summer stress. The final date of data collection was October 3rd, 2023.

For the bermudagrass trial declines in overall quality (Fig. 1A) and relative water content (Fig. 1B) were seen in all treatments, with notable drought stress when irrigation was reduced. However, preliminary analysis indicates that while there were significant changes over time (i.e. the accumulation of drought related damages), there were no statistical differences among treatments for turfgrass performance or soil microbial processes (Tables #1). Although, there is some data to still be processed, so analysis is preliminary.

A similar finding was found for the bentgrass green, with there generally being declines in overall quality (Fig 2A) and greater membrane damage (Fig 2B) as the season progressed due to the accumulation of damage. Again, there was not a significant treatment effect, and the biological products had no obvious effects on overall turfgrass performance.

Analysis for the field trial will be completed in the coming weeks, including microbial assays. Controlled environment experiments, which will include testing bermudagrass and zoysiagrass under drought conditions, and bentgrass under heat stress conditions, will be performed in the winter of 2023/2024. Currently, plants are establishing in the greenhouse for testing (Fig. 3).

Conclusions:

Preliminary analysis indicates that the tested microbial products may not provide the extensive benefits which have been previously claimed. However, experiments are ongoing, and controlled environment experiments may help reduce confounding variables that interfere with results and help answer if these products have the potential to be used in turfgrass systems. Working with microbial products does hold potential benefits for the turfgrass industry, but the diversity of specific products and complex environmental interactions make critical assessment a challenge.

Figures:

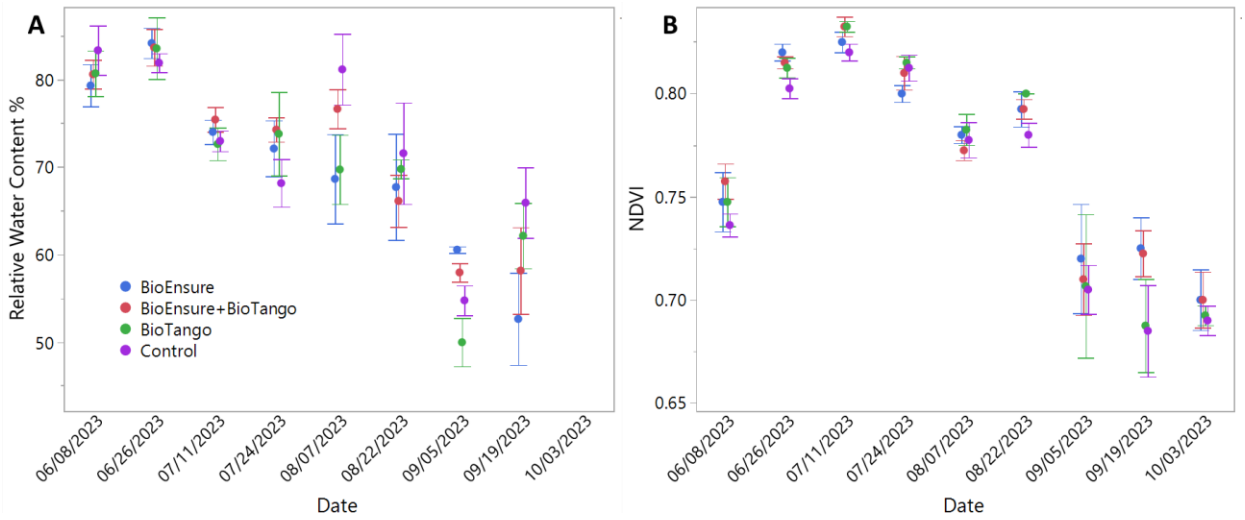

Figure 1: Results for (A) relative water content and (B) normalized difference vegetation index from the 2023 bermudagrass trial testing microbial products' effect on drought performance.

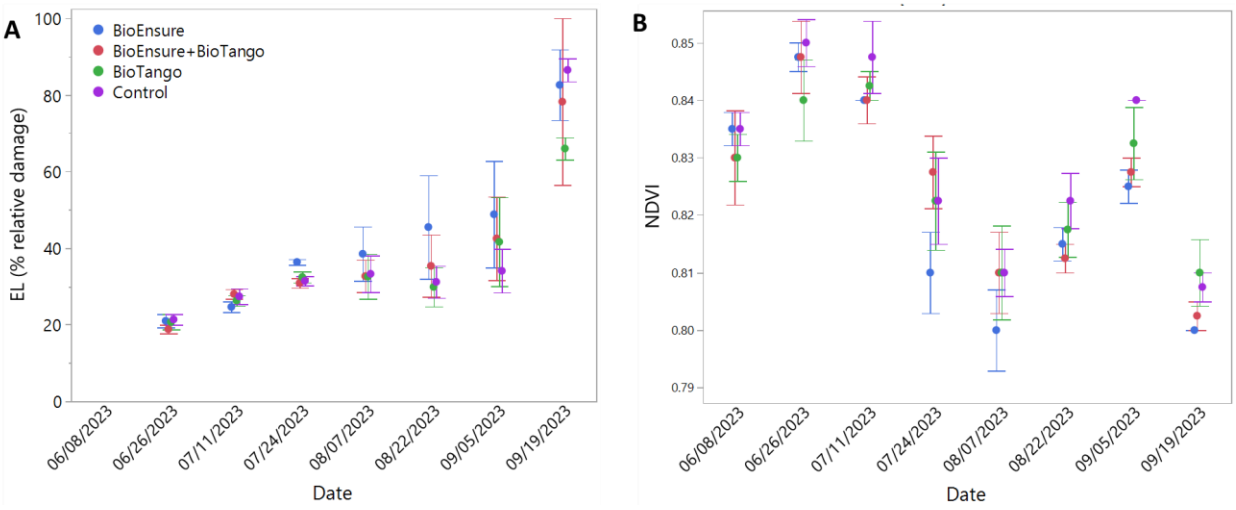

Figure 2: Results for (A) electrolyte leakage and (B) normalized difference vegetation index from the 2023 creeping bentgrass trial testing microbial products' effect on performance during summer heat stress.

Table 1: Preliminary statistical analysis for the 2023 trials

	Bermudagrass			Bentgrass		
	Relative Water Content	NDVI	Soil Respiration	Electrolyte Leakage	NDVI	Soil Respiration
Treatment	N.S. ($p = 0.87$)	N.S. ($p = 0.517$)	N.S. ($p = 0.77$)	N.S. ($p = 0.99$)	N.S. ($p = 0.80$)	N.S. ($p = 0.84$)
Date	$p < 0.001$	$p < 0.001$	-	$p < 0.001$	$p < 0.001$	-
Treatment*Date	N.S. ($p = 0.23$)	N.S. ($p = 0.91$)	N.S.	N.S. ($p = 0.94$)	N.S. ($p = 0.84$)	N.S.

Figure 3: Establishing plants for testing by Masters student Chiara Ammaturo.