

**Title:** Growth and Stress Tolerance of Hybrid Bermudagrass in Response to Stimulagro

**Location:** Plant Science Greenhouse Complex, University of Georgia, Athens, GA

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### **Materials and Methods:**

'Tifway 419' hybrid bermudagrass (1-year old) was sodded on July 23, 2015 into 6-inch diameter circular pots (1 gallon volume) filled with a 2:1 ratio of a sandy clay loam soil and sand (medium particle size) with a pH of 6.1. A starter fertilizer (6-21-2) was applied to the turfgrass canopy at 1 lb N/1000 ft<sup>2</sup> at sodding and watered in with 0.25 inches of water. Plants were allowed to grow in the greenhouse for one month. During establishment and trial conduction, all pots were mowed at 1.5 inches (2 times per week) and received approximately 1 inch of water per week. One month after sodding and just prior to treatment application, four pots were destructively harvested in order to confirm rooting uniformity and distribution. The trial was arranged in a randomized complete block design with four replications of treatments. Three pots of each treatment within each replication were used in order to conduct a time-lapsed harvest over an 8 week period.

Treatments were initiated on August 27, 2015 and consisted of an untreated check (no fertility), starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup>, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A, and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup>. Treatments were applied by hand using a shaker jar or with a CO<sub>2</sub> pressurized backpack sprayer calibrated to deliver 40 GPA at 32 PSI. A sequential application of all treatments were made one month after initial applications (September 25, 2015).

Visual ratings of turfgrass color and turfgrass quality were recorded at the initiation of the trial (August 27, 2015) and weekly thereafter on a scale of 1 to 9. NDVI (Normalized Difference Vegetative Index) was also recorded to indicate turfgrass health and vigor throughout the trial. Turfgrass color, turfgrass quality, and NDVI ratings were converted to change over time ( $\Delta$ ) in order to account for slight differences between pots at trial initiation. Pots were destructively harvested at 4 and 8 weeks after treatment (WAT). Root length (inches) was measured and photographs were taken to compare treatments. Above-ground (shoot) and below-ground (root) tissue were separated, dried in an oven, and weighed to determine biomass (grams). At 8 WAT (October 26, 2015), the remaining pots of each treatment were subjected to acute drought stress. Visual turfgrass color and turfgrass quality ratings along with NDVI readings were recorded 3, 7, 11, 14, and 18 days after drought initiation. Clippings (anything above the 1.5 inch mowing height) were harvested 3, 7, 11, and 14 days after drought initiation. Clippings were weighed when fresh and again once dried in order to determine leaf moisture content.

### **Results and Discussion:**

Initial applications were made on August 27, 2015. All pots were assessed with respect to turfgrass color, turfgrass quality, and NDVI on August 27, 2015. Initial turfgrass color ranged from 6.87 to 6.92, while initial turfgrass quality ranged from 6.79 to 6.96 and initial NDVI ranged from 0.71 to 0.72. Turfgrass color (TC), turfgrass quality (TQ), and NDVI ratings were converted to change over time ( $\Delta$ ) in order to account for slight differences between pots at trial initiation.  $\Delta$ TC,  $\Delta$ TQ, and  $\Delta$ NDVI will be discussed. For the first month, all treatments

consistently had slight reductions in  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$  except starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A which exhibited no change or a slight increase in  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$ .

A destructive harvest was conducted on September 25, 2015. The untreated check pots resulted in root length of 8.6 inches (Fig 1.). Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> exhibited shorter roots (7.9 inches) than the untreated check, while starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A resulted in root lengths of 9 and 8.9 inches, respectively. Untreated check pots may have exhibited longer root lengths than several treatments, because the mature sod contained enough carbohydrate reserves to stimulate root extension through the soil profile in search of additional nutrients. On September 25, 2015 the untreated check pots exhibited root weight of 0.38 g. Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> was the only treatment that resulted in less roots (0.33 g) than the untreated check. The greatest root weight (0.5 g; 32% increase compared to the untreated check) was observed in response to starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A, while starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> treatments exhibited root weights of 0.43 g (13% increase compared to the untreated check). All treatments exhibited shoot weights greater than the untreated check pots (14.9 g). The greatest shoot weight (17.8 g; 19% increase compared to the untreated check) was observed in response to starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup>, while starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup>, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A, and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A resulted in shoot weights of 15, 15.4, and 15.7, respectively. Although the starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> treated pots exhibited the greatest shoot growth, they also exhibited the least root growth; therefore, this treatment may have stimulated too much shoot growth at the expense of root growth.



**Fig. 1:** Turfgrass roots at 1 month harvest. From left to right: untreated check (no fertility), starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup>, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> +

Stimulagro at 2.5 pts/A, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A, and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup>.

A second application of all treatments was made on September 25, 2015 to remaining pots. Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A, and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> all performed better than or equal to the untreated check pots through October 15, 2015. However, only starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A exhibited a greater increase in  $\Delta$ NDVI (0.041 on October 8, 2015 and 0.048 on October 15, 2015) compared to the untreated check (0.029 on October 8, 2015 and 0.03 on October 15, 2015). Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> performed worse than the untreated check with regards to  $\Delta$ TC,  $\Delta$ TQ, and  $\Delta$ NDVI from September 25, 2015 until the 2<sup>nd</sup> harvest on October 26, 2015. On October 23, 2015  $\Delta$ NDVI for starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A was 0.069, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A was 0.025, and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> was 0.034, while  $\Delta$ NDVI for the untreated check was 0.021 and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> was 0.01.

A destructive harvest was conducted on October 26, 2015. The untreated check pots resulted in root length of 9.75 inches (Fig 2.). All other treatments exhibited longer roots than the untreated check pots: starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> (10.25 inches), starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A (10.5 inches), starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A (11.375 inches), and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> (11.375 inches). On October 26, 2015 the untreated check pots exhibited root weight of 0.43 g. Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> was the only treatment with root weight (0.35 g) less than the untreated check. The greatest amount of roots was produced in response to starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> (0.6 g; 40% increase compared to the untreated check) followed by (fb) starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A (0.52 g; 21% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A (0.49 g; 14% increase compared to the untreated check). All treatments exhibited shoot weights greater than the untreated check pots (13.6 g). The greatest shoot weight (19.3 g; 42% increase compared to the untreated check) was observed in response to starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A (16.2 g; 19% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> (15.3 g; 13% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> (14.6 g; 7% increase compared to the untreated check).



**Fig. 2:** Turfgrass roots at 2 month harvest. From left to right: untreated check (no fertility), starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup>, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A, starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A, and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup>.

On October 26, 2015, the remaining pots were subjected to an acute drought scenario for 18 days. Rain and excessive cloud cover for several days immediately following the initiation of the drought may have prolonged adequate TC, TQ, and NDVI of turfgrass pots. All treatments exhibited a reduction in  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$  3 days after drought initiation (October 29, 2015). Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A had the least reduction and only exhibited reductions of  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$  of -0.125, -0.125, and -0.025, respectively. All treatments exhibited greater clipping weight production than the untreated check (1.15 g fresh weight). The greatest fresh clipping weights were in response to starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A (1.68 g; 46% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> (1.5; 30% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A (1.47 g; 29% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> (1.28 g; 11% increase compared to the untreated check). Comparison of fresh and dry weights did not reveal any differences in moisture content compared to the untreated check 3 days after drought initiation.

By 7 days after drought initiation (November 2, 2015), all treatments exhibited reductions in  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$  that were less or equal to the untreated check. Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A had the least reduction and only exhibited reductions of  $\Delta TC$  and  $\Delta TQ$  of -0.25 and -0.125, respectively. An increase in  $\Delta NDVI$  (0.0025) was reported in response to this treatment as well. All treatments exhibited greater clipping weight production than the untreated check (0.515 g fresh weight). The greatest fresh clipping weights were in response to starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A (0.68 g; 33% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> (0.64 g; 24% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> (0.59; 15% increase compared to the untreated check) and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at

5 pts/A (0.59 g; 15% increase compared to the untreated check). Comparison of fresh and dry weights did not reveal any differences in moisture content compared to the untreated check 7 days after drought initiation.

By 11 days after drought initiation (November 6, 2015), all treatments exhibited reductions in  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$  that were less than the untreated check. Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> had the least reduction and only exhibited reductions of  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$  of -0.125, -0.625, and -0.025, respectively. All treatments exhibited greater clipping weight production than the untreated check (0.455 g fresh weight). The greatest fresh clipping weights were in response to starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> (0.72 g; 58% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A (0.68 g; 49% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A (0.67 g; 47% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> (0.49; 8% increase compared to the untreated check). Comparison of fresh and dry weights revealed an increase in leaf moisture between all treatments and the untreated check 11 days after drought initiation. Leaf tissue of untreated check pots contained 53% moisture, while treated pots exhibited 60 to 62% moisture, regardless of treatment.

By 14 days after drought initiation (November 9, 2015), all treatments exhibited reductions in  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$  that were less than the untreated check. Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A had the least reductions and only exhibited reductions of  $\Delta TC$ ,  $\Delta TQ$ , and  $\Delta NDVI$  of -0.25, -0.5, and -0.0675; and -1.25, -0.5, and -0.065, respectively. All treatments except starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> (0.11 g fresh weight) exhibited greater clipping weight production than the untreated check (0.12 g fresh weight). The greatest fresh clipping weights were in response to starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A (0.24 g; 100% increase compared to the untreated check) and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A (0.24 g; 100% increase compared to the untreated check) fb starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> (0.22; 83% increase compared to the untreated check). Comparison of fresh and dry weights revealed an increase in leaf moisture between all treatments (except starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup>) and the untreated check 14 days after drought initiation. Leaf tissue of untreated check pots and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> contained 33% and 30% moisture, respectively; while all other treated pots exhibited 41 to 46% moisture, regardless of treatment.

By 18 days after drought initiation (November 13, 2015), all pots were no longer exhibiting adequate TC, TQ, or NDVI ratings. Untreated check pots exhibited TC of 1.375, TQ of 2.25, and NDVI of 0.41. Starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 2.5 pts/A and starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + Stimulagro at 5 pts/A were the best performing treatments at the conclusion of the trial. Both treatments exhibited a TC of 3.125 to 3.375 (-3.6225 to -3.75  $\Delta TC$ ), a TQ of 3.25 (-3.625 to -3.875  $\Delta TQ$ ), and an NDVI of 0.4925 to 0.5 (-0.2175 to -0.2375  $\Delta NDVI$ ). Although starter fertilizer (6-21-2) at 1 lb N/1000 ft<sup>2</sup> + AQM Seaweed Extract (AquaAid) at 3oz/1000 ft<sup>2</sup> exhibited a similar NDVI and  $\Delta NDVI$  as the Stimulagro treatments, it only exhibited a TC of 2.5 (-4.25  $\Delta TC$ ) and a TQ of 2.25 (-4.5  $\Delta TQ$ ).