

ORIGINAL ARTICLE

Applied Turfgrass Science

Nutrition of Florida lawns when summer fertilizer blackout period is enforced

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Assigned to Associate Editor Chase Straw.

Funding information

National Institute of Food and Agriculture, Grant/Award Number: Hatch project FLA FTL 005959

Abstract

In Florida, multiple counties restrict the application of N to turfgrass and landscapes during the summer rainy season. These summer fertilizer blackout periods could impact turfgrass quality and the functionality of warm-season turfgrass species. A 2-year study was conducted at the University of Florida's Fort Lauderdale Research and Education Center (FLREC) and West Florida Research and Education Center (WFREC) to assess turfgrass performance of 'Floritam' and 'Classic' St. Augustinegrass [*Stenotaphrum secundatum* (Walter) Kuntze] as well as 'Empire' and 'Palisades' zoysiagrass (*Zoysia japonica* Steud.), respectively, receiving no N fertilization during summer blackout period using eight fertilization programs compared to an unfertilized control. Visual quality, normalized difference vegetation index, percentage green cover, and dark green color index were assessed biweekly. Roots were collected before and after the fertilizer blackout period to determine root dry weight. While no differences were detected in St. Augustinegrass at the FLREC and zoysiagrass at the WFREC, all fertilized treatments except urea reached and maintained an acceptable turfgrass quality (≥ 6) throughout the blackout period, suggesting that urea by itself was not sufficient to support an optimal turfgrass performance during a fertilizer blackout period. The addition of P to nutrition programs did not influence turfgrass quality. Results indicate that N source is the most important factor to sustain turfgrass quality year-round in Florida.

Plain Language Summary

Fertilizer "blackout periods" are periods where it is prohibited to apply fertilizer, instituted to prevent the leaching of plant nutrients into water bodies. However, their effect on turfgrass health has not been extensively studied. In our research, we investigated eight different fertilizer programs that were applied outside the

Abbreviations: CRN, controlled release nitrogen; DGCI, dark green color index; FLREC, Fort Lauderdale Research and Education Center; NDVI, normalized difference vegetation index; WFREC, West Florida Research and Education Center.

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summer blackout fertilizer period. Results indicate that N fertilization during the spring is essential to maintain turfgrass health when summer fertilizer blackout periods are enforced. However, older turfgrass stands could sustain turfgrass quality with limited to no N applications year-round.

1 | INTRODUCTION

Since peak growth potential for warm-season turfgrasses is reached during midsummer, summer fertilization is recommended to achieve a healthy and visually appealing lawn (Christians et al., 2016). University of Florida nutrition recommendations for turfgrass divide the state into three geographical regions with recommended annual N rates for St. Augustinegrass and zoysiagrass, ranging from 4 to 6 lb N 1000 ft⁻² yr⁻¹ and 2.5 to 4.5 lb N 1000 ft⁻² yr⁻¹ respectively in south Florida, and from 2 to 4 lb N 1000 ft⁻² yr⁻¹ and 2 to 3 lb N 1000 ft⁻² yr⁻¹, respectively in north Florida (Trenholm et al., 2021; Unruh et al., 2022). In recent years, many counties and municipalities have implemented fertilizer bans or fertilizer “blackout periods,” which restrict the application of fertilizer during the summer rainy season (Hochmuth et al., 2012; Ryan et al., 2019). The implementation of fertilizer bans during periods of active turfgrass growth raises concerns. For turfgrass grown in north and central Florida, fertilizer applications would be restricted to fall, winter, and early spring, when turfgrass is semi-dormant or dormant (Shaddox et al., 2016).

In Florida, St. Augustinegrass is the most widely used warm-season lawn species because it adapts well to most soils and climate regions and is more tolerant to shaded conditions than other warm-season species (Trenholm & Unruh, 2007; Trenholm et al., 2021). Zoysiagrass, which could be used on golf courses and residential and commercial lawns, is gaining popularity as a valuable turfgrass option in Florida due to adaptability to the state’s environmental conditions and low nutritional requirements (Patton et al., 2017). As local counties and municipalities implement stricter nutrient rules, research is needed to understand the effect of fertilizer blackout periods on turfgrass performance. The objective of this study was to assess the impact of eight nutrition programs on the yearly turfgrass performance of St. Augustinegrass and zoysiagrass with no fertilization applied during the summer blackout period.

1.1 | Site description and maintenance

A 2-year study was conducted in 2021 and 2022 at the University of Florida’s Fort Lauderdale Research and Education Center (FLREC) and West Florida Research and Education

Center (WFREC) in Jay, FL. At the FLREC, treatments were applied to a mature stand of ‘Floritam’ St. Augustinegrass and a 2-month-old ‘Empire’ zoysiagrass grown on a Hallandale fine sand (Siliceous, isohyperthermic Lithic Psammaquent) with a pH of 7.5 and 3.4% organic matter (OM) content at 4-inch depth. At the WFREC, treatments were applied to 4-year-old stands of ‘Classic’ St. Augustinegrass and ‘Palisades’ zoysiagrass grown on a Fuquay loamy sand (a loamy, kaolinitic, thermic Arenic Plinthic Kandudults) with a pH of 6.2 and an OM content of <4% at a 4-inch depth. At both sites, turfgrass was mowed weekly at 3.5 inches for St. Augustinegrass and 2 inches for zoysiagrass. All plots, except the control, were treated for prevention of disease (Propiconazole), insects (Bifenthrin and Chlorantraniliprole), and weeds (Prodiamine, Dithiopyr, Simazine). Plots were irrigated as needed to prevent drought stress.

1.2 | Nutrition treatments

Treatments consisted of eight nutrition programs compared to an unfertilized control. The fertilizer blackout period lasted from May 15 to October 31 at FLREC and from June 1 to September 30 at WFREC. At FLREC, Programs 1 to 4 were applied at equal rates in March, April, May, and November to St. Augustinegrass (Table 1), and in March, May, and November to zoysiagrass (Table 2). Programs 5 and 6 were applied monthly outside the blackout period (Table 1 and 2), and Programs 7 and 8 were applied in February, April, May, and December (Table 1 and 2). At WFREC, Programs 1 to 4 were applied at equal rates in April, May, October, and November to St. Augustinegrass (Table 3), and in April, May, and October to zoysiagrass (Table 4). Programs 5 and 6 were applied to St. Augustinegrass in February, March, April, May, October, and November (Table 3), while zoysiagrass was fertilized in April, May, October, and November (Table 4). and Programs 7 and 8 were applied in January, March, May and November (Table 3 & 4). At both locations, Programs 5 and 7 received five annual applications of Fe at 2.5 fl oz 1000 ft⁻² and May fertilization consisted of 50% controlled release N (CRN), while Programs 6 and 8 received five annual applications of Fe at 2.5 fl oz 1000 ft⁻² and May fertilization consisted of 65% CRN. Fertilizer sources applied in both years at both locations are presented in Supplemental Table S1 to S2.

T A B L E 1 Monthly and total annual fertilizer rates (lb N-P₂O₅-K₂O 1000 ft⁻²) for 'Floritam' St. Augustinegrass grown in Ft. Lauderdale, FL, in 2021 and 2022.

Treatment	Jan.	Feb.	Mar.	Apr.	May	June-Sep.	Oct.	Nov.	Dec.	Total annual
	—lb N-P ₂ O ₅ -K ₂ O 1000 ft ⁻²									
Control	—	—	—	—	—	—	—	—	—	—
Program 1	—	—	0.7-0-0	0.7-0-0	0.7-0-0	—	—	0.7-0-0	—	2.8-0-0
Program 2	—	—	0.7-0.23-0.47	0.7-0.23-0.47	0.7-0.23-0.47	—	—	0.7-0.23-0.47	—	2.8-0.9-1.9
Program 3	—	—	0.7-0-0.38	0.7-0-0.38	0.7-0-0.38	—	—	0.7-0-0.38	—	2.8-0-1.5
Program 4	—	—	0.7-0.23-0.47	0.7-0.23-0.47	0.7-0.23-0.47	—	—	0.7-0.23-0.47	—	2.8-0.9-1.9
Program 5	0.17-0-0.23	0.17-0-0.23	0.7-0-0.32	0.31-0-0.46	2-0-0.92	—	—	0.7-0-0.32	0.17-0-0.23	4.2-0-2.2
Program 6	0.17-0-0.23	0.17-0-0.23	0.7-0-0.38	0.31-0-0.46	2-0-0.26	—	—	0.7-0-0.38	0.17-0-0.23	4.2-0-2.6
Program 7	—	0.31-0-0.46	—	1-0-0.79	2-0-0.92	—	0-0-0.46	—	0.17-0-0.23	3.5-0-2.8
Program 8	—	0.31-0-0.46	—	1-0-0.84	2-0-0.26	—	—	—	0.17-0-0.23	3.5-0-1.8

T A B L E 2 Monthly and total fertilizer rates (lb N-P₂O₅-K₂O 1000 ft⁻²) for 'Empire' zoysiagrass grown in Ft. Lauderdale, FL, in 2021 and 2022.

Treatment	Jan.	Feb.	Mar.	Apr.	May	June-Sep.	Oct.	Nov.	Dec.	Total annual
	—lb N-P ₂ O ₅ -K ₂ O 1000 ft ⁻²									
Control	—	—	—	—	—	—	—	—	—	—
Program 1	—	—	0.7-0-0	—	0.7-0-0	—	—	0.7-0-0	—	2.1-0-0
Program 2	—	—	0.7-0.23-0.47	—	0.7-0.23-0.47	—	—	0.7-0.23-0.47	—	2.1-0.7-1.4
Program 3	—	—	0.7-0-0.38	—	0.7-0-0.38	—	—	0.7-0-0.38	—	2.1-0-1.1
Program 4	—	—	0.7-0.23-0.47	—	0.7-0.23-0.47	—	—	0.7-0.23-0.47	—	2.1-0.7-1.4
Program 5	0.17-0-0.23	0.17-0-0.23	0.7-0-0.23	0.31-0-0.46	1-0-0.46	—	—	0.31-0-0.46	0.17-0-0.23	2.8-0-2.3
Program 6	0.17-0-0.23	0.17-0-0.23	0.7-0-0.38	0.31-0-0.46	1-0-0.13	—	—	0.31-0-0.46	0.17-0-0.23	2.8-0-2.1
Program 7	—	0.31-0-0.46	—	0.7-0-0.78	1-0-0.46	—	0-0-0.46	—	0.17-0-0.23	2.2-0-2.4
Program 8	—	0.31-0-0.46	—	0.7-0-0.38	1-0-0.13	—	—	—	0.17-0-0.23	2.2-0-1.2

T A B L E 3 Monthly and total annual fertilizer rates (lb N-P₂O₅-K₂O 1000 ft⁻²) for 'Classic' St. Augustinegrass grown in Jay, FL, in 2021 and 2022.

Treatment	Jan.	Feb.	Mar.	Apr.	May	June–Sep.	Oct.	Nov.	Dec.	Total annual
lb N-P ₂ O ₅ -K ₂ O 1000 ft ⁻²										
Control	–	–	–	–	–	–	–	–	–	–
Program 1	–	–	–	0.7-0-0	0.7-0-0	–	0.7-0-0	0.7-0-0	–	2.8-0-0
Program 2	–	–	–	0.7-0.23-0.47	0.7-0.23-0.47	–	0.7-0.23-0.47	0.7-0.23-0.47	–	2.8-0.9-1.9
Program 3	–	–	–	0.7-0-0.38	0.7-0-0.38	–	0.7-0-0.38	0.7-0-0.38	–	2.8-0-1.5
Program 4	–	–	–	0.7-0.23-0.47	0.7-0.23-0.47	–	0.7-0.23-0.47	0.7-0.23-0.47	–	2.8-0.9-1.9
Program 5	–	0.15-0-0.23	0.17-0-0.23	0.7-0.06-0.32	2-0.17-0.9	–	0.7-0.06-0.32	0.31-0-0.46	–	4-0.3-2.5
Program 6	–	0.15-0-0.23	0.17-0-0.23	0.7-0.23-0.47	2-0.15-0.30	–	0.70-0.23-0.47	0.31-0-0.46	–	4-0.6-2.2
Program 7	0.17-0-0.23	–	0.7-0.06-0.32	–	2-0.17-0.92	–	–	0.7-0.06-0.32	–	3.6-0.3-1.8
Program 8	0.17-0-0.23	–	0.7-0.23-0.47	–	2-0.15-0.30	–	–	0.7-0.23-0.47	–	3.6-0.6-1.5

T A B L E 4 Monthly and total annual fertilizer rates (lb N-P₂O₅-K₂O 1000 ft⁻²) for 'Palisades' zoysiagrass grown in Jay, FL, in 2021 and 2022.

Treatment	Jan.	Feb.	Mar.	Apr.	May	June–Sep.	Oct.	Nov.	Dec.	Total annual
lb N-P ₂ O ₅ -K ₂ O 1000 ft ⁻²										
Control	–	–	–	–	–	–	–	–	–	–
Program 1	–	–	–	0.7-0-0	0.7-0-0	–	0.7-0-0	–	–	2.1-0-0
Program 2	–	–	–	0.7-0.23-0.47	0.7-0.23-0.47	–	0.7-0.23-0.47	–	–	2.1-0.7-1.4
Program 3	–	–	–	0.7-0-0.38	0.7-0-0.38	–	0.7-0-0.38	–	–	2.1-0-1.1
Program 4	–	–	–	0.7-0.23-0.47	0.7-0.23-0.47	–	0.7-0.23-0.47	–	–	2.1-0.7-1.4
Program 5	–	–	–	0.17-0-0.23	2-0.17-0.92	–	0.7-0.06-0.32	0.17-0-0	–	3-0.2-1.5
Program 6	–	–	–	0.17-0-0.23	2-0.15-0.30	–	0.7-0.23-0.47	0.17-0-0.23	–	3-0.4-1.2
Program 7	0.17-0-0	–	0.17-0-0.23	–	2-0.17-0.92	–	–	0.7-0.06-0.32	–	3-0.2-1.7
Program 8	0.17-0-0.23	–	0.17-0-0.23	–	2-0.15-0.30	–	–	0.7-0.23-0.47	–	3-0.4-1.2

1.3 | Data collection

Visual quality, normalized difference vegetation index (NDVI), percentage green cover, and dark green color index (DGCI), were assessed biweekly. Visual quality was measured on a scale of 1 to 9 where 1 = dead/brown turfgrass and 9 = optimal healthy/green. A score of 6 was considered sufficient quality for a home lawn (Morris & Shearman, 1999). NDVI was assessed using a RapidSCAN CS-45 (Holland Scientific) on a scale from 0 to 1. Percentage of green cover and DGCI were assessed through digital image analysis (Karcher & Richardson, 2003; Richardson et al., 2001) from one image taken per plot. One soil core (5-inch diameter $\times$ 6-inch depth) per plot was collected before and after the fertilizer blackout period. Roots were washed free of sand and dried for 72 h in a forced-air oven at 72°C to determine root dry weight (oz).

1.4 | Experimental design and statistical analysis

The study was arranged as a randomized complete block design with four replicates. Plot size was 5 ft by 5 ft. Model residuals were analyzed for normality and homogeneity of variance with the Studentized residual test. Where necessary, data were transformed logarithmically which satisfied assumptions of analysis of variance (ANOVA). Compound symmetry covariance structure with SAS Proc Glimmix (ver. 9.4; SAS Institute) was used to analyze variables using months as repeated measures. No significant effect of year was observed for the evaluated variables; therefore, data were pooled across year. Means were separated using Fisher's protected least significant difference test at the 0.05 significance level. No effect of treatments was observed for St. Augustinegrass at FLREC and zoysiagrass at WFREC; therefore, data are not presented.

1.5 | Zoysiagrass performance at FLREC

The interaction of fertilizer treatment and month affected turfgrass performance ($P \leq 0.05$). Turfgrass quality of fertilized zoysiagrass reached minimal acceptable quality (≥ 6) in the spring (Figure 1). All fertilization treatments showed a higher quality than the control. However, from July to November, quality of turfgrass fertilized with Program 4 was similar to the control. Research shows that acceptable quality for zoysiagrass can be achieved with applications of 1 to 2 lb N 1000 ft⁻² yr⁻¹ (Dunn et al., 1995; Bae, 2009; Patton et al., 2010; Trenholm et al., 2012), regardless of the N source (Trappe & Patton, 2013). However, the N rate has a greater impact on quality when the grass is actively growing (Schwartz et al., 2020). Between April and May, turfgrass fer-

tilized with Programs 2, 5, and 6 exhibited 17%, 16%, and 21% higher NDVI than the control (Figure 1). This may be due to the earlier fertilization, especially for Programs 5 and 6, that had received 2.35 lb N by May.

At the beginning of the blackout period, all fertilized plots had between 12% to 23% higher NDVI compared to the control, but no differences were found thereafter. A similar trend was observed for percentage green cover and DGCI, with fertilized treatments showing 27%, 20%, and 21%, higher percentage green cover and 38%, 28%, and 24% higher DGCI compared to the control from June to August (Figure 1). No effect of fertilization treatment was observed in root dry weight; however, overall root dry weight before the blackout period was higher than at the end of the blackout period (0.25 oz ft⁻² and 0.12 oz ft⁻², respectively). Nutrition had no effect on St. Augustinegrass performance at FLREC. This may be attributed to the age of the sward (12 years), which might have increased soil organic matter content and therefore provided sufficient N to maintain turfgrass health (Schiavon et al., 2021).

1.6 | St. Augustinegrass performance at West Florida Research and Education Center

Turfgrass performance was affected by the interaction of fertilizer treatment and month ($P \leq 0.05$). All fertilized treatments, except for Program 1, reached and maintained an acceptable turfgrass quality (≥ 6) throughout the blackout period (Figure 2). Similar results were found by Gautam (2015) and Wasylik (2015) when applying 2 lb N 1000 ft⁻² before the blackout period, concluding that turfgrass health and quality in the summer depends on the rate of CRN applied before the blackout period. Overall, fertilized plots had higher turfgrass quality compared with the control, except for plots fertilized with Program 1. Other studies have found similar turfgrass quality in fertilized plots regardless of the N rate, source, and N-P-K ratios (Broschat et al., 2008; Saha et al., 2007; Trenholm & Unruh, 2005). However, in this study Program 1 (urea alone) showed lower quality than the rest of the Programs. Research by Telenko et al. (2015) indicates that after two years of establishment turfgrass fertilized with urea showed lower quality than plots fertilized with slow-release N. Normalized difference vegetation index increased from March to June (Figure 2). Before the blackout period, turfgrass fertilized with Program 7 had 38% higher NDVI than Program 1 and 74% higher than control. After the start of the fertilizer blackout period, NDVI declined in July and increased again in August, with Programs 5 and 6 showing 35% and 34% higher NDVI than the control, possibly due to the higher frequency of fertilizer applications in these treatments (Table 3). Consistent with our results, Schiavon et al. (2021) also observed a decline in NDVI during July with an

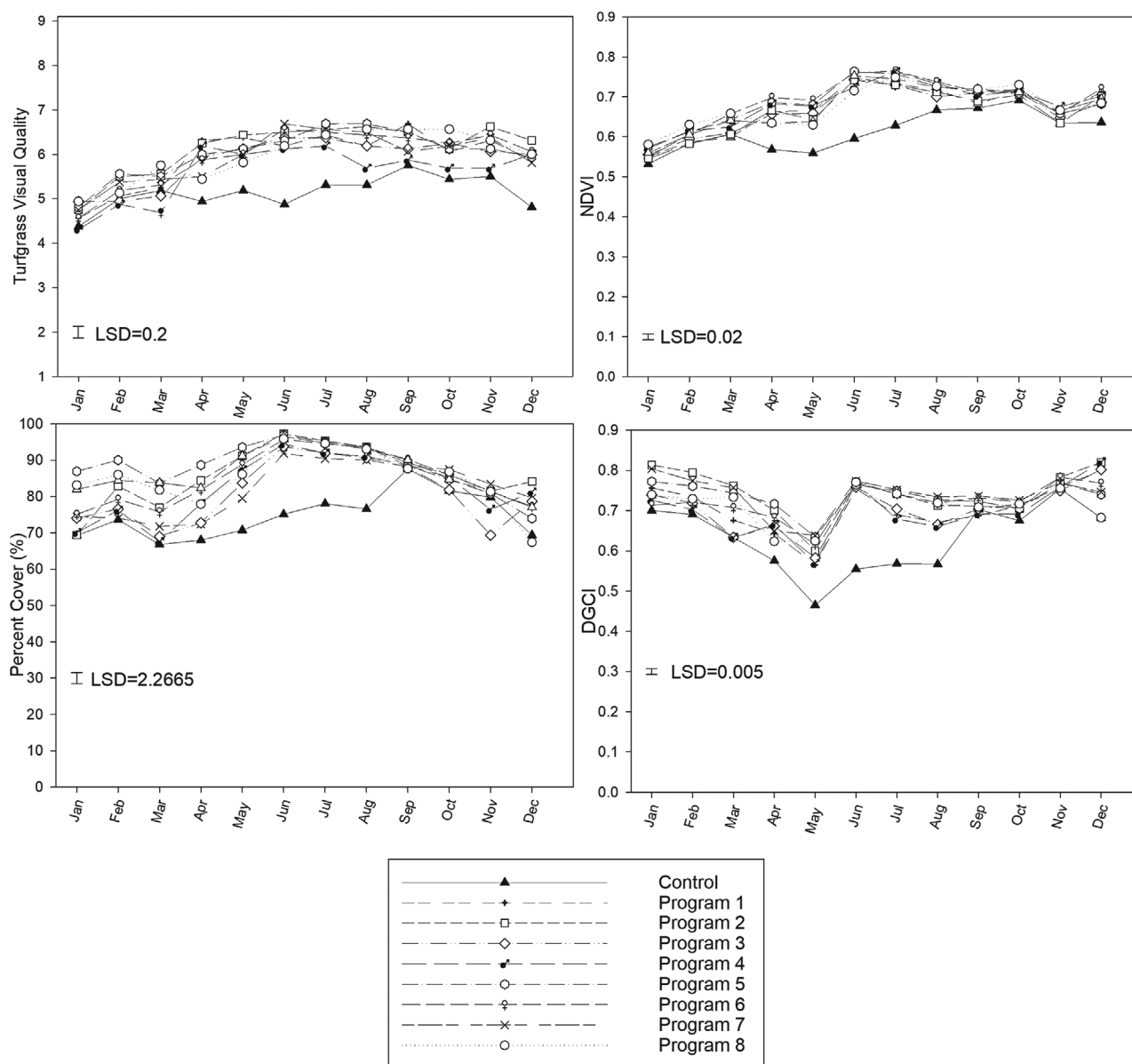


FIGURE 1 Turfgrass visual quality on a scale of 1 to 9 (1 = dead/brown turfgrass, 9 = optimal healthy/green, and 6 = minimum acceptable quality), normalized difference vegetation index (NDVI), percentage of green cover (%), and dark green color index (DGCI) of 'Empire' zoysiagrass in Ft. Lauderdale, FL, as affected by the interaction of fertilizer and month.

increase in August for three consecutive years. This increase may be due to higher precipitations typical in the month of August. Similar to NDVI, percentage green cover reached its peak in June, with fertilized treatments showing an average green cover of 95% (Figure 2) compared to the control (68%). Higher-percentage green cover was detected in April and May, in Programs 7 and 8, compared with Program 1 and the control. This may be attributed to the earlier fertilization (January) received by these treatments. During and after the blackout period all fertilized treatments had a higher percentage green cover compared to control. Similar results were detected for DGCI (Figure 2). No difference among treatments was found in root dry weight before and after the blackout

period (results not shown). Lack of nutrition effect on zoysiagrass at the WFREC may be attributed to the shorter growing season (Supplemental Figure S1), lower nutritional requirements of this species, and finer-textured soil with greater nutrient holding capacity.

2 | CONCLUSIONS

Results confirm that spring nutrition is necessary to maintain turfgrass health and sustain turfgrass quality when fertilization blackout periods are enforced. Overall, the use of urea alone may not be sufficient to support an optimal turfgrass

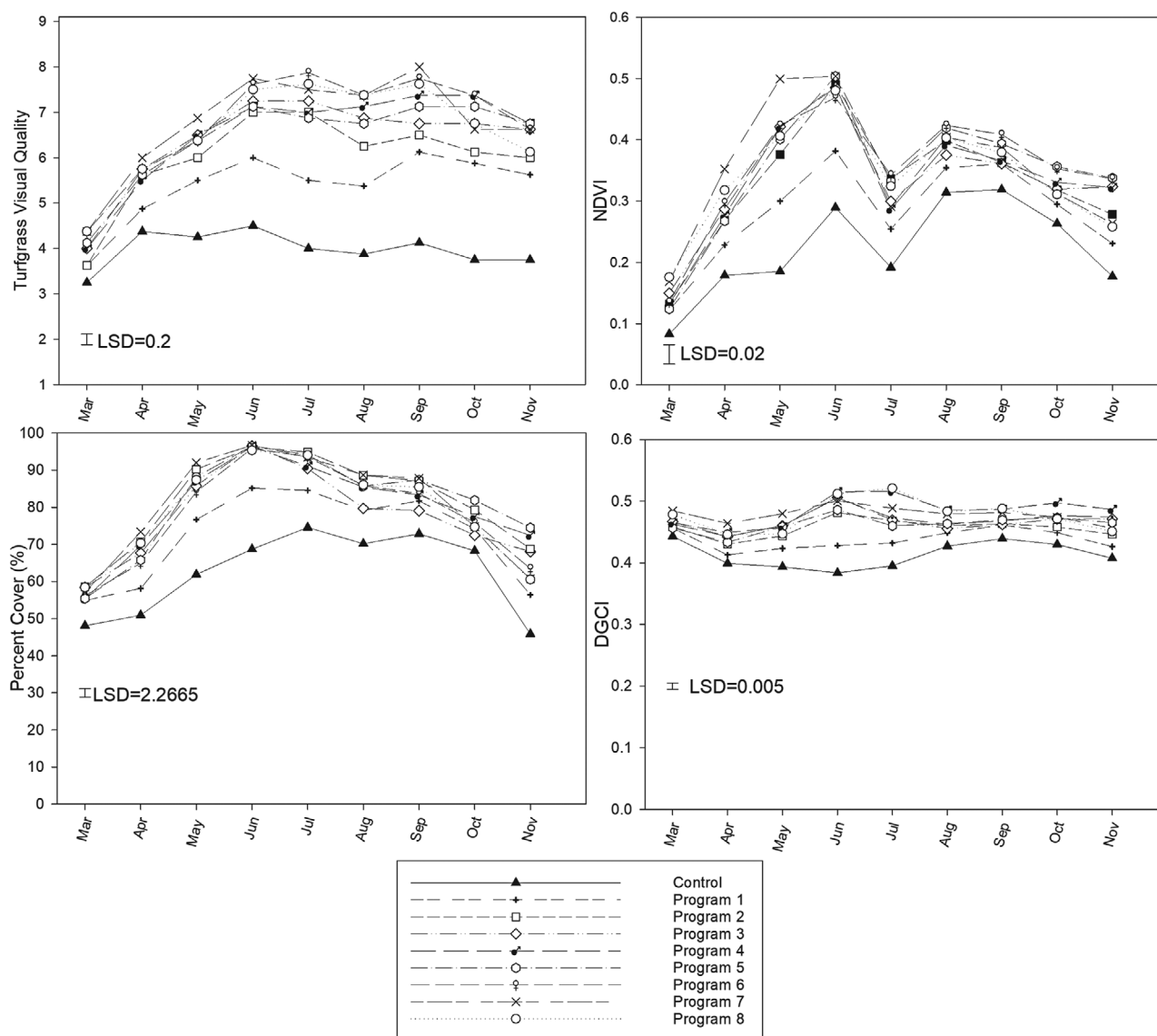


FIGURE 2 Turfgrass visual quality on a scale of 1 to 9 (1 = dead/brown turfgrass, 9 = optimal healthy/green, and 6 = minimum acceptable quality), normalized difference vegetation index (NDVI), percentage of green cover (%), and dark green color index (DGCI) of Classic St. Augustinegrass in Jay, FL, as affected by the interaction of fertilizer and month.

performance of St. Augustinegrass in North Florida during a fertilizer blackout period. The ideal time for fertilizing zoysiagrass is likely confined to the summer months when the grass reaches its peak growth (Supplemental Figure S1). Conversely, no fertilization is recommended during the dormancy or semi-dormancy period. Additionally, mature stands of St. Augustinegrass in South Florida may not require extra fertilization, as the high soil organic matter content, could provide ample N for turfgrass health. Moreover, results suggest that enforcing blackout periods could negatively impact the performance of recently established zoysiagrass in South Florida. Turfgrass performance did not improve with programs containing phosphorus (P), likely because the soil already supplied sufficient P (Supplemental Tables 3 & 4). This aligns with UF-IFAS recommendations, emphasizing

the application of phosphorus only when deficient (Trenholm et al., 2021; Unruh et al., 2022). Use of Fe did not improve turfgrass quality compared to programs that received N and K only.

AUTHOR CONTRIBUTIONS

I. Alejandra Sierra Augustinus: Data curation; formal analysis; investigation; writing—original draft. **P. Agustin Boeri:** Investigation; writing—review and editing. **A. Fernanda Arevalo Alvarenga:** Investigation. **J. Bryan Unruh:** Funding acquisition; investigation; resources; writing—review and editing. **Marco Schiavon:** Conceptualization; data curation; funding acquisition; investigation; methodology; project administration; resources; supervision; validation; visualization; writing—review and editing.

ACKNOWLEDGMENTS

This research was made possible by grants from the USDA National Institute of Food and Agriculture, Hatch project FLA FTL 005959, and Yara International.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Sierra Augustinus, I. A., Boeri, P. A., Arevalo Alvarenga, A. F., Unruh, J. B., & Schiavon, M. (2024). Nutrition of Florida lawns when summer fertilizer blackout period is enforced. *Crop, Forage & Turfgrass Management*, 10, e20265. <https://doi.org/10.1002/cft2.20265>