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Rooting Comparison of Zoysiagrass Cultivars in the Greenhouse

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Summary

This study evaluated the growth performance of 12 zoysiagrass genotypes under controlled conditions to assess the relationship between rooting characteristics and shoot quality for drought tolerance. The experiment was conducted from May to August 2023 at the Kansas State University Department of Horticulture and Natural Resources, Throckmorton Plant Sciences, Manhattan, KS. Zoysiagrass cultivars were sampled from turf plots and planted in polyvinyl chloride (PVC) pipes filled with calcined clay to facilitate root observation. The experiment used a completely randomized design with five replicates for each cultivar. Weekly data collection included recording maximum root length and shoot quality on a 1 to 9 scale (9 = best, 6 = acceptable), with clippings dried and weighed. Root harvesting occurred from the 14th to the 19th week after planting for further analysis. Root analysis involved scanning and processing with WinRHIZO Pro software, while shoot quality was rated visually. Results showed significant variability among cultivars in root growth patterns, shoot quality, and drought tolerance. Cultivars such as Chisholm and DALZ 1701 demonstrated extensive rooting, while others showed varying degrees of performance. Rooting depths varied among cultivars, indicating differences in root establishment. This study provided valuable insights into the growth performance and potential drought avoidance of zoysiagrass genotypes, facilitating cultivar selection for various landscaping and turf applications.

Objective

The objective was to evaluate the growth performance of 12 zoysiagrass genotypes under controlled conditions and determine the relationship between the rooting characteristics and shoot quality for drought avoidance.

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Study Description

In May 2023, a greenhouse study was conducted at the Department of Horticulture and Natural Resources, Throckmorton Plant Sciences, Manhattan, KS. Polyvinyl chloride (PVC) pipes retaining a clear polyethylene root tube were used to hold the growing material for grasses. Each clear polyethylene root tube was filled with calcined clay as a growing medium to facilitate root observation and minimize damage during harvest. Each PVC pipe, serving as one experimental unit, received 10 ml of a 24-8-16 N-P-K soluble fertilizer (Scotts Miracle-Gro, Marysville, OH.). These pipes were arranged at a 20^0 angle from vertical in a tube rack to allow for root growth observation (Figure 1c). The soil mix was saturated with water before planting to ensure adequate moisture for the grasses.

The 12 zoysiagrass genotypes; Meyer, Emerald, Zeon, Innovation, Chisholm, Gateway, KSUZ 1201, DALZ 1701, DALZ 1702, DALZ 1808, DALZ 1311, and FAES 1319 were sampled from turf plots at the Olathe Horticulture Research Center. After sampling, the roots were washed and trimmed to the crown to encourage new growth (Figure 1b). Each plug was then planted in the root tubes arranged randomly in a completely randomized design with five replicates, resulting in 60 samples. Throughout the experiment, the average day/night air temperature was maintained at 85° F and 70° F respectively. Fertilizer was applied weekly, in the first three weeks, 20ml of fertiler to supply 1.8 lbs. N/1,000 sq. ft. was applied and subsequently was reduced to 10ml to provide 0.15 lb. N/1,000 sq. ft twice a week to maintain optimal nutrient levels.

Mist irrigation was manually applied three times a day to facilitate root establishment. The frequency and volume of irrigation treatments were adjusted as the roots developed, transitioning from three times daily to twice daily, and eventually to once a day as root growth became extensive. By the ninth week, irrigation was reduced to every other day until the study's conclusion in August 2023. Additionally, zoysiagrass maintenance included weekly mowing to a height of 1 inch during the first 5 weeks. Due to the vigorous growth of zoysiagrass, clippings were collected twice weekly thereafter to manage turf density and growth.

Weekly data collection included recording maximum root length and shoot quality on a 1 to 9 scale, with 9 indicating the highest quality. Clippings were dried at 100°C and weighed. Root harvesting occurred from the 14th to the 19th week after planting. Maximum root extension was measured, and root tubes were dissected into sections ranging from 0 to 10 cm, 10 to 20 cm, 20 to 30 cm, 30 to 60 cm, and 60 to 90 cm. Roots were washed and stored in plastic bags at 4°C (39.2°F) in a cold storage room. Root analysis involved scanning and processing with WinRHIZO Pro software to estimate various parameters (Figure 1e). Roots and shoots were dried and weighed to calculate the root/shoot ratio. Data from each year were analyzed separately using ANOVA in Python, with Tukey HSD mean separation at $P \leq 0.05$. This approach provided detailed insights into zoysiagrass growth and performance,

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allowing for cultivar comparisons and highlighting significant differences in root and shoot characteristics.

Results

Our study presents a comprehensive analysis of the performance of the 12 zoysiagrass genotypes for 13 weeks, from late May to late August 2023. The data collected on different dates illustrated the variability in root growth patterns and vigor among the cultivars including Chisholm, DALZ (1311, 1701, 1702, 1808), Emerald, FAES 1319, Gateway, Innovation, KSUZ 1201, Meyer, and Zeon.

Shoot quality rated on a scale of 1 to 9 (9 = best, 6 = acceptable) varied among cultivars. DALZ 1701 had the highest shoot quality, indicating it possesses traits or adaptations that allow it to produce the overall shoot quality among the tested genotypes. DALZ 1808, Chisholm, Zeon, and FAES 1319 also performed well, with shoot qualities above the acceptable threshold (6) but not as high as DALZ 1701. The remaining cultivars had shoot quality ratings below acceptable quality possibly due to less favorable genetic traits or poorer adaptations to the study conditions (Figure 2). Overall, shoot quality can be linked to their genetic makeup. Some cultivars may have better shoot growth characteristics due to their genetic traits which can influence factors such as leaf density, color, texture, and overall appearance.

Most of the cultivars had greater root length extension in the second week after planting, this can be attributed to their adaptation to a new environment and a recovery from transplant shock. Longer root extension in the second week could also be attributed to plants starting to explore the soil for nutrients and water aggressively. The root length varied significantly among cultivars with Chisholm having the longest root extension, this could indicate its high efficiency in exploring the growing media for resources. FAES 1319 and DALZ 1701, DALZ 1311, Gateway, and Innovation also showed substantial root length extension which suggests that they share similar favorable traits for root growth. KSUZ 1201, Zeon, and DALZ 1702 showed significantly lower values compared to other cultivars, this indicates their less aggressive root growth traits or might be less adapted to the growing medium (Figure 3).

Cultivars like Chisholm and DALZ 1701 demonstrated relatively extensive rooting which could enhance drought avoidance. Cultivars like FAES 1319, Gateway, and Innovation also showed good rooting characteristics but may not be as robust in drought conditions as Chisholm and DALZ 1701. However, with additional management practices or improved breeding techniques, these cultivars can still be viable options for drought-prone areas.

Rooting depths indicated that some cultivars do not have roots in the deepest area measured at 60 to 90 cm (Figure 4). This indicates a limitation in their ability to access deeper soil moisture and cultivars with shallower root systems are more vulnerable to drought stress. These cultivars may require frequent irrigation to maintain their health and productivity. For the shoot-to-root ratio, there was no

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significant difference, while root length and depth vary, the overall allocation of biomass between shoots and roots remains consistent. A consistent shoot-to-root ratio indicates balanced growth, which is essential for overall plant health. However, in drought conditions, the absolute depth and extent of roots may be more critical than the ratio.

Conclusions

This study highlights the importance of selecting cultivars based on their performance. The variation in root length extension during the second week after planting highlights the genetic diversity in root growth traits. The superior performance of Chisholm, FAES 1319, and DALZ 1701 suggests that these cultivars have advantageous genetic traits that promote extensive root development, which is crucial for efficient nutrient and water uptake. These traits can also be selected and modeled into breeding other genotypes. The performance of Chisholm and DALZ 1701 in terms of extensive rooting makes them prime cultivars for drought avoidance due to their ability to access deeper soil moisture. Cultivars such as FAES 1319, Gateway, and Innovation can also be effective with additional management practices to support their growth in drought conditions. The rooting depth limitation observed in some cultivars explains the importance of selecting plants with deeper root systems for areas prone to drought.

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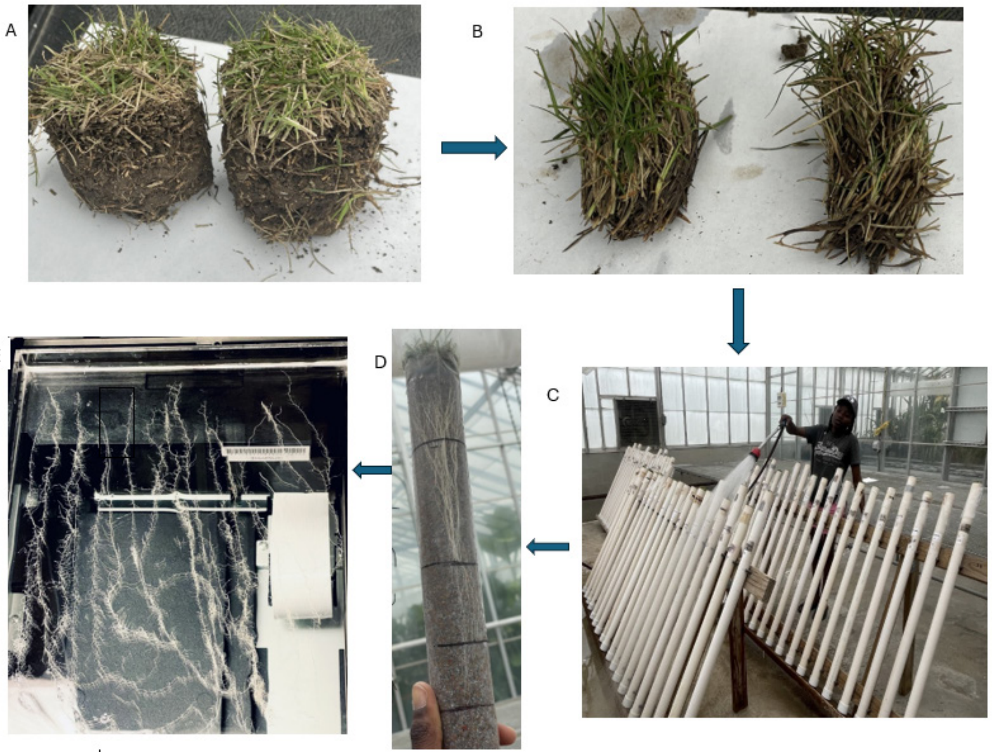

Figure 1. Step-by-step method of root plugging: A) plugs harvested from the experimental field; B) washed and trimmed plugs before planting in PVC pipes; C) PVC pipes containing polyethylene tubes made to rest at 20° for easy rooting identification; D) weekly data collected on maximum root length; and E) rooting characteristics analyzed in WinRHIZO.

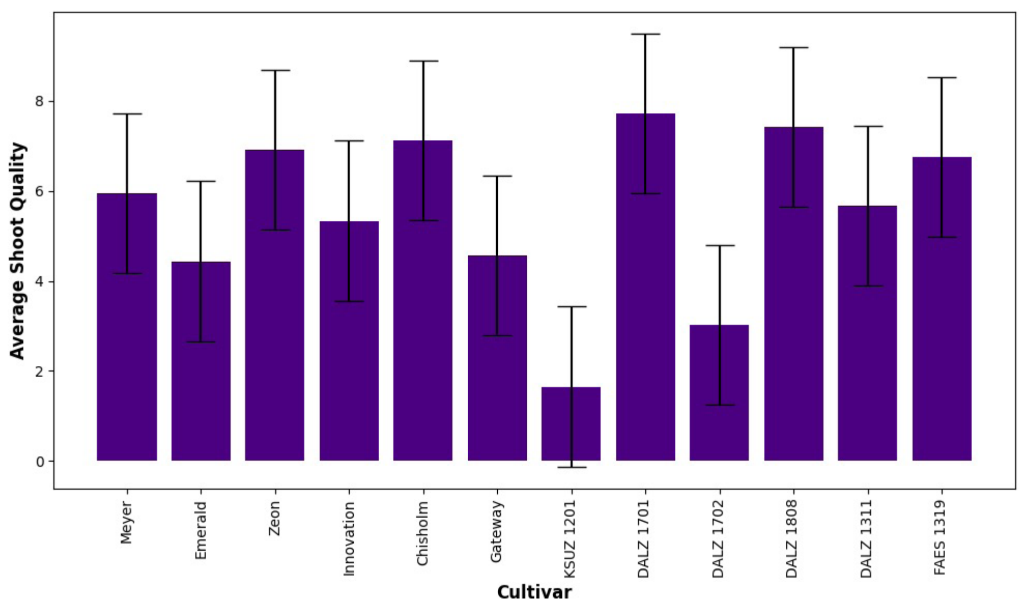

Figure 2. Average shoot quality across cultivars throughout the experiment

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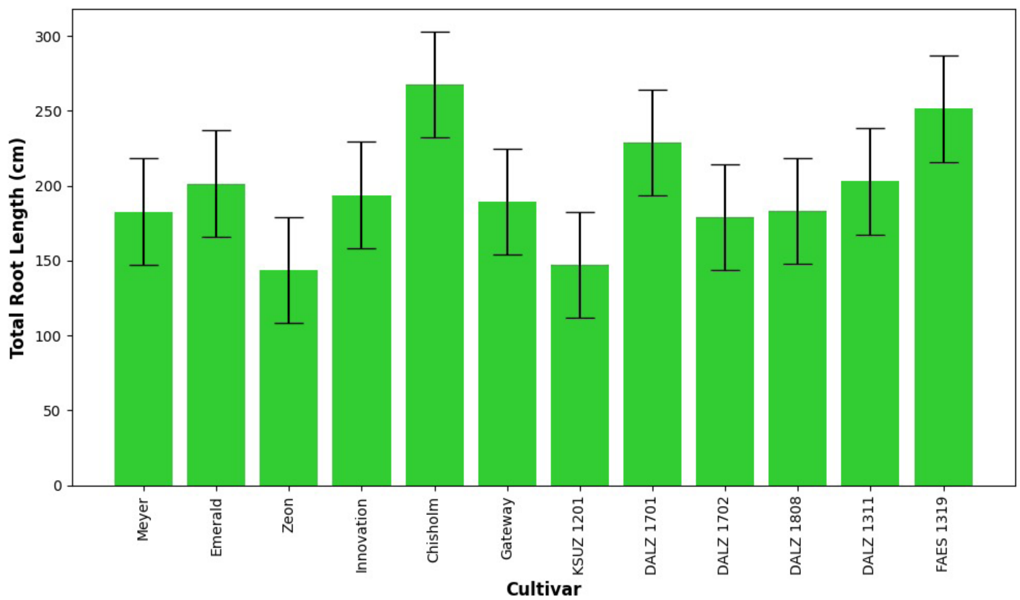

Figure 3. Total root lengths across cultivars throughout the experiment

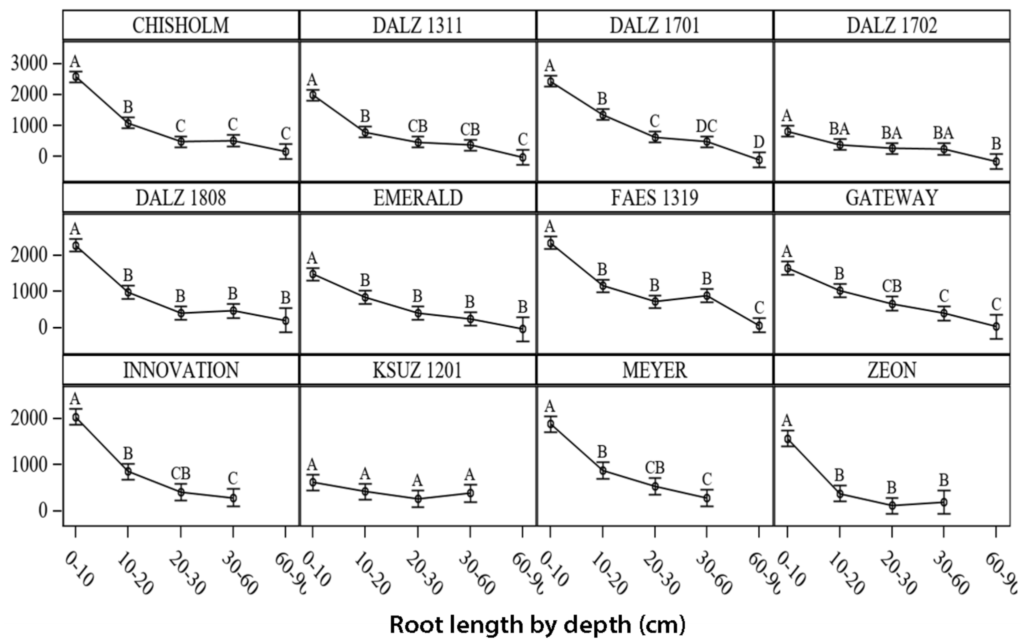

Figure 4. Overall root length by depths across cultivars

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