Polyethylene Glycol Effects on Zoysiagrass Root Growth and Leaf Mass Production in a Hydroponic System

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Introduction and Materials and Methods

- Limited water resources increase the need for improved drought tolerance in turfgrass
- PEG has been used in several crop species to select for drought responses
- Hydroponics can be used to test for genotypic differences that indicate improved drought responses
- Providing water stress in a hydroponic system may be a better way to screen for favorable drought tolerance characteristics

- Twelve zoysiagrass genotypes planted into 150 cc conetainers
- RCBD with a split-plot arrangement and five replications
- Four treatments
- Treatments changed slightly for trial two
- Entries trimmed weekly to a height of 5 cm and leaf mass was dried and weighed
- Turf quality and firing ratings taken weekly
- After 28 days, roots were removed and scanned through the EPSON scanner using WinRHIZO software

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Trial One Results

Table 1. Treatment mean separations for leaf mass production and rooting characteristics in trial 1

Treatment	Root Length (cm)	Root Surface Area (cm^2)	Leaf Mass 1	Leaf Mass 2
Water	1864.6 c*	122.3 c	0.093 a	0.259 ab
Gradual PEG	2067.4 ab	142.6 ab	0.071 b	0.223 b
PEG EF	1925.2 bc	132.1 bc	0.037 c	0.128 c
10%PEG	2236.9 a	148.8 a	0.041 c	0.266 a

*Values in the same column followed by the same letter are not significantly different at the 0.05 p level

Table 2. Treatment mean separations for turf quality ratings and leaf firing in trial 1

Treatment	Leaf Firing**	Turf Quality 1***	Turf Quality 2	Turf Quality 3	Turf Quality 4
Water	8.98 a	8.38 a*	8.20 a	8.37 a	8.20 a
Gradual PEG	8.95 a	7.68 b	7.60 b	8.32 a	7.92 ab
PEG EF	7.48 c	8.55 a	8.21 a	7.75 b	7.70 bc
10%PEG	8.70 b	7.82 b	7.78 b	7.70 b	7.50 c

*Values in the same column followed by the same letter are not significantly different at the 0.05 p level
**Leaf wilting/firing visually rated on a scale of 1 to 9, with 9 being no wilting/firing and 1 being complete wilting/firing
***Turf quality ratings taken on a scale of 1 to 9, with 9 being the best and 1 being the worst

Table 3. Genotypic mean separations for leaf mass production and rooting characteristics in trial 1

Genotype	Average Root Diameter (mm)	Root Length (cm)	Root Surface Area (cm^2)	Leaf Mass 1	Leaf Mass 2
18%PEG	0.210 bc	2741.9 a	180.2 a	0.094 a*	0.352 a
Empire	0.230 a	2125.8 bcd	154.8 abc	0.082 ab	0.316 ab
Palisades	0.211 bc	2630.4 ab	172.8 ab	0.068 bcde	0.314 ab
Water	0.215 b	2210.3 abc	149.1 abc	0.059 bcdef	0.262 bc
FAES1307	0.217 b	2515.2 ab	171.3 ab	0.057 cdef	0.186 e
FAES1319	0.209 bc	2425.7 ab	158.9 ab	0.046 ef	0.197 de
FAES1314	0.218 b	1113.3 f	76.5 e	0.076 abc	0.111 fg
FAES1313	0.202 c	1694.0 cde	106.6 de	0.072 abcd	0.208 cde
Icon	0.236 a	1665.3 de	121.7 cd	0.051 def	0.204 cde
10%PEG	0.216 b	1794.7 cd	120.5 cd	0.061 bcdef	0.253 bcd
FAES1322	0.213 b	2135.9 bcd	141.9 bcd	0.039 fg	0.147 ef
Zeon	0.213 b	1229.6 ef	83.1 e	0.021 g	0.080 g

*Values in the same column followed by the same letter are not significantly different at the 0.05 p level

- 10% PEG had greater root length and root surface area compared to the water (no PEG) and the simulated ebb and flow system (Table 1)
- Leaf mass was consistently high without PEG (Table 1)
- Turf quality was consistently higher for the water treatment and occasionally not different from the ebb and flow or gradual PEG (Table 2)
- Leaf firing was less for water and gradual PEG, but was never below and acceptable value for any treatment (Table 2)
- 18%PEG and Empire are in the highest significance group four out of five times (Table 3)
- 10%PEG, FAES1322, and Zeon are never found in the highest significance group (Table 3)

Trial Two Results

Table 4. Treatment mean separations for leaf mass production and rooting characteristics in trial 2

Treatment	Average Root Diameter (mm)	Leaf Mass 2	Leaf Mass 3
Water	0.218 c*	0.091 a	0.060 a
WEF	0.220 bc	0.057 b	0.050 a
PEG EF	0.239 a	0.050 b	0.051 a
15%PEG	0.227 b	0.041 b	0.033 b

*Values in the same column followed by the same letter are not significantly different at the 0.05 p level

Table 5. Treatment means separations for turf quality and leaf firing ratings in trial 2

Treatment	Leaf Firing 1**	Leaf Firing 2	Leaf Firing 3	Leaf Firing 4	Turf Quality Original***	Turf Quality 2	Turf Quality 3	Turf Quality 4
Water	9.00 a*	9.00 a	9.00 a	9.00 a	8.10 a	8.18 a	8.32 a	8.10 a
WEF	8.90 a	8.62 b	8.53 b	8.72 a	8.20 a	8.32 a	8.28 a	8.13 a
PEG EF	8.73 b	7.08 c	6.72 c	6.93 c	8.27 a	7.60 b	7.60 b	7.38 b
15%PEG	8.97 a	8.7 ab	8.63 b	7.83 b	7.75 b	7.82 ab	7.87 b	7.62 b

*Values in the same column followed by the same letter are not significantly different at the 0.05 p level
**Leaf wilting/firing visually rated on a scale of 1 to 9, with 9 being no wilting/firing and 1 being complete wilting/firing
***Turf quality ratings taken on a scale of 1 to 9, with 9 being the best and 1 being the worst

Table 6. Genotypic mean separations for leaf mass production and rooting characteristics in trial 2

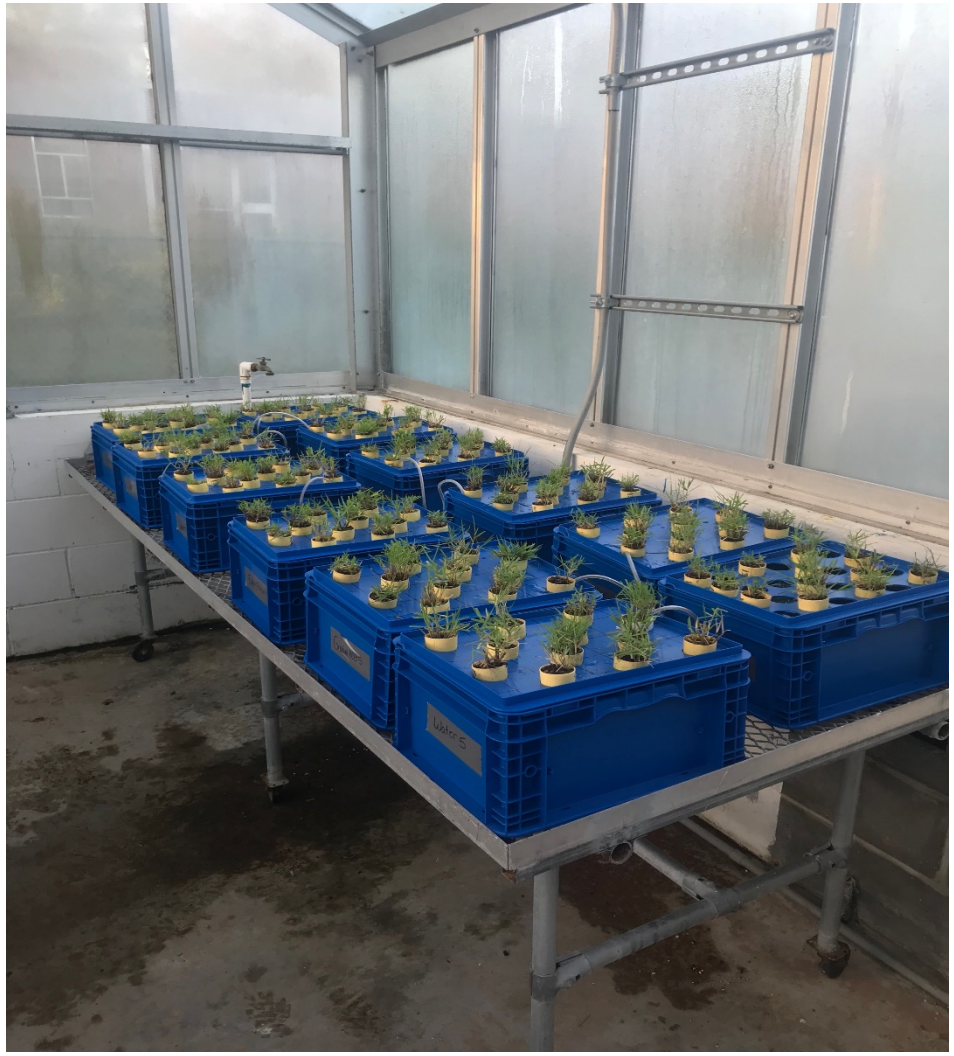
Genotype	Root Length (cm)	Root Surface Area (cm^2)	Leaf Mass 1	Leaf Mass 2	Leaf Mass 3	Leaf Mass 4
Palisades	2492.5 a*	178.8 a	0.120 bc	0.091 a	0.093 a	0.070 a
Water	2171.2 ab	144.9 bcd	0.141 ab	0.097 a	0.074 ab	0.053 b
Empire	2104.8 ab	149.9 abc	0.095 cd	0.073 abc	0.066 bc	0.056 ab
FAES1319	2410.8 a	173.1 ab	0.066 de	0.049 cde	0.057 bcd	0.054 ab
10%PEG	1651.5 c	117.9 de	0.155 a	0.086 ab	0.046 cdef	0.049 bc
FAES1322	2271.3 a	157.9 ab	0.047 ef	0.049 cde	0.037 defg	0.033 cde
FAES1307	2528.5 a	178.0 a	0.044 ef	0.048 cde	0.035 defg	0.033 de
FAES1313	1776.7 bc	120.1 cde	0.047 ef	0.038 de	0.032 efg	0.029 de
Icon	1579.5 cd	116.4 de	0.063 de	0.053 cd	0.043 cdef	0.029 de
FAES1314	1526.6 cd	108.6 ef	0.024 f	0.044 de	0.028 fg	0.030 de
18%PEG	1795.7 bc	122.5 cde	0.116 bc	0.063 bcd	0.054 bcde	0.045 bcd
Zeon	1172.7 d	81.2 f	0.023 f	0.025 e	0.018 g	0.021 e

*Values in the same column followed by the same letter are not significantly different at the 0.05 p level

- The PEG ebb and flow treatment produced the greatest diameter roots (Table 4)
- Water (no PEG) consistently had higher leaf mass over the duration of the study (Table 4)
- Water and water ebb and flow had the highest turf quality and the least leaf firing among treatments (Table 5)
- PEG ebb and flow produced the most leaf firing, but no ratings were below an acceptable level (Table 5)
- Palisades scored in the highest significance group for five variables (Table 6)
- Zeon was in the lowest significance group for all variables (Table 6)
- Genotypes FAES1313, Icon, FAES1314, and 18%PEG were never found in the highest significance group for these variables (Table 6)

Results and Discussion

- Significant differences between treatments and genotypes were seen in both trials
- Both trials indicate increased rooting under water stress provided by the hydroponic system
- Both trials also indicate that the stress from the treatments effects the turf quality and leaf firing of the entries
- Genotypic performance was not consistent between trials, except for Zeon, which consistently rated poorly across all variables
- Future experiments will need to be conducted to determine if an interaction between treatment and genotype can be seen which will determine if the use of PEG can be an efficient screening method for selecting drought-tolerance



Conclusions and Future Work

- Field evaluations do not provide an optimal environment for identifying drought tolerance in zoysiagrass; however, there is a need for an efficient screening method to be developed
- Well-watered hydroponic systems have been able to indicate favorable drought tolerance characteristics
- Hydroponic screening methods may be improved by providing water stress to the plants
- Currently, three higher concentrations of PEG are being used to put one genotype under severe water stress to identify the concentration that results in noticeable visual differences and favorable rooting characteristics