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

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Introduction

- Polyethylene glycol (PEG) has been used in several crop species to screen and select for drought/rooting responses at seed germination.
- Hydroponics have been used as a way to test for genotypic differences in characteristics that can indicate improved drought tolerance.
- Providing water stress in a hydroponic system using PEG may be a better screening method to identify drought tolerance characteristics in hydroponic culture.
- Improved drought tolerance in turfgrass is becoming increasingly important as water resources become more limited; however, using field evaluations to assess drought tolerance can be unpredictable.
- As water stress continues to be an issue, the ability of plants to tolerate drought stress and survive in unfavorable conditions is becoming more important.
- The development of a hydroponic PEG screen for drought tolerance will allow for an efficient evaluation of genotypes early in a breeding cycle.

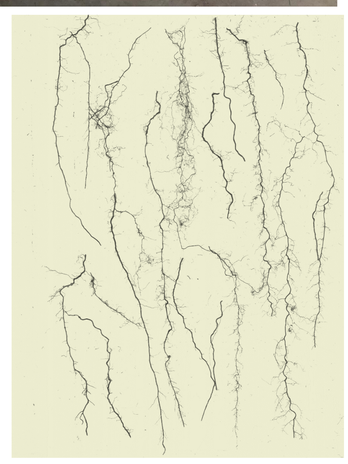
Materials & Methods

- Twelve zosiagrass (*Zoysia spp.)* genotypes were planted into 150 cc conetainers filled with Turface calcined clay.
- Conetainers were then grown in hydroponic culture with a water (no PEG) control, an gradually increasing concentration of PEG over the course of four weeks, a constant 10% PEG solution, or a simulated ebb and flow system (PEG EF) with entries placed in a 10% PEG solution for 10 minutes twice a day (Figure 1).
- In Trial 2, treatments were changed slightly to a constant 15% PEG, a simulated ebb and flow with 15% PEG (EF) , no PEG, and a simulated ebb and flow with no PEG (WEF).
- Set up as an RCBD in a split-plot arrangement, with the main plot being treatment and the sub-plot being genotype, and five total replications.
- Entries were trimmed weekly to a height of 5 cm, clippings were collected, dried and weighed and recorded “Leaf Mass 1”, “Leaf Mass 2”, etc.
- Turf quality and leaf firing ratings were taken weekly on a scale of 1 to 9, with 9 being the best and 1 being the worst
- After the 28-day treatment period, the roots of the entries were removed and scanned through an EPSON scanner using WinRHIZO software to evaluate rooting (Figures 2 and 3).

Figure 1. Conetainers in hydroponic culture in trial 1

Figure 2. (Left) Roots being set up for the EPSON scanner

Figure 3. (Right) An image file ready for analysis after scanning



Results

Table 1. Treatment mean separation 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 separation 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. Treatment mean separation 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 4. Treatment mean separation for turf quality ratings and leaf firing 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

Results and Discussion

Trial One

- 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
- 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 (no PEG) and gradual PEG, but was never below and acceptable value for any treatment (Table 2)

Trial Two

- The PEG ebb and flow treatment produced the greatest diameter roots (Table 3)
- Water (no PEG) consistently had higher leaf mass over the duration of the study (Table 3)
- Water (no PEG) and water ebb and flow had the highest turf quality and the least leaf firing among treatments (Table 4)
- PEG ebb and flow produced the most leaf firing, but no ratings were below an acceptable level (Table 4)

Conclusions

- Differences were seen between treatments and genotypes in both trials.
- Both trials indicate an increase in rooting under water stress in a hydroponic system and that this stress effects the turf quality and leaf firing of entries.
- Future experiments will need to be conducted to determine if an interaction between treatment and genotypes can be found which will determine if the use of PEG can be an efficient screening method for selecting drought-tolerance.
- 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.