Impact of Drought Stress on Cool-Season Turfgrass: Comparative Analysis of Mixture and Monoculture Responses

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Objective

Determine the performance of mixtures and monocultures capable of withstanding long drought periods under low input management.

Methods

Table 1. Timeline for field experiments.

	Run 1	Run 2
Seeding	5 Oct. 2020	12 May 2021
Initial species presence observation (Io)	10 June 2021	1 June 2022
Beginning of 1st drought	10 June 2021	3 June 2022
Beginning of 1st recovery	7 July 2021	1 July 2022
Species presence observation (R1)	3 Aug. 2021	2 Aug. 2022
Beginning of 2nd drought	4 Aug. 2021	2 Aug. 2022
Beginning of 2nd recovery	31 Aug. 2021	30 Aug. 2022
Species presence observation (R2)	28 Sept. 2021	27 Sept. 2022

Table 2. List of monoculture and mixtures used.

Monoculture and mixture number	Species Composition		
	HD	KB	PR
	----------%----------		
Hard Fescue 'Beacon' (HD)	100		
Kentucky Bluegrass 'Tirem' (KB)		100	
Perennial Ryegrass 'Manhattan 5' (PR)			100
Mixture 4	67	33	
Mixture 5	67		33
Mixture 6	33	67	
Mixture 7		67	33
Mixture 8	33		67
Mixture 9		33	67

Figure 1. Rainout shelter and plot layout in run 1.

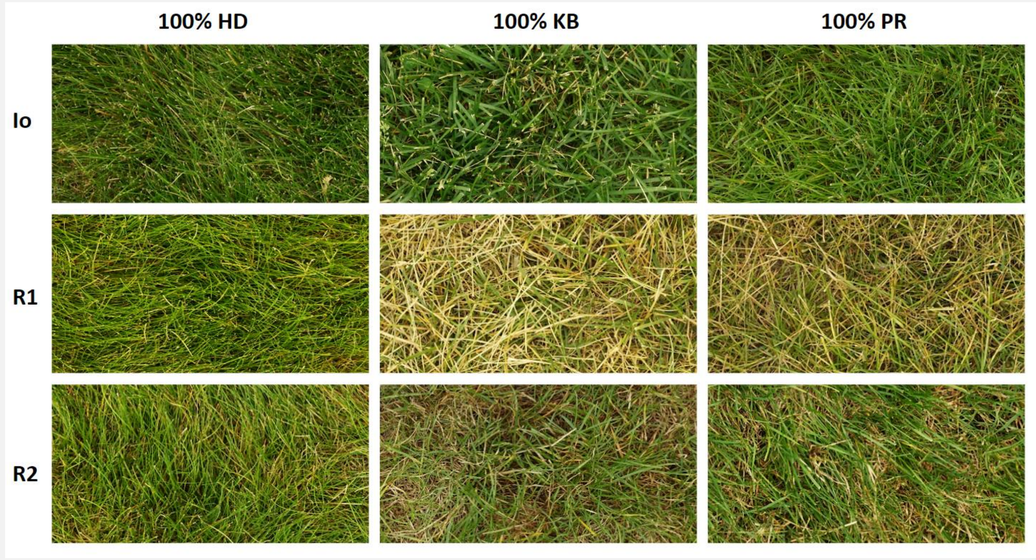

Figure 2. Visual comparison of long-lasting drought effects on monoculture plots at the initial observation (Io), after the first recovery (R1), and after the second recovery (R2) in run 1.

Hard fescue can maintain a green lawn in drought

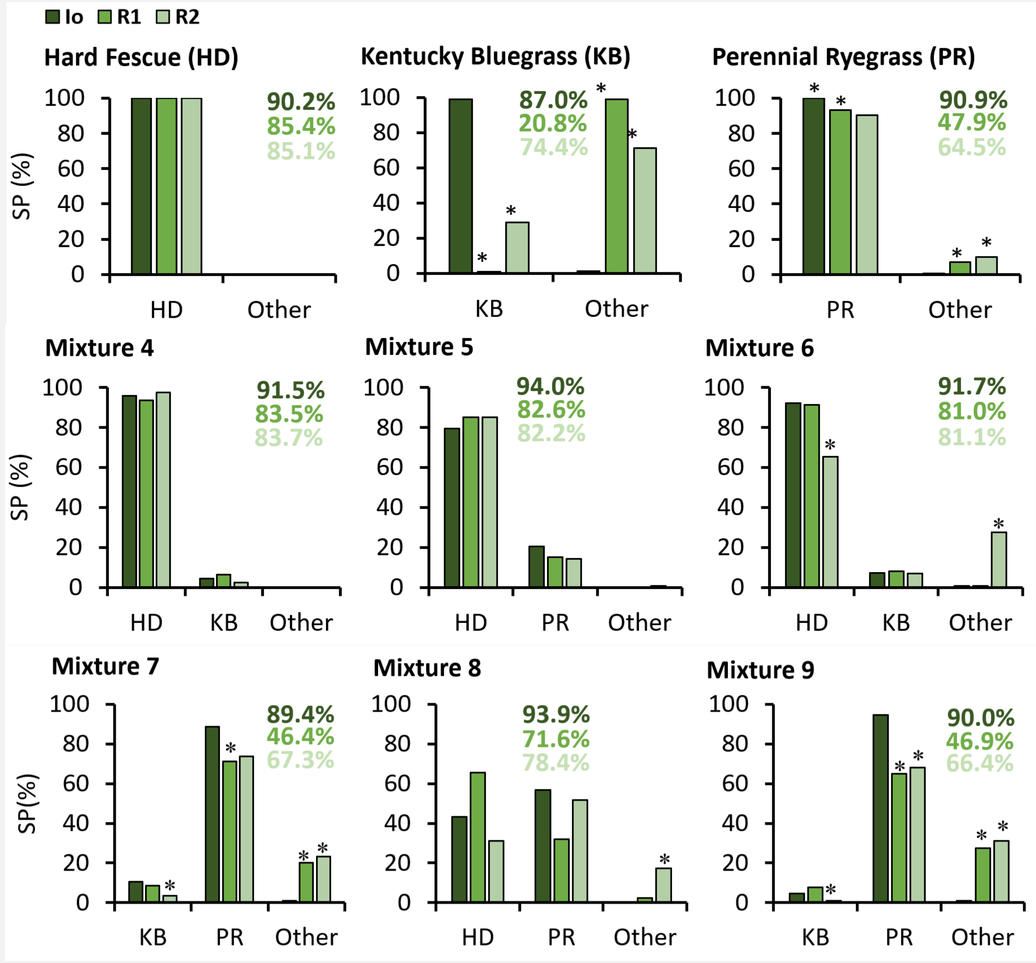

Figure 3. Average species presence (SP%) and corresponding percentage of green cover in the colored gradient numeric percentages during run 1. An * indicates a statistical difference observed between the two recovery time points (R1 and R2) and the initial observation (Io).

Results and Discussion

- Hard fescue exhibited the highest level of drought tolerance (Figure 2) and species presence (Figure 3). Mixtures with a lower initial seed composition of hard fescue gradually become predominant in the plot overtime (Table 2, Figure 3). Plots that included hard fescue outperformed other species across the two drought and recovery cycles.

- Percentage of green cover for hard fescue mixtures and monocultures remained high through both initial observation (Io) and recoveries (R1, R2) (Figure 3).

- To quantify plant stress, data was collected on percentage of green cover, normalized difference vegetation index (NDVI), turf quality rating, and photochemical efficiency (F_v/F_m)(Figure 4).

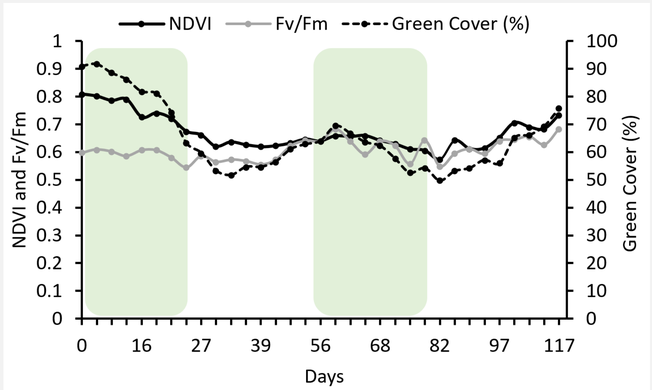

Figure 4. NDVI, F_v/F_m , and percent green cover combined across all treatments and runs; green regions indicate a drought period.

- The permanent wilting point, typically observed within the range of 6-9% (1), remained unattained during the experiment's drought phase, thereby limiting the ability to observe more pronounced outcomes (Figure 5).

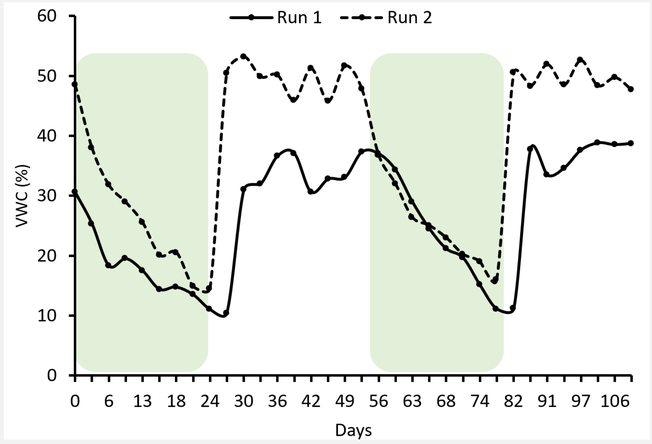

Figure 5. Volumetric water content percentage across all treatments and runs; green regions indicate a drought period.

References

(1) Hendrickson, A. H., and F. J. Veihmeyer. (1945). "Permanent wilting percentages of soils obtained from field and laboratory trials." *Plant Physiology*, vol. 20, no. 4, pp. 517–539, https://doi.org/10.1104/pp.20.4.517.