Superoxide dismutase activity in leaves and stolons of two warm-season turfgrass species in an arid environment

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Introduction

Drought, salinity and heat are typical environmental stresses for arid and semi-arid areas. Reactive Oxygen Species may be formed in the photosynthetic pathway in plants subjected to such stresses, as a result of excessive energy absorbed by light harvesting complex that cannot be transduced by photosystem II. The first defense mechanism of plants against these species is the Superoxide Dismutase (SOD) enzyme that catalyzes the transformation of superoxide radical into hydrogen peroxide.

Objectives

- To investigate the effects of soil surfactants and plant growth regulators on quality of drought stressed bermudagrass and seashore paspalum
- To study changes in SOD activity in leaves and stolons of drought stressed bermudagrass and seashore paspalum

Material and Methods

Location: Las Cruces, New Mexico; Plant Hardiness Zone 8b

Soil: Sandy skeletal mixed thermic Typic Torriorthent

Grass species: 'Princess' Bermudagrass (*Cynodon dactylon*) and 'Sea Spray' seashore paspalum (*Paspalum vaginatum*)

Fertilization: 20 g N, 20 g P_2O_5, and 20 g K_2O m^{-2} $year^{-1}$

Mowing: 2 cm, 2 to 3 times per week

Irrigation: applied daily at 50% ET_0 from either Toro ®MPR spray nozzles or Toro DL2000® subsurface-drip system (30 cm grid, emitter delivery rate 2 l/h, 12 cm depth)

Water Quality: potable (0.6 dS m^{-1}) and saline (2.9 dS m^{-1})

Treatments: Trinexapac-ethyl (TE; Primo Maxx®; 0.05 Kg ha^{-1} $month^{-1}$) or Revolution® (20 L ha^{-1} $month^{-1}$) tested against untreated control

Climate Data: see Figure 1

Data: Visual ratings collected bi-weekly (subsequently averaged to monthly) during the summers of 2012, 2011, and 2012. Monthly quantification of superoxide dismutase (SOD) activity in plant leaves and stolons (units/mg proteins; Giannopolitis and Rice, 1977)

Experimental Design: Completely randomized block (SAS Proc Mixed Fisher's protected LSD, P<0.05; repeated measures)

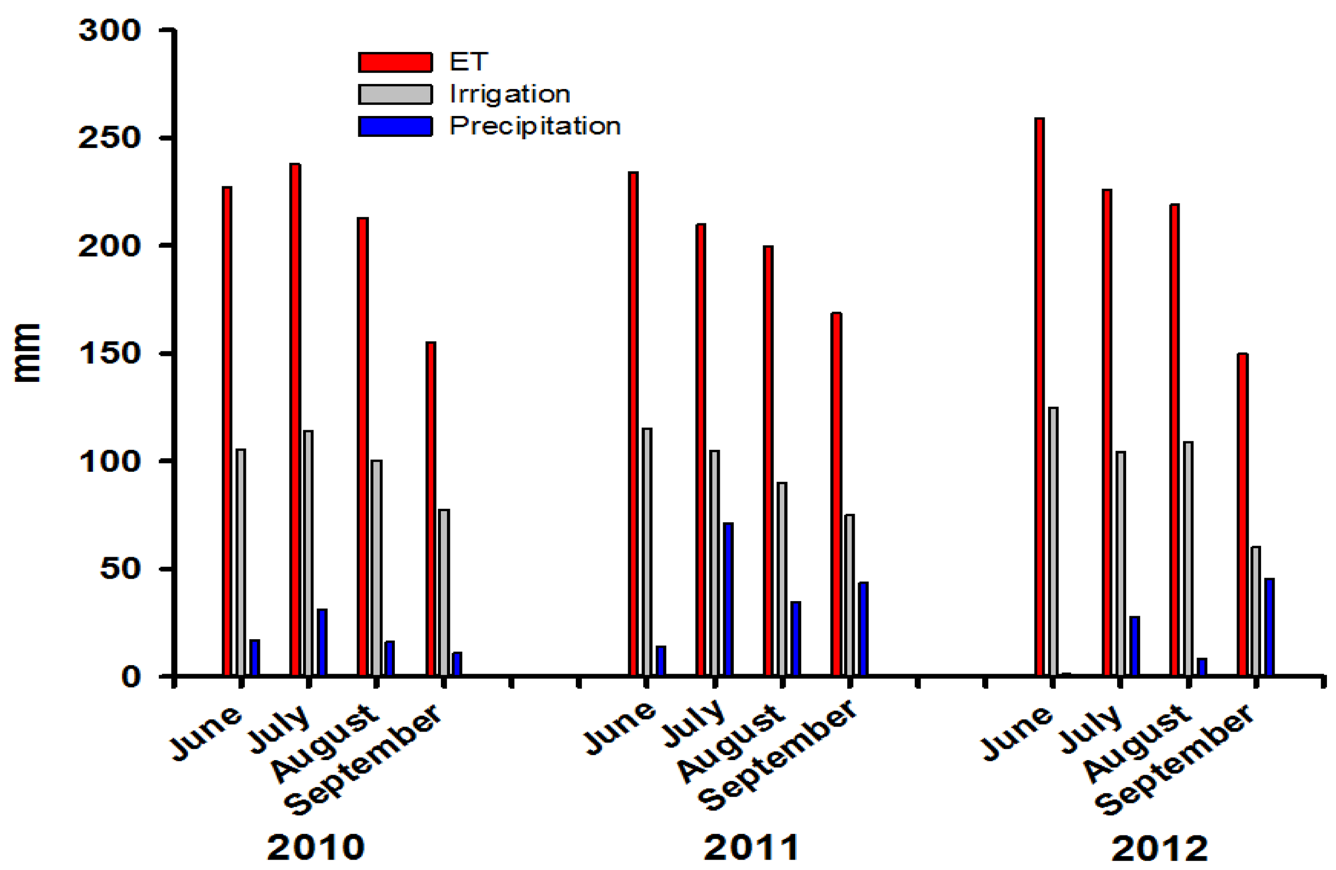

Figure 1. Monthly total reference evapotranspiration (ETo), irrigation applied, and precipitation during the Summers of 2010, 2011 and 2012.

Results

1. TE enhanced visual quality for all combinations of water quality and grass species, whereas Revolution increased turf quality only on seashore paspalum irrigated with potable water (Figure 2 and 4)
2. TE had no effect on SOD in seashore paspalum leaves, but increased SOD activity in bermudagrass leaves (Figure 3 and 5)
3. SOD activity was greatest in stolons of plots treated with TE (Table 1)
4. No correlation was found between turf visual quality and SOD activity

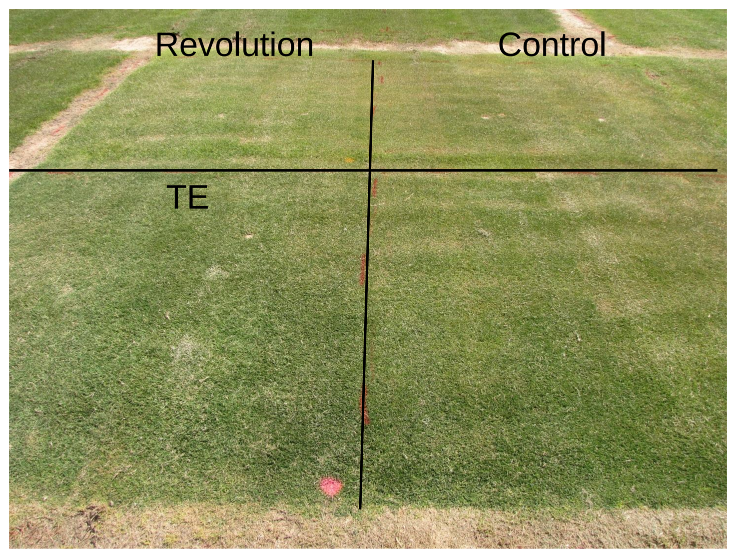

Figure 2. Bermudagrass irrigated with potable water from a subsurface drip system and treated with TE (bottom left), Revolution® (top left), or untreated (top right).

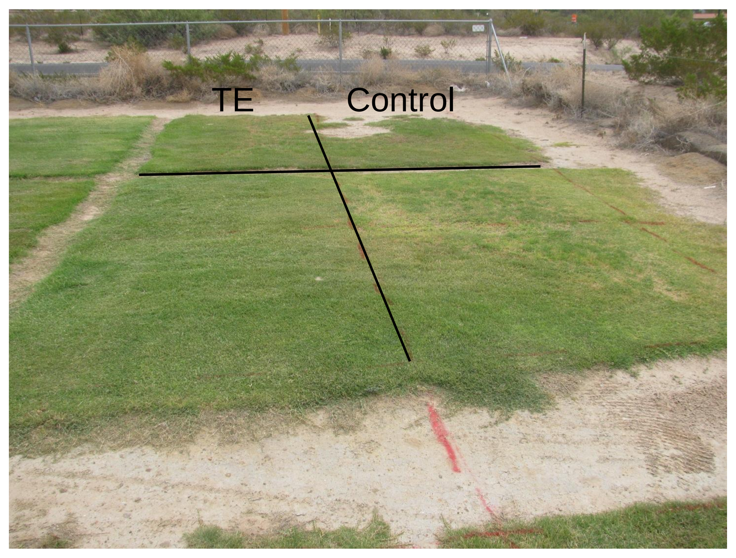

Figure 3. Bermudagrass (bottom) and seashore paspalum (top) irrigated with saline water and a sprinkler system during drought stress treated with TE (left) or untreated (right).

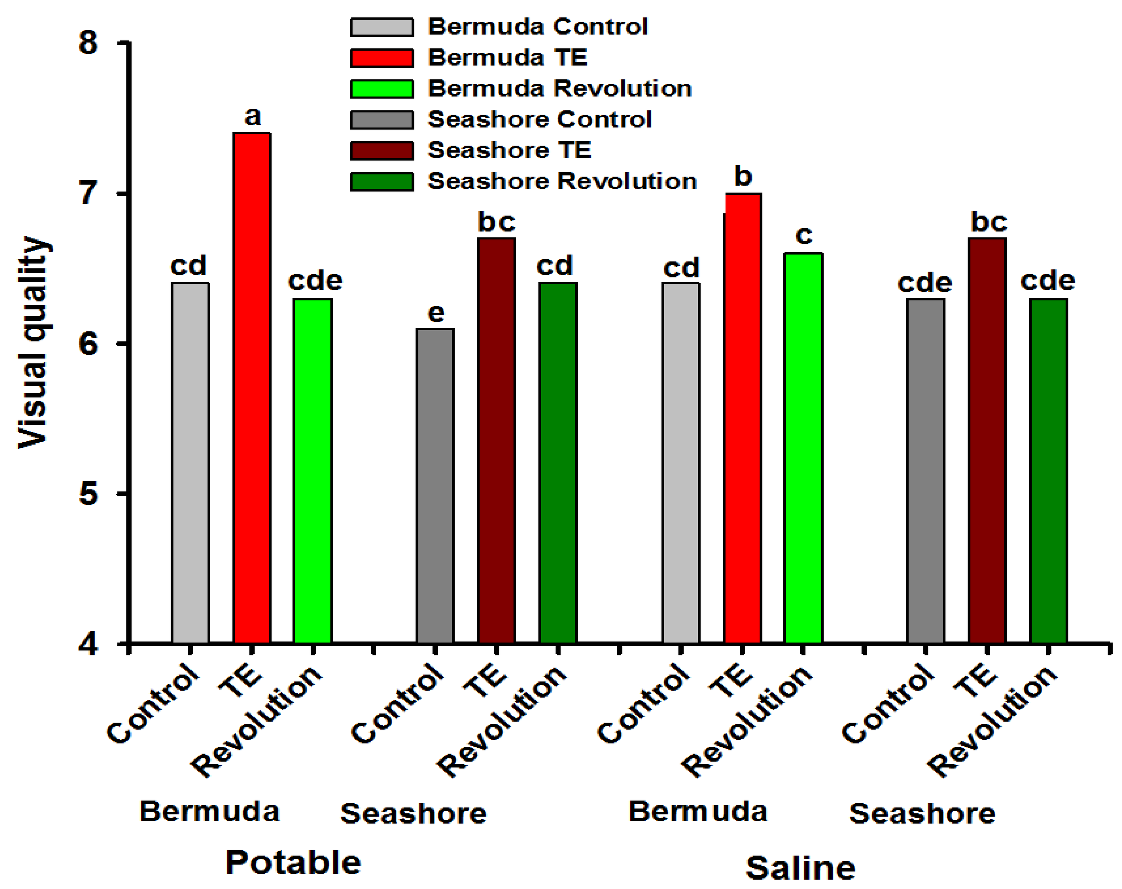

Figure 4. Visual quality of bermudagrass and seashore paspalum irrigated with either saline or potable water and treated with TE, Revolution® or left untreated. Values represent the average of 9 sampling dates (3 months and 3 years), 2 irrigation systems, and 3 replicates.

Table 1. Superoxide dismutase activity (units/mg proteins) in stolons of bermudagrass and seashore paspalum treated during 3 Summers (2010 to 2012) with either trinexapac-ethyl or Revolution®. Control plots received water only. Values represents an average of 72 data points and are pooled over 2 water qualities (saline and potable), 2 irrigation system (sprinkler and subsurface-drip), 2 grass species, 3 sampling months and 3 replicates.

Treatment	2010	2011	2012
Control	12.44 c†	18.71 ab	15.66 bc
TE	13.5 bc	21.93 ab	29.89 a
Revolution	14.07 bc	23.29 ab	16.49 bc

† Values followed by the same letter are not significantly different from one another (Fisher's protected least significant difference, α = 0.05).

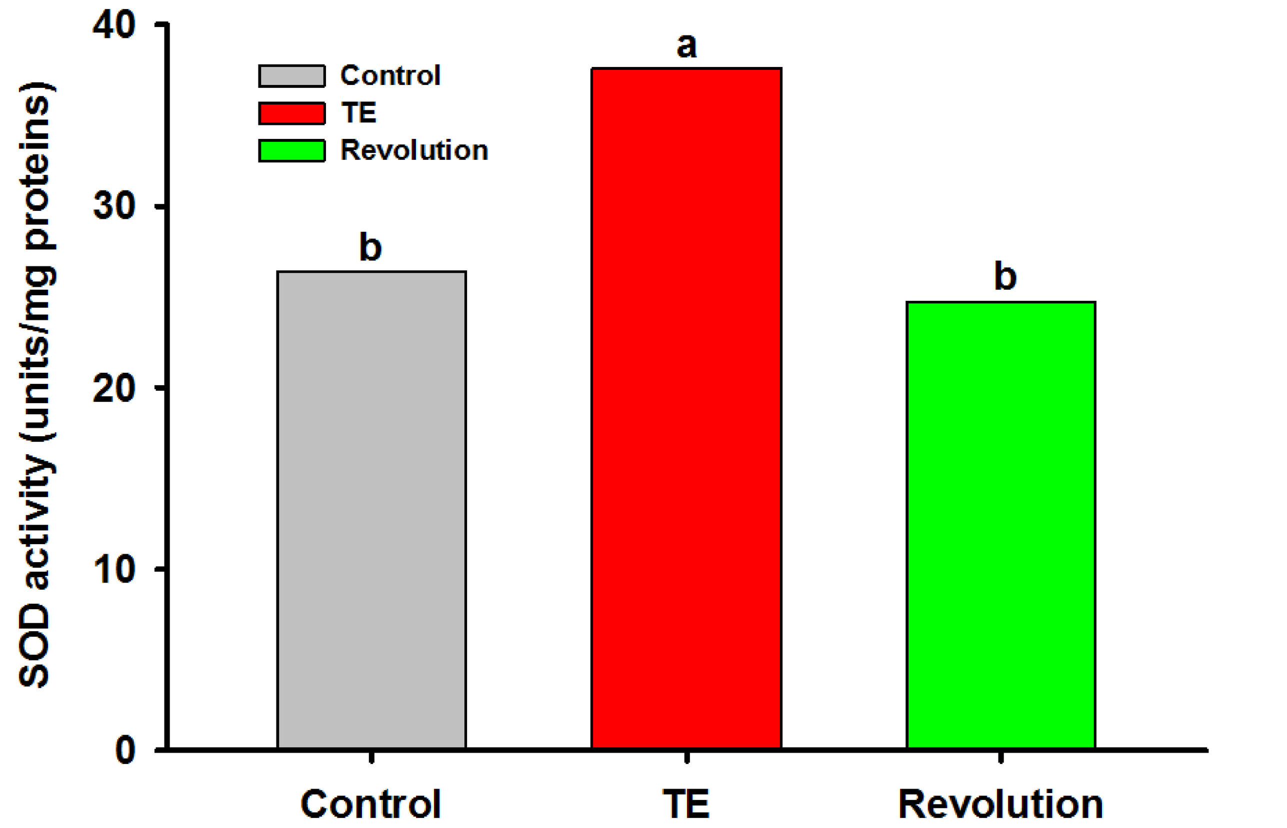

Figure 5. Superoxide dismutase activity (units/mg proteins) in leaves of bermudagrass plots treated with either TE or Revolution®. Control plots received water only. Values represent the average of 9 sampling dates (3 months and 3 years), 2 water qualities (saline and potable), 2 irrigation systems (sprinkler and subsurface-drip) and 3 replicates.

Conclusion

- Trinexapac-ethyl improved visual quality and SOD activity in bermudagrass and seashore paspalum. Enzyme activity in leaves was affected by TE only in bermudagrass
- Revolution had no effect on turf quality and SOD activity
- Superoxide dismutase activity increased during the driest year only in stolons, but not in leaves
- Generally, saline irrigation water did not affect turf quality. Nevertheless, bermudagrass irrigated with potable water and treated with TE had higher quality than bermudagrass irrigated with saline water
- SOD activity was not affected by water quality
- Irrigation systems did not affect turf quality or SOD activity suggesting that subsurface drip systems may be an alternative to sprinkler systems

Acknowledgements

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