

## Evaluation of Turfgrass Species and Varieties for Drought Tolerance in a Renovated Linear Gradient Irrigation System

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Funding: \$10,000

**Objectives:** Federal, state, and municipal efforts towards landscape water conservation highlight the importance of research identifying the most drought tolerant turfgrasses and cultural strategies for promoting water use efficiency. The objectives of this 3-year linear gradient irrigation system (LGIS) project were to 1) quantify the extent of water stress that different turfgrass species and varieties can withstand while maintaining acceptable turf quality, 2) determine the implications of deficit irrigation practices on reflective heat load generation, and 3) determine how cultural management (mowing heights and nitrogen rates) impacts performance under drought.



**Impact:** Information gained through the LGIS project is contributing to improved water conservation in managed turfgrass systems. Project results are being used to provide science based recommendations to municipalities, turfgrass managers, landscape developers, construction companies, university extension personnel, and homeowners.

**Summary:** LGIS creates a linear gradient of water availability such that the inner section of each 65 ft. plot is irrigated to 120% of reference evapotranspiration (ET<sub>o</sub>), while the outer section receives no irrigation. Main plots are split into either high or low mowing heights, and further split into either high or low nitrogen application rates within each species. Over the course of multiple years, parameters including turfgrass quality, reflective canopy and soil temperatures, soil moisture, density, fall & spring color, weed pressure, and root development have been evaluated across this gradient at points representing 'wet' (82% of ET<sub>o</sub>), 'semi-wet' (28% of ET<sub>o</sub>), 'semi-dry' (5% of ET<sub>o</sub>), and 'dry' (unirrigated) soil conditions. Although the study was not conducted under rainout shelter, prolonged (4-6 week) drought stress periods were encountered throughout the study, which challenged the turfgrasses and produced ideal conditions for meeting the objectives of this study. Irrigation was provided twice weekly to reflect commonly imposed municipal water restrictions.

Interestingly, supplemental irrigation was generally not needed to achieve acceptable quality in the warm-season grass species until mid-June of each season. This demonstrates that with adequate rainfall during winter and early spring, water storage capacity of these clay soils is

sufficient to support turfgrass growth into early summer. However, by mid-late summer of each season, considerable water stress developed within 'semi-dry' and 'dry' plot zones, producing a visible gradient in turfgrass quality across the plots (see aerial image above). The severity of this gradient differed among species and cultivars.

Of the six species studied, tall fescue generally exhibited unacceptable quality in areas of plots receiving less than 82% ETo, resulting in considerable thinning and weed pressure. Due to its poor performance when managed under irrigation deficit, it would not be recommended for use as a drought-tolerant turf option in Texas.

During the majority of moderate drought periods encountered in the study, buffalograss, sports-type bermudagrasses, and japonica-type zoysiagrasses all performed well into 'semi-dry' or 'dry' zones with only minimal levels of irrigation. Top performing cultivars within these species included '609' buffalograss, 'Tifsport' and 'Tifway 419' bermudagrass, as well as 'Empire' and 'Jamur' zoysiagrass. St. Augustinegrass entries 'Raleigh' and 'Texas Common' exhibited similar levels of drought tolerance to the other warm-season species during the first two seasons, however plots suffered severe winter kill due to prolonged freezing temperatures between the second and third year of the study. Areas within St. Augustinegrass plots receiving less than 50% ETo never fully recovered from this injury.

During the most severe drought of the study, a 6-week period in 2010 from mid-July through late August, evapotranspiration rates at the site approached 0.5 inch per day and temperatures exceeded 100° F. Unlike all earlier periods, no species maintained acceptable quality below the 28% ETo mark during this period. 'Tifsport', 'Tifway 419', and 'Celebration' bermudagrass, as well as 'Empire' and 'Palisades' zoysiagrass were noted as maintaining acceptable quality down to irrigation deficits of 28% ETo during this time, however, all other varieties required up to 82% ETo to achieve acceptable levels. With the exception of St. Augustinegrass (which suffered severe winterkill) and tall fescue, all species exhibited good recovery from drought in unirrigated areas of plots once rainfall resumed during fall or spring of the following season.

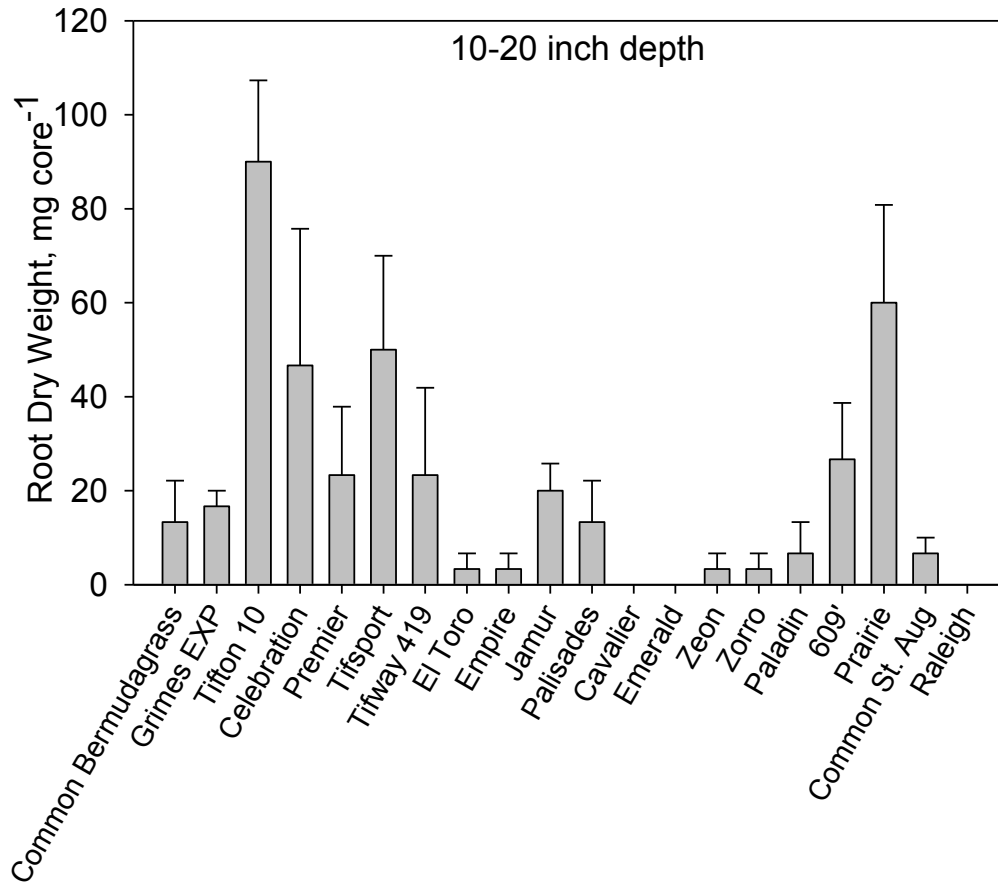
Very few consistent effects on drought tolerance could be attributed to cultural differences in mowing height and nitrogen application rate during the study.

Reducing irrigation also generated substantially greater heat loads in most species, with up to 25° F differences recorded from 'wet' to 'dry' zones of plots. Late summer canopy temperatures approached 135° F in some species. This increase was most substantial in matrella-type zoysiagrasses. Conversely, buffalograss ('609' and 'Prairie') and at times, bermudagrass ('Celebration', 'Grimes EXP', and 'Tifton 10') displayed relatively stable canopy temperature when moving from 'wet' to 'dry' zones of plots. This was likely due to deeper rooting and possibly lower transpiration rates among these species resulting in greater conservation of soil water.

At the conclusion of the study, soil samples were obtained for determining root mass within each species. Samples were taken from the 0-10 and 10-20 inch depths using a hydraulically driven soil sampling probe. Samples were obtained from the 'semi-wet' (28% ETo) plot zones. This point was selected because it was the area where transition from acceptable to

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unacceptable quality had been noted in many species. Although very little difference in root mass was noted between species at the 0-10 inch depth, noticeable differences were detected at the 10-20 inch depth (see figure below). The matrella-type zoysiagrasses had few, if any roots within the 10-20 inch depth, whereas buffalograss and bermudagrasses were the species producing the majority of roots at this depth.



Taken collectively, the results suggest that for a typical growing season on these clay soils, supplemental irrigation may not be needed for maintaining acceptable quality until early summer for any of the warm-season species studied. During moderate drought, consistently top performing species and varieties included 'sports-type' bermudagrasses 'Tifsport' and 'Tifway 419', '609' buffalograss, and japonica-type zoysiagrasses, which all maintained acceptable quality down to levels of only 5% of reference ETo in these periods. During severe drought, all species required irrigation levels of >28% ETo for maintaining acceptable quality, although the 'sports-type' bermudagrasses and japonica-type zoysiagrasses maintained the best quality.

## **Develop Resistance to Southern Chinch Bugs and Hunting Billbug in Texas Turfgrasses**

Scientists: Project Leader: James A. Reinert – Texas AgriLife Research, Dallas, TX

Cooperators: Kevin Kenworthy, University of Florida, Gainesville, FL, Ron Qu, North Carolina State University, Raleigh, NC, Yanqi Wu, Oklahoma State University, Stillwater and Brian Schwartz, University of Georgia, Tifton.

Funding: \$6,000

**Objectives:** Objectives of this study were to delineate the spread of the new virulent strain (Biotype 2) of the southern chinch bug (SCB) (*Blissus insularis*) across Texas and to evaluate germplasm from the St. Augustinegrass (*Stenotaphrum secundatum*) breeding program at Texas AgriLife Research-Dallas and other breeding programs for resistance to Biotype 2 that has overcome the resistance in 'Floratam', 'FX-10', and 'Captiva'.

**Impacts:** These cultivars have previously provided a high level of resistance (antibiosis or high mortality) to populations of SCB in Florida and Texas. The new virulent Biotype 2 of SCB that I discovered in Texas in 2005 has spread throughout most of the state based upon sample populations that I have collect. A number of samples have shown that we still have populations of SCB in Dallas, Houston, Longview, and Corpus Christy that are controlled by the resistance in both Floratam and FX-10 but no populations have been found that respond favorable to the resistance found in the new Captiva cultivar. A number of hybrids with Floratam as a parent have been identified and propagated and will be evaluated to see if one of them has resistance better than Floratam. Plant materials have been assembled and propagated to evaluate Zoysia genotypes for resistance to the hunting billbug. Additionally, at least four cooperators have been identified where trapping stations will be installed to monitor the life history of the hunting billbug under Texas conditions. These traps will also provide large populations that will be used to evaluate the germplasm in greenhouse and field studies.

### **Summary:**

**Susceptibility of turfgrasses to the southern chinch bug:** The reproductive potential of southern chinch bug on 24 cultivars from seven genera in eight turfgrasses were evaluated under greenhouse conditions (Table 1). St. Augustinegrass was the most susceptible with the highest population development. *S. secundatum* ('Raleigh', 'Texas Common', and 'Captiva') was the most susceptible among all the turfgrass genera and each produced populations  $\geq 97.5$  bugs per 15 cm diam plant within the 11-wk test period from July to September 2008. Substantial populations also developed on zoysiagrass (*Zoysia* spp.) ('Emerald', 'Empire', 'Palisades', and 'Zorro') cultivars and on '609' buffalograss (*Buchloë dactyloides*). Low population development was recorded on cultivars of bermudagrass (*Cynodon* spp.), centipedegrass (*Eremochloa ophiuroides*), seashore paspalum (*Paspalum vaginatum*), bahiagrass (*Paspalum notatum*), and tall fescue (*Festuca arundinacea*).

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**Table 1. Rate of reproduction and development of southern chinch bug on cultivars and genera of turfgrass.**

Genera of grasses	Nymphs			Adults <sup>a, b</sup>	Total <sup>a, b</sup>
Cultivars	1 <sup>st</sup> a, b	5 <sup>th</sup> a, b	Total nymphs <sup>a, b</sup>	(A)	(N + A)
<i>Stenotaphrum secundatum</i> (St Augustinegrass)					
Raleigh	34.3a*	45.8a*	163.0a*	17.8a*	180.8a* A**
Texas Common	25.3a	30.0b	117.5ab	4.3b	121.8b A
Captiva	30.7a	18.5b	93.3b	4.3bc	97.6b A
FX-10	1.0bc	0.0c	1.3d	0.0d	1.3d B
Floritam	0.8bc	0.3c	1.1d	0.0d	1.1d B
<i>Zoysia</i> spp. (Zoysiagrass)					
Palisades	5.8b	0.5c	16.5c	2.5bcd	19.0c A
Emerald	1.3bc	1.0c	8.8cd	1.0cd	9.8cd AB
Zorro	1.3bc	2.3c	8.0cd	0.0d	8.0cd AB
Empire	0.8bc	0.8c	4.3cd	1.3bcd	5.6cd AB
Cavalier	0.0c	0.0c	0.3d	0.8d	1.1d B
<i>Buchloë dactyloides</i> (Buffalograss)					
609	3.7bc	0.3c	7.5cd	2.5bcd	10.0cd ns
Prairie	0.8bc	0.0c	1.0cd	0.8d	1.8d
<i>Festuca arundinacea</i> (Tall Fescue)					
Rebel	2.0bc	1.0c	5.0cd	1.0cd	6.0cd ns
Paladin	2.8bc	0.0c	3.3cd	0.8d	4.1cd
<i>Cynodon</i> spp. (Bermudagrass)					
Tifton 10	1.3bc	0.5c	2.8cd	0.3d	3.1cd ns
Tifway	0.0c	1.3c	1.3cd	0.0d	1.3d
Texturf 10	0.3c	0.0c	0.5d	0.0d	0.5d
TifSport	0.0c	0.0c	0.0d	0.0d	0.0d
Common	0.0c	0.0c	0.0d	0.0d	0.0d
<i>Paspalum notatum</i> (Bahia grass)					
Argentine	1.8bc	0.0c	2.0cd	0.0d	2.0d ns
Pensacola	0.0c	0.0c	0.0d	0.0d	0.0d
<i>Paspalum vaginatum</i> (Seashore Paspalum)					
Seadwarf	0.3c	0.0c	1.5cd	0.5d	2.0cd ns
AZ-1	0.0c	0.0c	0.0d	0.0d	0.0d
<i>Eremochloa ophiuroides</i> (Centipedegrass)					
Tifblair	0.0c	0.3c	0.3d	0.3d	0.6d

<sup>a</sup> Mean number of 1<sup>st</sup> and 5<sup>th</sup> instars, total nymphs, adults, and total population on each turfgrass cultivar after an 11-wk development period. <sup>b</sup> Data in each column was transformed [ $\sqrt{(n + 0.001)}$ ] for analysis; untransformed means are reported.

\*Means in a column followed by the same lower case letter are not significantly different by Fishers protected LSD ( $P=0.05$ ) (Analysis among all turf groups). \*\* Means in the total column for each grass followed by the same upper case letter are not significantly different by Fisher's protected LSD ( $P=0.05$ ) or by Student's t-test (Analysis within a turf group only).

**Spread of Biotype 2 Southern Chinch Bugs:** Samples of SCB populations have been collected from the Dallas area, Waco, Austin, San Antonio, Wharton, Bay City, League City, Houston, Huntsville, College Station, Bryan, Longview, and Corpus Christi, TX. The populations were returned to the laboratory and assayed for their susceptibility to Floratam, FX-10, and Captiva<sup>®</sup> and compared to two susceptible cultivars, 'Raleigh' and 'Texas Common'. At each of these locations most of the populations expressed a high tolerance to the antibiosis resistance formerly expressed by the cultivars, Floratam, FX-10, and Captiva. However, some populations in Dallas, Houston, Longview, and Corpus Christi were highly susceptible to the resistance in Floratam and FX-10. Table 2, shows the high susceptibility of two populations in Corpus Christi as compared to the complete loss or resistance expressed by two populations in Dallas and Austin.

**Table 2.** Susceptibility or resistance at 7 and 14 days (expressed as mortality) on Floratam, FX-10, Captiva, Texas Common, and Raleigh St. Augustinegrass to populations of southern chinch bugs at locations across Texas (4-5 reps. each).

Mean % mortality (antibiosis) at 7-d and 14-d in no-choice lab experiment								
Cultivar	Dallas		Austin		Corpus Christi 1		Corpus Christi 2	
	7-d	14-d	7-d	14-d	7-d	14-d	7-d	14-d
Floratam	4 a*	48 a*	8 ab*	42 a*	56 a*	96 a*	92 a*	100 a*
FX-10	2 a	48 a	14 a	52 a	64 a	98 a	96 a	100 a
Captiva	6 a	24 b	4 b	8 b	4 b	26 b	32 b	40 b
TX Com	4 a	12 b	0 b	6 b	16 a	26 b	30 b	38 b
Raleigh	8 a	16 b	2 b	4 b	12 b	28 b	14 b	30 b

\* Means in a column for each SCB population followed by the same letters are not significantly different by Fishers protected LSD ( $P = 0.05$ ).

**Summary of Southern Chinch Bug Populations across Texas:** A summary of the results from all the tests on populations from across Texas is provided in Table 3. An average of only 40-44% mortality was expressed on Floratam and FX-10 at 7 days with the levels rising to 66-72% by 14 days. Mortality levels were similar for Raleigh and Texas Common at both 7 and 14 days exposure and only slightly higher when bugs were confined on Captiva. Mortality on Captiva never exceeded 34% at 7 days or 68% at 14 days. A mortality of ~ 10% is considered normal due to natural mortality.

**Table 3.** Summary of mean % mortality and range for sampled populations of southern chinch bug populations across Texas.

Cultivar	Mortality (%) and Range			
	7-d	Range	14-d	Range
Floratam	40%	4-92%	66%	42-100%
FX-10	44%	2-96%	72%	48-100%
Captiva	19%	4-54%	27%	8-68%
TX Common	11%	2-34%	19%	4-48%
Raleigh	11%	0-34%	15%	6-38%

## Value-Added Turfgrass Trait Development via Synergistic Mutagenesis

Scientist: Russell Jessup

Funding: \$10,000

### Objectives:

- 1) Optimize the methodology incorporating synergistic combinations of mutagens (physical and chemical) and DNA repair inhibiting treatments in several turfgrasses (bermudagrass, zoysiagrass, buffalograss, bluegrass, etc.).
- 2) Develop and screen suites of novel mutants in target turfgrass species for traits with value for breeding, marker development, and gene discovery efforts.

**Impacts:** The mutants recovered provide a valuable germplasm resource towards future efforts to develop bermudagrass, buffalograss, and blue grama cultivars with improved drought tolerance, as well as being candidates for molecular investigations of genetic mechanisms governing this phenotype in grasses. Both the recently recovered centipedegrass mutant and previously recovered bermudagrass mutant similarly provide novel germplasm for breeding and gene discovery purposes. The improved synergistic mutagenesis method further provides a deployable platform for investigating other additional traits of value across turfgrasses.

**Summary:** Exposure series to mutagens were completed for bermudagrass, buffalograss, blue grama, zoysiagrass, and centipedegrass in order to determine treatments of maximum efficiency (Figure 1).

Figure 1. Example exposure series demonstrating maximum effective mortality ( $1 \times 10^3$ ).



Synergistic mutagenesis treatments have been completed for  $5 \times 10^6$  bermudagrass seed,  $1 \times 10^6$  buffalograss seed,  $1 \times 10^6$  blue grama seed,  $1 \times 10^6$  zoysiagrass seed, and  $2 \times 10^6$  centipedegrass seed. Leaf pigment mutants remained rare events, with only a single variegated centipedegrass mutant being recently identified (Figure 2).

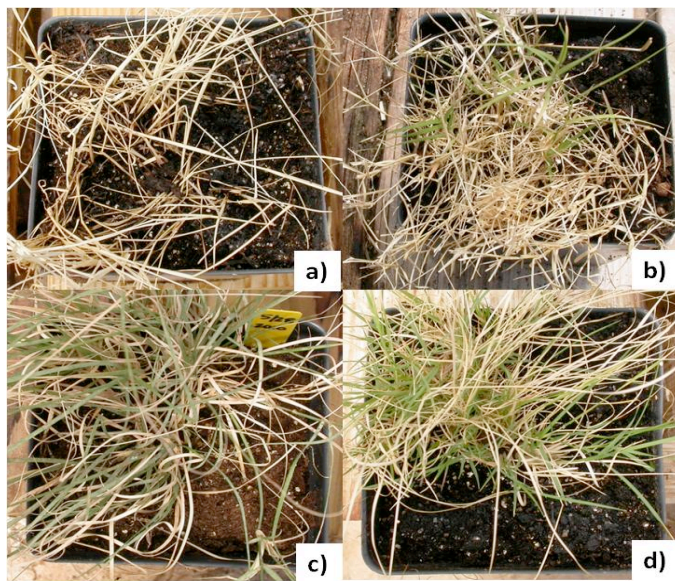


Figure 2. Centipedegrass chlorophyll deficient mutant



Putative drought tolerant mutants were recovered after 60:2:70 (dry:wet:dry) day trials in bermudagrass (15 individuals), buffalograss (11 individuals), and blue grama (6 individuals). Indicative phenotypes are shown in Figure 3 below.

Figure 3. Putative drought mutants: a) Control (untreated), b) Bermudagrass, c) Buffalograss, and d) Blue grama



### Impacts:

The mutants recovered provide a valuable germplasm resource towards future efforts to develop bermudagrass, buffalograss, and blue grama cultivars with improved drought tolerance, as well as being candidates for molecular investigations of genetic mechanisms governing this phenotype in grasses. Both the recently recovered centipedegrass mutant and previously recovered bermudagrass mutant similarly provide novel germplasm for breeding and gene discovery purposes. The improved synergistic mutagenesis method further provides a deployable platform for investigating other additional traits of value across turfgrasses.