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FIELD PERFORMANCE OF MUTANT AND SOMACLONAL VARIATION LINES OF ST. AUGUSTINEGRASS [STENOTAPHRUM SECUNDATUM (WALT.) KUNTZE]

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ABSTRACT

St. Augustinegrass (*Stenotaphrum secundatum*) is commonly used for home lawns in the southeastern United States due to its superior shade tolerance, stoloniferous growth habit, and relatively low maintenance requirements. However, there is a need for improved varieties of St. Augustinegrass that possess semi-dwarf traits and improved winter survival in the transition zone. This study was conducted to evaluate the field performance of St. Augustinegrass entries in reference to their establishment rates, growth characteristics, and winter survivability. Entries included four somaclonal variants from tissue culture (SVC3, SV20, SV27, 904AT2), two mutants from gamma ray irradiation (GF, GF2), three germplasm collections (Elm4, Ray, and WS), and 'Raleigh' as a standard. Field plots were established at three locations by plugging ten entries in a randomized complete block design with three replications. Establishment rates were measured using digital imaging and line intersect methods. Data on disease incidence, winter survival, leaf length, internode length, and stolon length were also collected. While GF2, GF, WS, and Elm4 were the fastest to establish, only the semi-dwarfs GF2 and GF exhibited qualitative traits superior to Raleigh. Germplasm collections WS and Elm4 produced quality similar to Raleigh. SV27, 904AT2, and SV20 were also semi-dwarfs that possessed better qualitative characteristics than Raleigh, although SV27 and 904AT2 were consistently slower to establish. Winter survival was inconsistent between locations with only 904AT2 and SVC3 surviving better than Raleigh at one location. This research illustrates that semi-dwarf traits are genetically stable in field plantings and can consistently produce turf quality superior to Raleigh. Further research is still needed for potential development of new cultivars from these promising lines.

Keywords: Cold tolerance, Digital image analysis, Gamma ray irradiation, Germplasm, Semi-dwarf growth, Tissue culture

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INTRODUCTION

St. Augustinegrass (*Stenotaphrum secundatum*) is a warm-season turfgrass species commonly used in the southeastern United States in home lawns and utility turf. It is desirable for its superior shade tolerance, stoloniferous growth habit, and relatively low maintenance requirements when compared to other warm-season turfgrasses like bermudagrass (*Cynodon spp.*) and zoysiagrass (*Zoysia spp.*). St. Augustinegrass performs best in sandy soils and some cultivars can persist in a range from full sun to heavy shade. It thrives throughout the southeastern United States from Texas to Florida and as far north as the coastal areas of North Carolina and Virginia. However, its lack of cold tolerance limits its use farther north or inland. St. Augustinegrass is the least cold tolerant of any of the warm-season turfgrass species and is therefore very susceptible to significant winter injury when planted outside its range of adaptation (Turgeon, 2005). Despite the demand for St. Augustinegrass improvement, limited breeding activities have been performed (Busey, 2003). Crossing (Riordan et al., 1980; Philley et al., 1998), gamma ray mutagenesis (Busey, 1980; Powell and Toler, 1980; Toler et al., 1985), and clone selection (see Busey, 2003) were employed in St. Augustinegrass breeding.

'Raleigh' is a cultivar that is known to have superior cold tolerance to many other St. Augustinegrass cultivars, but it can incur significant winter injury when planted in North Carolina (Busey et al., 1982). Raleigh is a diploid (2n = 18) cultivar (Arumuganathan et al., 1999), and taxonomically belongs to the Gulf Coast Group within the Breviflorus Race (Busey, 2003). Raleigh was originally collected from a home lawn in Raleigh, North Carolina (NC), and developed by Dr. W.B. Gilbert at North Carolina State University in the early 1980's. Like many other cultivars of St. Augustinegrass, Raleigh has coarse leaf texture and long internodes compared to other warm-season turfgrasses. Therefore, despite its superior cold hardiness, the aesthetic characteristics of Raleigh are often undesirable when planted in home lawns, much like other St. Augustinegrass varieties.

The NC sod industry has a demand for a cultivar of St. Augustinegrass that has improved cold-hardiness, as well as semi-dwarf growth characteristics when compared to existing cultivars. As a result of this demand, a multi-year study was initiated in 2003 using various approaches including germplasm collection and evaluation, inductions of somaclonal variations, and irradiation mutagenesis. This was in an attempt to create a larger germplasm pool in a short time period for selection of plant lines with improved freezing tolerance and/or semi-dwarf growth habit. Among the approaches employed, induction of somaclonal variation was applied to St. Augustinegrass breeding the first time (Li et al., 2009a). Over a four year period, 36 germplasm accessions were collected and St. Augustinegrass tissue culture responses were improved (Li et al., 2006). In addition, over 7900 plants of Raleigh were regenerated from tissue culture, and approximately 3300 plants of Raleigh were recovered from gamma ray irradiation-treated calli and dormant buds. It turned out that the approaches were efficient in generating morphological variants and mutants: 15 somaclonal variant lines and 13 mutant lines were identified with clearly altered morphological traits while still maintaining growth vigor. Among them, most had semi-dwarf growth habit (Li, 2007; Li et al., 2009a; Li et al., 2009b). The first group of 9 lines, including 4 somaclonal variants, 2 mutants, and 3 germplasm collections, were selected for field performance evaluation.

These 9 entries, along with Raleigh as a standard, were planted in early July of 2007, at three separate locations in NC. The objectives of this study were to determine differences among the varieties regarding their establishment rates, cold tolerance, and growth characteristics which included measurements on leaf length and width, internode length, disease incidence, and overall quality.

MATERIALS AND METHODS

Establishment of field plots

The source and main characteristics of the ten entries included in the field test are listed in Table 1. All of the mutants and somaclonal variants were developed from cv. Raleigh (Li, 2007). Field plots of these entries were established at three locations during the summer of 2007. These locations included two commercial sod farms and one North Carolina State University (NCSU) research facility. The research facility (NCSU Turfgrass Field Lab) is located in Raleigh, NC. The two commercial sod farms are located in Maiden, NC (Piedmont Turf), and Hendersonville, NC (Turf Mountain Sod), each about 150 kilometers and 200 kilometers west of Raleigh, NC, respectively. These sod farms were selected due to their locations within the mountains of NC and their potentially colder climates relative to the Raleigh location.

All three trial locations were fumigated using methyl bromide on 30 May 2007 at the rate of 400 kg ha^{-1}. The sites were then tilled, leveled, and prepared for planting. Trials at each site consisted of a randomized complete block design (RCBD), with three replications of 1 m^2 plots. Trials at each site were independently randomized, but they all contained the same ten entries of St. Augustinegrass as listed in Table 1. Temperature loggers (HOBO Pro v2, Onset Co., Pocasset, MA) were installed at each location and set to record both soil and air temperatures at one hour intervals for the duration of the study. On 2 July 2007 the two commercial sod farm sites were planted with eighteen greenhouse plugs of each entry per replication. Immediately prior to planting, an 18-24-12 fertilizer was applied by hand at the rate of 50 kg P ha^{-1}. Oxadiazon [2-tert-butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-Δ-1,3,4-oxadiazolin-5-one], (Ronstar G, Bayer Environmental Science, Research Triangle Park, NC) was also applied prior to planting at the rate of 3.4 kg ha^{-1} for control of summer annual weeds. The trial at the NCSU Turfgrass Field Lab was planted in a similar fashion on 3 July 2007. All sites were subsequently fertilized with 16-4-8 at 50 kg N ha^{-1} 6 weeks after planting and 22-3-14 at 50 kg N ha^{-1} 9 weeks after planting. All plots were irrigated to prevent drought stress and mowed at 7.6 cm as needed after establishment.

Table 1. Sources of ten St. Augustinegrass entries included in field performance evaluations in North Carolina.

Entry	Source†	Remarks
Raleigh	Check treatment	Most cold tolerant cultivar in market
GF	Mutant from gamma ray irradiation	Semi-dwarf
GF2	Mutant from gamma ray irradiation	Semi-dwarf
SV27	Somaclonal variant from tissue culture	Semi-dwarf
WS	Accession collected from Kernersville, NC	Cold tolerance similar to Raleigh in lab tests
Elm4	Accession collected from Raleigh, NC	Cold tolerance superior to Raleigh in lab tests
Ray	Accession collected from Polk county, NC	Cold tolerance similar to Raleigh in lab tests, shorter leaves
904AT2	Somaclonal variant from tissue culture	Semi-dwarf, most compact
SVC3	Somaclonal variant from tissue culture	Cold tolerance superior to Raleigh in lab tests
SV20	Somaclonal variant from tissue culture	Semi-dwarf

†Mutants, accessions, and somaclonal variants from Li (2007). Mutants and somaclonal variants were developed from Raleigh.

Determination of Establishment Rates and Winter Survival

Data on establishment rates were collected at each location every two weeks during establishment through a line intersect method and a digital imaging method. The line intersect method consisted of a square constructed from aluminum tubing that was placed over each plot. The square contained string on 5.08 cm centers for a total of 289 intersects. Each string intersect that contacted live turf was counted as 1 and the string intersects that did not intersect turf were counted as 0. The total number of intersects with live turf were then divided by the total number of intersects to achieve percent cover. For digital imaging, pictures were taken in full sunlight with no cloud cover using a Sony Cybershot DSCW1 3x optical zoom digital camera mounted on a tripod stand to a height of 1.5 meters. Resolution used was 1280 x 960 pixels. The pictures were then analyzed using Sigmascan Pro digital imaging software (SPSS, 2002). Analyses of the pictures were performed using a Sigmascan Pro macro named "Perform Cover Analysis" as described by Karcher and Richardson (2005). The software calculates the number of green pixels in each image and then divides that number by the total number of pixels to calculate percent coverage.

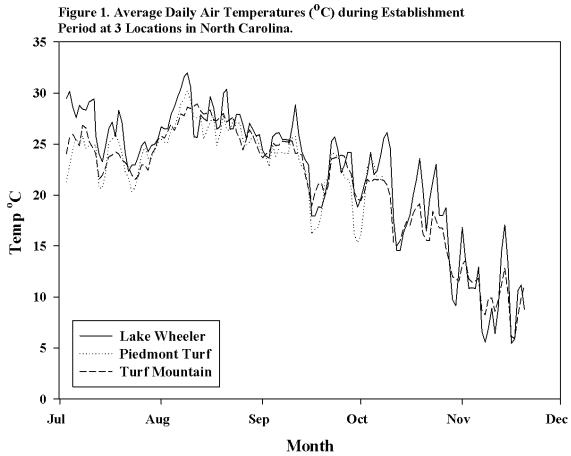
In order to assess winter survival rates after the winter of 2007-2008, digital images were taken on 1 May 2008 at each sod farm and on 2 May 2008 at the NCSU Turfgrass Field Lab. Images were taken and analyzed using the method described above with one exception, that is, the green pixels represented live turf that survived throughout the winter of 2007-2008 and brown pixels represented soil or dead turf.

Qualitative Characteristics

Large patch (*Rhizoctonia solani*) infection readings were collected on three rating dates during the 2007 establishment period utilizing a 1 to 9 scale with 1 = 100% infection, 5 = minimally acceptable infection, and 9 = no infection. Morphological characteristics were evaluated on 18 June 2008 at the NCSU Turfgrass Field Lab and included measurements of leaf lengths, internode lengths, and stolon lengths. Leaf lengths were taken by measuring the oldest leaf located on the third node from the terminal end of each stolon. Internode lengths were measured as the distance between the third node and second node of each stolon, while stolon length was measured as the total length from the third node to the terminal end of each stolon. Leaf length, internode length, and stolon length were taken and analyzed as eight subsamples from each of three replications. Overall quality ratings were taken on 17 June 2008 and were also rated on a 1 to 9 scale, where 1 = dead turf, 5 = minimally acceptable, and 9 = ideal turf.

Statistical analysis

Analysis of variance utilizing the Statistical Analysis System (General Linear Model (GLM) procedure) was individually conducted on all data sets including establishment rates, winter survival, and morphological characteristics (SAS Institute, Inc., 2003). ANOVA tables were constructed and means separation tests performed using least significant difference (LSD) test with $\alpha = 0.05$. Correlation coefficients were also determined to compare establishment rates via the line intersect method and digital image analysis method.



RESULTS AND DISCUSSION

Establishment rates and qualitative characteristics

Establishment rates of each of the ten entries varied widely and were relatively consistent across all 3 locations. Average daily air temperatures during the establishment period at all three locations were calculated and presented in Figure 1. Raleigh is known for its aggressiveness with regard to lateral spread, which was observed at all locations. At the NCSU turfgrass field lab location, no entry was statistically more established than Raleigh on any rating date except Elm4 on 10 Jul (Table 2). This trend was also observed at the two sod farm locations in which Raleigh was in the top-performing group on every rating date at Piedmont turf (Table 3) and every rating date except the first two at Turf Mountain Sod (Table 4).

Although Raleigh's quick establishment is advantageous to sod-producers, its coarse texture is a characteristic that is less desirable. Therefore, entries that are as aggressive, or even more aggressive, than Raleigh and possess finer texture would most certainly be in demand. Semi-dwarf entries in this field test that exhibited this combination include GF2 and GF (Tables 1-5). GF2 was as fast as, or faster to establish than, Raleigh over all locations and rating dates. Likewise, GF was as fast as, or faster to establish than, Raleigh over all locations and rating dates except 23 July and 14 August at Piedmont Turf. Analysis of the entries indicated that the mutants and somaclonal variants maintained the altered traits in field performance, and the observed changes were genetically stable (Li, 2007). The two mutants and three somaclonal variants had shorter lengths of leaf, internode, and stolon compared to Raleigh, whereas the fourth somaclonal variant, SVC3, actually exhibited longer leaf and stolon than Raleigh. In the overall turf quality ratings, GF, 904AT2, and SV20 exhibited significantly better quality ratings than Raleigh. Furthermore, GF and

Table 2. Establishment rates of ten St. Augustinegrass entries at NCSU Turfgrass Field Lab (Raleigh, NC) during 2007.

	Rating Date								
Treatment	10-July	24-July	15-Aug	29-Aug	11-Sept	24-Sept	9-Oct	6-Nov	20-Nov
	% Cover†								
Raleigh	27 bc	50 ab	88 a	94 a	98 a	99 a	100 a	100 a	100 a
GF2	29 ab	48 ab	84 a	91 ab	96 a	98 a	100 a	100 a	100 a
GF	28 abc	46 ab	83 a	91 ab	96 a	97 a	99 a	100 a	100 a
SV27	19 d	28 cd	64 cd	76 cd	85 b	85 b	91 c	94 b	94 b
WS	30 ab	52 a	87 a	94 a	98 a	99 a	100 a	100 a	100 a
Elm4	32 a	58 a	87 a	96 a	99 a	99 a	100 a	100 a	100 a
Ray	26 bc	38 bc	78 ab	88 b	95 a	97 a	98 ab	99 a	100 a
904AT2	10 e	19 d	59 d	72 d	81 b	85 b	92 c	95 b	95 b
SVC3	23 cd	48 ab	84 a	90 ab	96 a	97 a	98 ab	99 a	100 a
SV20	18 d	31 cd	72 bc	80 c	87 b	88 b	94 bc	95 b	95 b
LSD	4.74	13.22	9.75	6.56	6.17	6.77	5.41	3.51	3.08
Pr > F	< 0.0001	0.0003	< 0.0001	< 0.0001	< 0.0001	0.0005	0.0115	0.0061	0.0003

† Percent Cover ratings derived from Line-Intersect Method as described in Materials and Methods.
‡ Digital image analysis performed during the same period produced a correlation coefficient of r = 0.76876.

Table 3. Establishment rates of ten St. Augustinegrass entries at Piedmont Turf (Maiden, NC) during 2007.

	Rating Date						
Treatment	**9-July**	**23-July**	**14-Aug**	**27-Aug**	**10-Sept**	**25-Sept**	**8-Oct**
	% Cover†						
Raleigh	36 a	70 a	97 a	99 a	100 a	100 a	100 a
GF2	34 abc	62 ab	94 ab	97 ab	99 ab	100 a	100 a
GF	41 a	57 b	90 bc	95 abc	97 abc	98 a	99 ab
SV27	21 def	40 c	84 cde	91 cde	94 c	98 a	99 ab
WS	28 bcd	63 ab	97 ab	98 a	100 a	100 a	100 a
Elm4	35 ab	68 a	97 ab	98 a	98 ab	100 a	100 a
Ray	26 cde	57 b	95 ab	97 ab	100 a	100 a	100 a
904AT2	17 f	40 c	79 e	90 de	94 c	94 b	97 bc
SVC3	19 ef	46 c	83 de	88 e	90 d	92 b	96 c
SV20	24 def	46 c	87 cd	93 bcd	95 bc	98 a	98 ab
LSD	7.41	8.43	6.59	4.58	3.64	2.29	1.66
Pr > F	< 0.0001	< 0.0001	< 0.0001	0.0004	0.0003	< 0.0001	0.0024

† Percent Cover ratings derived from Line-Intersect Method as described in Materials and Methods.
‡ Digital image analysis performed during the same period produced a correlation coefficient of r = 0.91677.

Table 4. Establishment rates of ten St. Augustinegrass entries at Turf Mountain Sod (Hendersonville, NC) during 2007.

	Rating Date								
Treatment	**9-July**	**23-July**	**14-Aug**	**27-Aug**	**10-Sept**	**25-Sept**	**8-Oct**	**5-Nov**	**19-Nov**
	% Cover†								
Raleigh	19 bcd	32 b	78 ab	88 abc	89 abc	91 ab	93 ab	92 ab	91 ab
GF2	26 ab	32 b	75 abc	86 bc	86 bc	91 ab	93 ab	95 ab	94 ab
GF	25 ab	32 b	76 abc	88 abc	89 abc	96 a	97 ab	96 a	95 a
SV27	10 e	23 c	64 bcd	78 c	79 c	83 b	85 b	85 b	84 b
WS	28 a	46 a	88 a	96 a	98 a	99 a	99 a	100 a	100 a
Elm4	24 abc	40 a	84 a	92 ab	93 ab	95 a	97 a	98 a	100 a
Ray	15 de	23 c	66 bcd	79 c	81 bc	87 ab	92 ab	94 ab	94 ab
904AT2	12 e	16 c	53 d	64 d	63 d	68 c	71 c	74 c	74 c
SVC3	17 cde	20 c	64 cd	61 d	64 d	66 c	71 c	73 c	73 c
SV20	20 bcd	31 b	80 ab	87 abc	88 abc	90 ab	92 ab	93 ab	92 ab
LSD	7.29	7.51	16.12	12.31	11.99	12.5	11.23	9.76	9.85
Pr > F	0.0008	< 0.0001	0.0057	0.0002	< 0.0001	0.0002	0.0001	0.0001	0.0001

† Percent Cover ratings derived from Line-Intersect Method as described in Materials and Methods.
‡ Digital image analysis performed during the same period produced a correlation coefficient of r = 0.93023.

Table 5. Qualitative characteristics of ten St. Augustinegrass entries at NCSU Turfgrass Field Lab (Raleigh, NC) during 2007-2008.

Treatment	**Leaf length**	**Internode length**	**Stolon length**	**Large patch *R. solani***	**Overall turf quality**
			cm		
Raleigh	1.4 b	3.7 a	14.1 c	7.6 a†	6.3 de‡
GF2	0.9 e	2.4 c	10.2 e	7.4 a	7.0 bcd
GF	1.0 de	2.4 c	9.7 e	7.0 ab	8.3 a
SV27	1.07 de	2.0 d	8.9 f	6.3 bc	7.0 bcd
WS	1.5 b	3.8 a	14.7 ab	6.9 ab	6.7 cde
Elm4	1.5 b	3.8 a	14.3 bc	6.9 ab	6.0 e
Ray	1.14 cd	3.0 b	11.4 d	6.5 bc	6.0 e
904AT2	1.0 de	2.0 d	7.7 g	6.0 c	8.3 a
SVC3	2.2 a	3.7 a	15.1 a	3.1 d	4.3 f
SV20	1.2 c	1.6 e	7.1 g	6.0 c	7.3 bc
LSD	0.15	0.22	0.6	0.72	0.66
Pr > F	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

†Large patch ratings averaged over 4 monthly rating dates during 2007 establishment using a 1 to 9 rating scale, where 1 = 100% infection, 5 = minimally acceptable infection, and 9 = no infection.
‡Overall Turf Quality rated on a 1 to 9 scale where, 1 = dead turf, 5 = minimally acceptable, and 9 = ideal turf.

904AT2 performed better than SV20. WS and Elm4 also exhibited fast establishment rates. Elm4 established as fast as, or faster than, Raleigh over all rating dates and locations, while WS was comparable to Raleigh and only slower on 9 July at Piedmont turf. However, neither of these two entries exhibited any qualitative characteristics superior to Raleigh regarding leaf length, internode length, stolon length, disease incidence, or overall quality when rated at the NCSU Turfgrass Field Lab.

SV27 and 904AT2 were consistently the slowest to establish at all locations and rating dates while results for Ray, SVC3, and SV20 were inconsistent. Ray and SV20 both possessed shorter leaf, internode, and stolon lengths compared to Raleigh, but only SV20 exhibited better overall quality when rated on 17 June 2008 at the NCSU Turfgrass Field Lab. Generally speaking, all of the semi-dwarfs (GF, GF2, SV27, 904AT2, and SV20) produced desirable leaf, stolon, and internode lengths that were superior to Raleigh. SVC3 exhibited the coarsest leaf texture, longest stolon lengths, and lowest overall quality of any entry, including Raleigh. Although, turfgrass color was not rated in this trial, it was also observed that SVC3 possessed a lighter green color than all other entries, which is typically less desirable in terms of end use. SVC3 was more susceptible to large patch and grey leaf spot (*Pyricularia grisea*) (not rated) at all locations during the establishment period. Large patch and grey leaf spot were both observed during the establishment period and samples were submitted to the NCSU Turfgrass Diagnostic Lab for accurate diagnosis. Although both pathogens were present, it was determined that Large patch was most responsible for injury, therefore it was rated and reported in Table 5.SVC3 was observed to have the most severe infections of large patch, but also had minor incidences of grey leaf spot. The infection was severe enough that azoxystrobin, [Methyl (E)-2{2-[6-(2-cyanophenoxy)pyrimidin-4-yloxy]phenyl}-3-methoxyacrylate, (Heritage 50WG, Syngenta Crop Protection, Greensboro, NC) was applied to all plots on 25 September 2007 at all locations at the rate of 0.12 g m^{-2} to prevent plot loss.

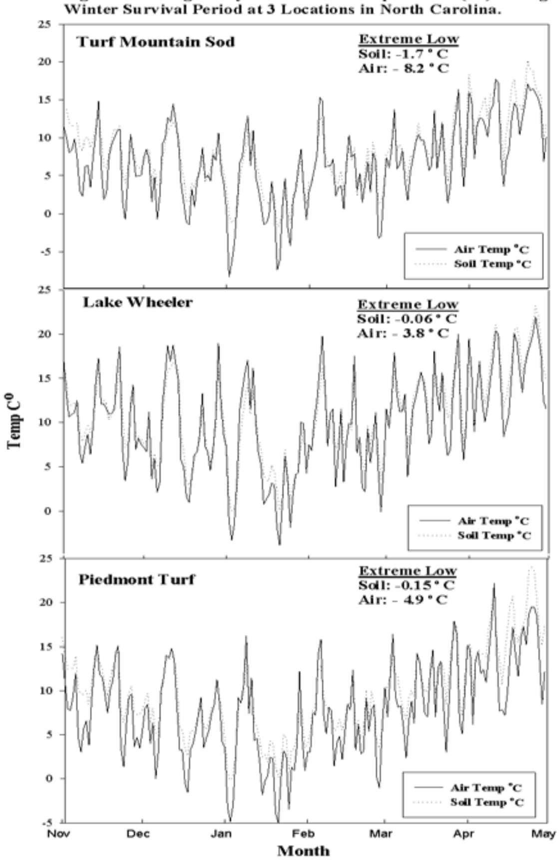
All establishment rates were collected via two methods, line-intersect and digital image analysis. The data appeared to be similar and a correlation of the two sets of data was established using SAS analysis. Correlation coefficients are provided in Tables 2, 3, and 4, which are r = 0.76876 at the NCSU Turfgrass Field Lab location, r = 0.91677 at Piedmont Turf, and r = 0.93023 at Turf Mountain Sod. Interpretation of the statistical analysis performed through SAS's GLM procedure showed that both methods consistently produced high F ratios and low *p* values. This implies that results produced through the line-intersect method and digital image analysis method were both valid. However, it was observed that digital image analysis over-estimated percent cover early in the trial and under-estimated it late in the trial. The over-estimation early in the trial was a result of a large amount of algae present in the plots. Frequent irrigation was necessary until the plugs became firmly rooted. As a result of frequent irrigation, algae appeared in the plots. Digital image analysis was unable to distinguish between green pixels of turfgrass or algae, and therefore percent coverage was overestimated during the early weeks of establishment. However, the algae subsided after the first two to three weeks as irrigation became less frequent, thus making the digital imaging results much more accurate and representative of actual establishment rates Underestimation of percent cover through digital image analysis late in the trial is a result of shadows present in the mature plots, particularly after mowing began in late September at a height of 7.6 cm. For these reasons, line-intersect method data was determined to be more representative of the establishment rates of the various entries and therefore was presented with only correlation coefficients from digital image analysis.

Table 6. Winter survival of ten St. Augustinegrass entries at 3 locations in North Carolina during 2007-08.

Treatment	Lake Wheeler	Piedmont Turf	Turf Mountain
		% Cover†	
Raleigh	89 ab	68 bcd	44 a
GF2	90 ab	79 ab	45 a
GF	86 ab	81 ab	46 a
SV27	89 ab	78 abc	37 ab
WS	90 a	66 cd	43 a
Elm4	83 ab	74 bc	41 a
Ray	72 c	71 bcd	34 ab
904AT2	81 bc	87 a	21 bc
SVC3	86 ab	61 d	13 c
SV20	90 ab	87 a	48 a
LSD	9.16	12.55	19.26
Pr > F	0.015	0.0043	0.015

† Percent Cover ratings derived from Digital Image Analysis.

Figure 2. Average Daily Soil and Air Temperatures (°C) during Winter Survival Period at 3 Locations in North Carolina.



Winter survival

In addition to establishment rates and qualitative characteristics, winter survival of St. Augustinegrass is extremely important to sod producers and end-users, particularly in the transition zone where this research is currently being conducted. Ray was the only entry to exhibit less cold tolerance than Raleigh at the NCSU Turfgrass Field Lab location, while only 904AT2 and SVC3 were less cold-tolerant at the Turf Mountain Sod location (Table 6).

However, 904AT2 and SV20 survived better than Raleigh at Piedmont Turf. As expected, the Turf Mountain Sod location produced the coldest temperatures with extreme average daily lows of –1.7 °C (soil) and –8.2 °C (air) temperatures (Figure 2).

In addition to colder temperatures, the slower establishment at Turf Mountain Sod in 2007 may have contributed to higher mortality rates the following winter. Some plots did not reach full establishment during the 2007 growing season and therefore may have entered the winter weaker and more exposed to temperature extremes. SVC3 survived better than Raleigh in the lab freezing test (Li, 2007). However it was disease-prone in the field test, and that could have weakened the plants substantially, leading to lower winter survival. Elm4 was another line showing improved cold tolerance in lab test, but seemed to perform comparable to Raleigh in the field test. More data are needed to further investigate winter survival of these entries.

CONCLUSIONS

Six mutant or somaclonal variant lines and three germplasm accessions, with either semi-dwarf growth habit or improved cold tolerance in the lab tests, were included in this field test. Substantial differences exist among St. Augustinegrass entries regarding establishment rate, morphological traits, disease incidence, winter survival, and overall turf quality. When comparing entries to Raleigh (the standard cultivar for the transition zone), GF and GF2 consistently produced promising results regarding establishment rates, vegetative characteristics, and winter survivability at the three test locations. WS and Elm4 appeared promising in terms of their establishment rates and winter survival, but did not produce any better qualitative characteristics, while Ray and SV20 had shorter leaves, internodes, and stolons but were inconsistent in their establishment rates. SV27 and 904AT2 were consistently slow to establish, but produced much better qualitative characteristics. Overall, all of the semi-dwarf entries (GF, GF2, SV27, 904AT2, and SV20) produced desirable leaf, stolon, and internode lengths that were superior to Raleigh regarding these traits. As a result of these field performance evaluations, only SVC3 can definitely be excluded in future tests. Its coarse texture, light color, and high incidence of large patch and grey leaf spot, exclude it as being an entry with any foreseeable uses.

These field trials illustrate that semi-dwarf traits within these entries observed in lab evaluations were genetically stable in field tests, and some of them also had desirable establishment rates, winter survival and overall turf quality. Another advantage of semi-dwarf traits is that the plants have shorter internodes, which lead to higher wear tolerance (Busey, 2003). Although further evaluations are still needed, some of these entries appear promising for future cultivar development.

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