tends to ration water in Palm Beach County and around Lake Okeechobee, cutting area farmers' allotment in half (4).

The potential impact of soil subsidence was ranked last as an issue for sod producers. Among others, two important mediums that deplete soil reserves are biological and mechanical subsidence. Biological subsidence of organic soils is exacerbated by drainage for crop production thereby initiating aerobic activity. A "mechanical" subsidence takes place primarily in the harvesting process when a layer of soil is removed with the grass' root system. Over the years, the combined effects of biological oxidation and soil removal have depleted reserves substantially in many parts of Florida. For instance, between 1924 and 1980, muck soils at the Everglades Research Station in Belle Glade, Florida were reduced by 66 percent (5).

In turfgrass production, organic soils are subjected to both types of subsidence whereas mineral soils, lacking substantial decomposable matter, are affected primarily by soil removal. In light of this, a logical hypothesis is that farmers located on organic soils are more concerned over the issue of soil subsidence than farmers on mineral soils. Interestingly, however, this was not found to be the case. When the data was analysed by soil type (mineral vs organic) both groups of producers were only moderately concerned over the subsidence issue. What could account for this finding? Part of the answer is attributable to simple statistics. Producers on organic soils are a minority in terms of *numbers* of growers (although they account for roughly 55% of total production) and, in analyzing the frequency of responses, all growers were assigned equal weights. Therefore, through sheer numbers, the larger group dominates the outcome. A second reason is that some mineral-based sod producers also face limited soil reserves. Simply put, both groups have individuals confronted with critical soil subsidence problems.

The fact that sod growers *en masse* assigned the least weight to soil depletion warrants a brief discussion. First of all, for *most* producers, subsidence is not an immediate threat. Assuming current practices continue, perhaps in 20, 30, or even 50 years from now it will become important, but for these individuals it is currently not a "front burner" issue. Secondly, some growers also rent land as a supplement to their owned acres. One would anticipate concern over subsidence to be inversely related to the amount of land rented. A higher ratio of rented-to-owned land implies a greater indifference over soil subsidence. Third, improved harvesting methods, like laser-planing to smooth fields, better methods of establishing turf, and use of machines that minimize unnecessary soil removal indicate concern for subsidence. Substantial grower interest in improved production efficiencies (Figure 1) may support this assertion.

Concluding Comments. Sod growers place considerable emphasis on activities that alleviate many economic pressures. A desire to reduce costs and increase demand through improved production efficiencies and marketing are indicative of this behavior. Yet significant challenges remain. Longer run problems also loom in the distance, like the impact of soil subsidence and government regulation on the cost curves and the output of the industry. Yet regardless of whether the issue is a longer or shorter run problem, it is important to distinguish between concern for an issue and its ultimate resolution. The challenge to the sod industry is to develop the will and the capacity to implement the latter. The challenge to IFAS is to help the industry toward these goals.

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COMPARISON OF OVERSEEDED GRASSES FOR PUTTING GREENS

A. E. DUDECK AND L. B. MCCARTY
University of Florida, IFAS
Environmental Horticulture Department
Gainesville, FL 32611

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Abstract. **Differences between 24 cool-season turfgasses in one study and between 16 cool-season turfgrasses in a second study were noted through the 1988-1989 winter growing season at Gainesville, FL. Establishment of overseeded grass on 'Tifgreen' Bermudagrass at the optimum seeding time in November was not correlated with germination rate in an incubator but establishment rate 7 weeks later during cooler weather was correlated with germination rate. Slow establishment of bentgrass in the field was not due to germination rate but to poor seedling vigor.**

Perennial ryegrasses, either seeded alone or in blends along with mixtures of 'Laser' rough bluegrass and/or 'Jamestown' chewings fescue, were superior in turf establishment, rate of grass cover, turf quality, and growth rate. The poor performance of 'Exeter' and 'Highland' colonial bentgrass,

'Kingstown' velvet bentgrass, and 'Streaker' redtop in these and earlier *studies* questions their value as a sole component for overseeding.

Fertilizer coated 'Penncross' creeping bentgrass performed no differently from uncoated seed. To be evaluated properly, future studies should evaluate coated and uncoated cultivars from the *same* seed lot. This has not been the case in all studies conducted to date.

Tall fescue blend of 'Mustang' and 'Rebel' and a pure stand of 'Tribute' Tall fescue performed well in our studies. Future studies involving pure stands, blends and mixtures of other *Tall fescue* cultivars are warranted.

Overseeding putting greens with cool-season turfgrasses is a recommended practice in warm-season turfgrass areas during the winter months to improve and protect the playing surface. Many species and cultivars along with numerous mixtures and blends currently are available. Turfgrass breeders and seed producers continue to release new materials into the market place making it difficult for proper evaluation (1, 3). The purpose of these studies was to evaluate the suitability of selected cool-season turfgrass species and/or cultivars for overseeding in north Florida.

Materials and Methods

Two separate studies were conducted during the 1988-1989 winter period. Twenty-four entries of cool-seson grasses listed in Table 1 were overseeded on a 'Tifgreen' Bermudagrass putting green at the IFAS Turfgrass Field Laboratory, Gainesville, FL on 8 Nov. 1988. A second study involving 16 entries listed in Table 1 were overseeded adjacent to the first study on 28 Dec. 1988. The test area was verticut in several directions and topdressed one week before seeding with a fumigated soil identical to the Arrendondo fine sand (loamy, silicious, hyperthemic, Grossarenic Paleudult) at the rate of 7.4 ft^3 per 1,000 sq. ft. (approximately one-eighth inch of soil). After watering, the site was dragged and watered daily.

Large seeded entries such as ryegrass were applied by hand to each plot. Small seeded entries such as bentgrass were diluted with a handful of soil before hand seeding. After seeding, both sites were again topdressed to cover the seed. Preventative fungicides and insecticides were applied as needed throughout the study to minimize disease and insect problems, respectively. Even with preventative applications of fungicides, above normal winter temperatures with overcast, foggy days caused pythium problems, especially in the first study. Light frequent irrigation was applied twice a day for the first two weeks after seeding. Irrigation was then reduced to a frequency of once per day to meet daily evapotranspiration loss. Fertilizer was applied biweekly, rotating between a 16-4-10, 15-0-15, and ammonium sulphate. Fertilizer rate was at the equiva-

Table 1. Seeding rates of cultivars, mixtures, and blends of cool-season turfgrasses overseeded 8 Nov. (Study 1) and/or 28 Dec. 1988 (Study 2) on Tifgreen Bermudagrass putting green at Gainesville, FL.

Entree	Seeding Rate lbs./1000 sq. ft.	Study
Fiesta Perennial ryegrass	35	1
Gator Perennial ryegrass	35	1
Marvelgreen Supreme Ryegrass blend (50% Palmer, 30% Prelude, 20% Yorktown II)	35	1 & 2
Perennial ryegrass blend (40% Gator, 30% Repell, 30% Fiesta II)	35	2
Marvelgreen and Jamestown Chewings fescue (75:25)	30	1 & 2
Jamestown Chewings fescue	25	1 & 2
Victory Chewings fescue	25	1 & 2
Mustang and Rebel Tall fescue (50:50)	25	1
Tribute Tall fescue	25	2
Marvelgreen and Laser Rough bluegrass (85:15)	25	1 & 2
Marvelgreen, Jamestown, Laser (60:25:15)	25	1 & 2
Jamestown and Laser (80:20)	18	1 & 2
America Kentucky bluegrass	10	1
Banff Kentucky bluegrass	10	1
Columbia Kentucky bluegrass	10	2
Colt Rough bluegrass	10	1 & 2
Laser Rough bluegrass	10	1 & 2
Sabre Rough bluegrass	10	1 & 2
Laser and Southshore Creeping bentgrass (60:40)	7	1 & 2
Exeter Colonial bentgrass	5	1
Highland Colonial bentgrass	5	1
Coated Penncross Creeping bentgrass	5	1
Southshore Creeping bentgrass	5	1
Penncross Creeping bentgrass	5	1 & 2
Pennlinks Creeping bentgrass	5	1
Streaker Redtop	5	1 & 2
Kingstown Velvet bentgrass	5	1

Table 2. Germination rate and total germination of selected cool-season grasses after 33 days with 8-hour photoperiods at 86°F with a light intensity of 10 W m^{-2} and 16-hour dark period at 59°F.

Cultivar	Species[z]	Study	Germination Total	Germination Rate[y]
Kingstown	VB	1	97.4 a-c[x]	19.1 a
Highland	Col B	1	97.9 ab	19.1 a
Coated Penncross	CB	1	98.1 a	18.9 ab
Gator	PR	1	96.0 a-c	18.7 a-c
Penncross	CB	1	96.5 a-c	18.4 a-d
Exeter	Col B	1	95.7 a-c	18.2 b-e
Marvelgreen/Laser	PR/RB	1 & 2	96.7 a-c	18.2 b-e
Marvelgreen Supreme	PR	1 & 2	94.5 a-d	18.1 b-e
Streaker	RT	1 & 2	93.6 c-e	18.0 c-e
Colt	RB	1 & 2	95.1 a-d	18.0 c-e
Laser	RB	1 & 2	96.7 a-c	17.6 d-f
Laser/Southshore	RB/CB	1 & 2	96.7 a-c	17.6 d-f
Marvelgreen/Jamestown Laser	PR/CF	1 & 2	96.7 a-c	17.5 e-g
Ryegrass blend	PR	2	90.9 de	17.2 f-h
Marvelgreen/Jamestown	PR/CF	1 & 2	89.7 ef	17.1 f-h
Southshore	CB	1	93.7 b-e	16.7 g-i
Tribute	TF	2	96.3 a-c	16.5 h-j
Fiesta	PR	1	86.1 f	16.1 i-k
Jamestown/Laser	CF/RB	1 & 2	97.2 a-c	15.7 jk
Jamestown	CF	1 & 2	96.0 a-c	15.6 k
Pennlinks	CB	1	91.1 de	15.5 k
Mustang/Rebel	TF	1	86.5 f	13.6 l
Victory	CF	1 & 2	68.5 hi	9.5 m
Banff	KB	1	76.1 g	8.1 n
America	KB	1	70.7 h	7.4 no
Sabre	RB	1 & 2	64.5 i	6.8 o
Penncross	CB	2	53.4 j	5.6 p

[z]CB = creeping bentgrass, CF = Chewings fescue, Col B = Colonial bentgrass, KB = Kentucky bluegrass, PR = Perennial ryegrass, RB = Rough bluegrass, RT = Red top, TF = Tall fescue, VB = Velvet bentgrass.
[y]Germination rate = sum of average daily germination percentage.
[x]Means within columns with the same letter are not significantly different (P = 0.05) using Waller-Duncan k-ratio *t* test.

lent of 0.5 pounds of N per 1,000 sq. ft. Plots were mowed at least three times per week at 3/8 of an inch, and clippings were removed.

Field data were gathered on rate of establishment based on visual estimates of percent overseeded cover every three to four days during the first two months and then weekly thereafter. Data on percent cover were first transformed using angular or square root transformations accordingly before statistical analyses (2). Final data were retransformed back and presented in tabular form as retransformed treatment means on a monthly basis. Rate of ground cover was calculated as the sum of average daily ground cover estimates for the first 30 days after seeding. Turf quality estimates were recorded twice a week throughout the first month after seeding and then weekly thereafter but were summarized in tabular form as average monthly estimates. A rating scale of 1 to 9 was used where 1 = poor and 9 = best turf quality. Color was visually rated on a 1 to 9 scale where 1 = yellow-green and 9 = blue-green color. To measure growth rates, clippings were collected periodically by harvesting a longitudinal mower swath taken through the center of each plot. Samples were dried for a minimum of 48 hours at 150°F, weighed, and presented in tabular form as growth rates in dry matter production of shoot growth in kilograms per hectare per day.

As a further check on establishment rates in the field, a germination test was conducted in a controlled environment incubator to accurately assess total germination and germination rate between grasses. Seed were incubated for four weeks on a 1% agar medium in plastic petri dishes. Dishes were sealed with a plastic film to minimize water loss over time. Preweighed samples to approximate 100 seeds were sown per dish. Four replicates in a randomized complete block were seeded. Dishes were placed in an incubator at 59°F in darkness for 16 hours and 86°F during the 8-hour light period. Light intensity was 10 Wm^{-2}. Germinated seedlings which had roots and shoots as seen at 2X magnification were counted and removed every 3 to 4 days. Germination rate was calculated and presented in tabular form as the sum of average daily percent germination.

Both studies were arranged as randomized complete block designs each with four replications. Plot size was four by six feet. All data were subjected to analyses of variance and means were separated using Waller-Duncan analyses at the 5% level of probability.

Results and Discussion

Grasses differed markedly in rate and total germination in the first study (Table 2). Uncoated 'Penncross'

Table 3. Rate of ground cover during the first 31 days after seeding on 8 Nov. 1988, days to 50% cover, and average monthly ground cover estimates of cool-season grasses overseeded on Tifgreen Bermudagrass at Gainesvile, FL.

			Ground Cover						
			1988			1989			
Cultivar	Species[z]	$Cover_{50}$	Cover Rate[x]	Nov.	Dec.	Jan.	Feb.	Mar.	Mean
		d	%						
Gator	PR	7.4±0.5	41 a[w]	81 a	98 a	88 a	82 a	89 a	86 a
Marvelgreen/Laser	PR/RB	10.5±1.3	32 c-e	65 c-e	92 bc	85 a	77 ab	84 ab	79 b
Marvelgreen	PR	7.1±0.9	40 a	80 a	96 ab	80 a-c	62 bc	74 b-f	78 b
Fiesta	PR	8.0±1.2	38 ab	75 ab	95 a-c	79 a-d	64 b-d	77 b-d	77 bc
Marvelgreen/Jamestown/Laser	PR/CF/RB	9.8±1.2	34 bc	67 cd	94 bc	81 ab	66 b-d	80 bc	77 bc
Mustang/Rebel	TF/TF	11.8±1.3	30 de	60 d-f	91 b-d	79 a-d	68 a-c	80 bc	75 b-d
Marvelgreen/Jamestown	PR/CF	8.8±1.1	36 bc	71 bc	95 a-c	73 b-e	53 c-g	74 b-f	73 b-e
Victory	CF	10.0±0.9	33 cd	67 b-d	94 bc	73 b-e	51 d-g	73 c-g	72 c-e
Jamestown/Laser	CF/RB	11.8±1.6	30 d	60 d-f	90 cd	72 b-f	55 c-g	76 be	71 de
Laser	RB	14.2±2.3	26 fg	52 fg	82 ef	73 b-e	67 bc	77 b-d	70 d-f
Colt	RB	12.0±2.6	29 ef	59 ef	84 de	71 b-g	58 c-f	73 c-g	69 d-f
Jamestown	CF	9.9±1.0	33 cd	68 bc	95 a-c	70 cg	42 f-h	66 e-i	68 g-f
Sabre	RB	17.8±3.8	20 h-j	41 hi	74 fg	68 d-h	59 c-e	75 b-e	63 f-h
Laser/Southshore	RB/CB	18.2±3.7	21 hi	42 hi	67 g-i	65 e-j	58 c-f	77 b-d	61 gh
Streaker	RT	14.9±3.0	25 g	50 g	75 e-g	66 e-i	39 g-i	64 g-i	59 hi
Pennlinks	CB	17.3±3.4	22 g-i	44 g-i	70 gh	60 f-k	46 e-h	69 d-h	57 h-j
Banff	KB	20.0±2.9	17 j-l	32 j-l	74 fg	66 e-j	43 f-h	69 d-h	57 h-j
Penncross	CB	19.0±2.8	20 h-j	39 ij	61 h-j	59 g-i	40 gh	70 d-g	54 ik
Exeter	Col B	15.5±3.5	24 gh	48 gh	74 fg	56 h-k	25 ij	56 ij	52 i-k
America	KB	23.0±4.0	15 kl	30 kl	56 ij	55 ik	45 e-h	64 g-i	50 j-l
Coated Penncross	CB	21.4±4.0	18 i-k	38 i-k	57 ij	53 jk	32 hi	64 g-i	49 k-m
Highland	Col B	17.3±3.7	19 ij	41 hi	60 h-j	48 k	32 hi	59 hi	49 k-m
Southshore	CB	30.6±5.7	13 l	26 l	41 k	56 h-k	34 hi	65 f-i	44 lm
Kingstown	VB	15.7±3.9	23 g-i	46 g-i	54 j	47 k	17 j	44 j	42 m

[z]CB = creeping bentgrass, CF = Chewings fescue, Col B = Colonial bentgrass, KB = Kentucky bluegrass, PR = Perennial ryegrass, RB = rough bluegrass, RT = Red top, TF = Tall fescue, VB = Velvet bentgrass.
[y]$Cover_{50}$ = days to 50% overseeded cover.
[x]Cover rate = sum of average daily percent ground cover estimates.
[w]Means within columns with the same letter are not significantly different (P = 0.05) using Waller-Duncan k-ratio *t* test.

creeping bentgrass averaged 96% total germination in the first study, but a different seed lot used in the second study averaged only 53% total germination. Seven other entries ranged from 65% to 89% total germination. Rate of germination varied from a high of 19% to a low of 6% between grasses. Grasses having the fastest germination rates were fertilizer coated 'Penncross' creeping bent grass, 'Kingstown' velvet bentgrass, 'Highland' colonial bentgrass and 'Gator' perennial ryegrass. These data and previous results (1) confirm that slow establishment associated with bentgrass is due to poor seedling vigor and not to rate of germination.

Grases differed markedly in rate of ground cover and ground cover estimates throughout the 1988-89 growing season (Table 3). 'Fiesta', 'Gator,' and 'Marvelgreen' perennial ryegrasses had the best cover rates averaging 40%. 'America' and 'Banff' Kentucky bluegrasses and 'Southshore' creeping bentgrass had the poorest rates of ground cover averaging only 15%. These grasses needed 24 days of growth to produce 50% ground cover compared to only 7.5 days for the best group of grasses.

Although fertilizer coated 'Penncross' creeping bentgrass was superior to uncoated seed in a previous study (1), no differences were found in these studies as measured by germination rate (Table 2), rate of ground cover or ground cover production (Table 3). These conflicting results emphasize the importance of additional experimentation before releasing preliminary results.

'Gator' perennial ryegrass had the best seasonal ground cover average of 86% compared to all other grasses. Second best seasonal average cover of 76% was obtained with 'Fiesta' and 'Marvelgreen' perennial ryegrass; 'Mustang' and 'Rebel' Tall fescue blend; and mixtures of 'Marvelgreen' with 'Laser' rough bluegrass, with 'Jamestown' chewings fescue, and with 'Jamestown' chewings fescue plus 'Laser' rough bluegrass. Pythium was a serious problem in early January. Unfortunately, we had a serious phytotoxicity problem with subsequent turf thinning due to a mechanical problem with our power sprayer. This is reflected in lowered ground cover estimates from January through the end of the study.

'Gator' perennial ryegrass consistently had the highest monthly turf quality rating as well as the highest seasonal truf quality rating of 8.5. This is also reflected in the low coefficient of variability (C.V.) of 6.9%. The second best group of grasses had an average turf quality score of 7.6 and involved 'Marvelgreen' perennial ryegrass mixed with 'Laser' rough bluegrass and the mixture of 'Marvelgreen' with 'Jamestown' chewings fescue and 'Laser' rough bluegrass. As we reported previously (1), the colonial bentgrass cultivars of 'Exeter' and 'Highland,' 'Streaker' redtop, and 'Kingstown' velvet bentgrasses had the poorest turf quality scores. Because of this they should have limited use, if any, in overseeding programs.

Foliage color differed primarily between species while cultivars within species differed little (Table 4). The Kentucky bluegrass cultivars 'America' and 'Banff' had the bluest dark-green color score of 8.4.

Dry matter production in Table 5 reflects plant growth only during the last two months of the study. These data not only confirm the better performance of bentgrass at the end of the growing season but also reflect the con-

Table 4. Turf color and quality estimates of cool-season grasses overseeded 8 Nov. 1988 on Tifgreen Bermudagrass at Gainesville, FL.

Cultivar	Species[z]	Color Jan.	Quality Jan.	Feb.	Mar.	Apr.	Mean	C.V.
		Rating[y]						%
Gator	PR	7.0 b-e[x]	8.4 a	8.6 a	8.6 a	8.5 a	8.5 a	6.9
Marvelgreen//Laser	PR/RB	7.0 b-e	7.6 b	8.4 a	8.1 ab	7.0 b	7.8 b	14.5
Marvelgreen/Jamestown/Laser	PR/CF/RB	6.5 c-f	7.6 b	8.0 a	7.4 bc	6.5 b-e	7.4 bc	15.2
Marvelgreen/Jamestown	PR/CF	6.2 d-f	7.2 bc	6.8 b-d	7.0 cd	6.9 bc	6.9 cd	16.4
Marvelgreen	PR	5.8 f-h	7.5 b	6.6 b-d	6.6 c-f	6.6 b-e	6.8 c-e	12.8
Laser/Southshore	RB/CB	7.5 bc	7.2 bc	7.2 b	6.9 c-e	5.9 e-i	6.8 c-e	14.7
Mustang/Rebel	TF/TF	5.8 f-h	6.7 c-e	6.8 b-d	6.9 c-e	6.8 b-d	6.8 c-e	10.3
Fiesta	PR	6.5 c-f	7.2 bc	6.5 cd	6.5 d-f	6.5 b-e	6.7 d-f	11.1
Jamestown/Laser	CF/RB	6.0 c-g	7.2 bc	6.9 bc	6.6 c-f	5.6 f-i	6.6 d-f	17.4
Banff	KB	8.0 ab	7.1 bc	6.4 c-e	6.6 c-f	6.0 e-h	6.5 d-g	19.4
Jamestown	CF	6.8 c-f	6.6 c-f	6.4 c-e	6.4 d-f	6.4 b-f	6.4 d-h	16.8
Victory	CF	7.2 b-d	7.2 bc	6.2 c-f	6.1 e-g	6.1 c-h	6.4 d-h	24.8
Penncross	CB	6.5 c-f	5.8 f-h	6.2 c-f	6.5 d-f	6.9 bc	6.4 d-h	21.6
Sabre	RB	6.5 c-f	6.7 c-e	6.6 b-d	6.5 d-f	5.4 hi	6.3 eh	18.4
Laser	RB	6.2 d-f	6.8 b-d	6.5 cd	6.0 fg	5.1 i	6.1 f-i	17.0
Coated Penncross	CB	6.5 c-f	5.7 g-i	5.8 e-g	6.2 d-g	6.6 b-e	6.1 f-i	13.1
Colt	RB	4.5 i	6.2 d-g	6.1 d-f	6.1 e-g	5.4 hi	5.9 g-i	18.4
Pennlinks	CB	6.0 e-g	5.5 g-j	5.2 g-i	6.4 d-f	6.5 b-e	5.9 g-i	17.4
America	KB	8.8 a	6.0 e-g	5.6 f-h	5.5 g	6.2 b-g	5.8 h-j	15.3
Highland	Col B	5.0 g-i	4.8 jk	5.0 hi	5.9 fg	6.6 b-e	5.6 ij	21.2
Southshore	CB	6.2 d-f	4.9 i-k	5.2 g-i	5.5 g	5.9 e-i	5.4 j	15.6
Streaker	RT	5.8 f-h	5.2 h-j	4.8 ij	5.9 fg	5.5 g-i	5.3 j	20.4
Exeter	Col B	5.0 g-i	4.2 kl	4.1 j	4.4 h	5.1 i	4.4 k	19.0
Kingstown	VB	4.8 hi	3.9 l	3.0 k	4.2 h	5.1 i	4.1 k	27.8

[z]CB = creeping bentgrass, CF = Chewings fescue Col B = Colonial bentgrass, KB = Kentucky bluegrass, PR = Perennial ryegrass, RB = Rough bluegrass, RT = Red top, TF = Tall fescue, VB = Velvet bentgrass.

[y]Color rated 1 to 9 where 1 = yellow-green and 9 = blue-green; quality rated 1 to 9 where 9 = best.

[x]Means within columns with the same letter are not significantly different (P = 0.05) using Waller-Duncan k-ratio *t* test.

Table 5. Dry matter production of cool-season grasses overseeded 8 Nov. 1988 on Tifgreen Bermudagrass at Gainesville, FL.

Cultivar	Species[z]	Growth Rate of Clippings				
		2 Feb.	3 Mar.	17 Mar.	31 Mar.	*Mean*
		kg ha^{-1} d^{-1}				
Sabre	RB	13.5 bc[y]	10.4 ab	22.2 a	21.4 a	16.9 a
Colt	RB	14.9 b	10.4 ab	20.2 ab	17.2 b-e	15.7 ab
Jamestown/Laser	CF/RB	12.7 c-e	8.6 b-e	22.6 a	16.9 b-f	15.2 a-c
Fiesta	PR	17.8 a	10.0 a-c	14.8 fg	15.9 d-h	14.6 b-d
Laser/Southshore	RB/CB	9.2 g-i	6.9 c-h	22.5 a	19.8 a-c	14.6 b-d
Gator	PR	18.4 a	12.1 a	14.5 f-h	11.2 i	14.1 b-f
Pennlinks	CB	7.8 ij	6.1 d-h	18.6 b-d	22.7 a	13.8 c-g
Coated Penncross	CB	7.8 ij	6.1 d-h	18.8 bc	21.7 a	13.6 c-g
Laser	RB	12.9 c-e	7.2 b-g	18.2 b-e	16.2 c-h	13.6 c-g
Marvelgreen	PR	18.7 a	8.5 b-e	12.8 f-h	14.2 d-i	13.6 c-g
Marvelgreen/Laser	PR/RB	13.1 cd	7.8 b-f	17.2 e-g	15.2 d-h	12.8 d-g
Banff	KB	9.9 gh	7.3 b-f	18.3 b-e	15.6 d-h	12.8 d-g
Mustang/Rebel	TF/TF	11.9 d-f	9.2 a-d	13.4 f-h	15.1 d-h	12.6 e-h
Streaker	RT	9.0 hi	5.1 f-j	15.6 d-g	19.9 ab	12.4 f-i
Jamestown	CF	11.5 ef	5.5 e-j	15.8 c-f	15.6 d-h	12.1 g-i
Marvelgreen/Jamestown	PR/CF	12.5 c-e	7.5 b-f	14.5 f-h	13.7 e-i	12.0 g-i
Marvelgreen/Jamestown/Laser	PR/CF/RB	13.4 cd	7.3 b-f	14.5 f-h	12.8 hi	12.0 g-i
Victory	CF	10.7 fg	5.8 d-h	12.6 gh	14.0 d-i	10.8 h-j
Penncross	CB	6.5 jk	3.8 g-j	14.3 f-h	17.1 b-f	10.4 ij
Exeter	Col B	6.4 j-l	3.5 h-j	11.4 hi	16.8 b-g	9.5 j
Highland	Col B	5.2 k-m	3.4 ij	11.5 hi	17.7 b-d	9.5 j
Southshore	CB	4.9 lm	3.5 h-j	14.2 f-h	14.6 d-i	9.3 j
America	KB	4.4 m	4.7 f-j	13.5 f-h	13.1 g-i	8.9 jk
Kingstown	VB	4.5 m	2.0 j	9.1 i	13.5 f-i	7.3 k

[z]CB = creeping bentgrass, CF = Chewings fescue, Col B = Colonial bentgrass, KB = Kentucky bluegrass, PR = Perennial ryegrass, RB = Rough bluegrass, RT = Red top, TF = Tall fescue, VB = Velvet bentgrass.
[y]Means within columns with the same letter are not significantly different (P = 0.05) using Waller-Duncan k-ratio *t* test.

founding effects of 'Tifgreen' bermudagrass regrowth because of the warmer temperatures. 'Colt' and 'Sabre' rough bluegrasses and the mixture of 'Jamestown' chewings fescue with 'Laser' rough bluegrass had the highest average growth rate of 16 kilograms per hectar per day.

Grasses in the second study, which was seeded almost two months after the first study, also differed in rate of ground cover and ground cover estimates (Table 6). The perennial ryegrass blend of 'Gator,' 'Fiesta II,' and 'Repell' and the 'Marvelgreen' blend of 'Palmer', 'Prelude,' and

Table 6. Rate of ground cover during the first 30 days after seeding on 29 Dec. 1988, days to 50% cover, and average monthly ground cover estimates of cool-season grasses overseeded on Tifgreen Bermudagrass at Gainesville, FL.

Cultivar	Species[z]	$Cover_{50}$	Cover Rate	1989 Ground Cover			
				Jan.	Feb.	Mar.	Mean
		d	%				
Marvelgreen	PR	11.5 ± 1.8	33 a[w]	65 a	93 a	95 a	85 a
Ryegrass blend	PR	12.0 ± 1.6	32 ab	64 a	82 bc	95 a	81 ab
Marvelgreen/Jamestown	PR/CF	14.6 ± 2.6	29 b	60 a	86 ab	96 a	80 a-c
Marvelgreen/Lazer	PR/RB	18.4 ± 2.0	24 c	51 b	89 ab	94 a	79 b-d
Marvelgreen/Jamestown/Laser	PR/CF/RB	17.8 ± 2.0	24 c	53 b	83 bc	93 ab	77 b-e
Tribute	TF	21.1 ± 1.9	18 de	45 cd	89 ab	95 a	76 b-e
Colt	RB	19.4 ± 2.3	24 c	50 bc	84 bc	91 a-c	75 c-e
Jamestown	CF	21.3 ± 2.9	18 de	45 cd	84 bc	92 a-c	74 d-f
Victory	CF	23.6 ± 2.9	16 de	41 de	81 b-d	90 a-d	71 e-g
Jamestown/Laser	CF/RB	22.2 ± 2.8	19 de	44 cd	74 c-e	84 d-f	68 f-h
Laser	RB	26.4 ± 4.3	20 d	43 d	72 def	85 d-f	66 g-i
Streaker	RT	29.5 ± 3.1	15 e	35 ef	73 c-e	87 c-e	65 g-i
Sabre	RB	33.2 ± 3.3	9 f	27 g	70 ef	88 b-e	62 hi
Laser/Southshore	RB/CB	34.0 ± 3.7	15 e	34 f	65 ef	83 ef	61 i
Columbia	KB	41.0 ± 5.0	7 f	21 h	60 f	80 f	54 j
Penncross	CB	67.2 ± 5.5	2 g	6 i	28 g	60 g	31 k

[z]CB = creeping bentgrass, CF = Chewings fescue, Col B = Colonial bentgrass, KB = Kentucky bluegrass, PR = Perennial ryegrass, RB = Rough bluegrass, RT = Red top, TF = Tall fescue, VB = Velvet bentgrass.
[y]$Cover_{50}$ = days to 50% overseeded cover.
[x]Cover rate = sum of average daily percent ground cover estimates.
[w]Means within columns with the same letter are not significantly different (P = 0.05) using Waller-Duncan K-ratio *t* test.

Table 7. Turf color and quality estimates of cool-season grasses overseeded 28 Dec. 1988 on Tifgreen Bermudagrass at Gainesville, FL.

Cultivar	Species[z]	Color Jan.	Quality Jan.	Feb.	Mar.	Apr.	Mean	C.V.
		Rating[y]						%
Ryegrass blend	PR	7.0 b-d[x]	8.3 a	8.4 a	7.4 a-c	7.2 a	7.9 a	13.4
Marvelgreen	PR	7.3 a-c	8.1 ab	8.1 ab	7.6 ab	7.0 ab	7.7 a	12.0
Marvelgreen/Jamestown	PR/CF	6.8 cd	8.1 ab	8.2 ab	7.4 a-c	6.8 ab	7.6 ab	14.0
Marvelgreen/Jamestown/Laser	PR/CF/RB	7.0 b-d	7.9 ab	7.8 bc	7.8 a	6.9 ab	7.5 a-c	13.7
Tribute	TF	8.0 a	6.7 de	7.3 cd	7.2 a-e	7.4 a	7.2 b-d	11.6
Marvelgreen/Laser	PR/RB	6.8 cd	7.6 bc	7.6 bc	7.3 a-d	5.9 c-f	7.1 cd	18.8
Jamestown	CF	7.8 a	7.0 cd	6.8 de	6.9 b-f	6.3 b-d	6.8 d	15.4
Victory	CF	7.8 ab	6.7 de	6.6 e	6.8 c-g	6.7 a-c	6.7 d	18.0
Jamestown/Laser	CF/RB	6.2 d	6.0 ef	7.2 c-e	7.1 a-e	6.2 b-e	6.7 d	16.9
Colt	RB	3.0 g	5.3 f	6.8 de	6.5 e-g	5.2 fg	6.0 e	20.0
Streaker	RT	4.0 f	3.0 h	5.2 f	6.6 d-h	6.9 ab	5.4 f	31.4
Laser/Southshore	RB/CB	4.0 f	3.5 gh	5.0 f	6.1 gh	6.7 a-c	5.3 f	30.0
Sabre	RB	3.8 fg	3.3 gh	5.2 f	6.2 f-h	5.5 e-g	5.1 fg	26.8
Laser	RB	4.0 f	4.0 g	5.3 f	5.9 hi	5.1 g	5.1 fg	24.7
Columbia	KB	5.0 e	3.4 gh	4.1 g	5.1 i	5.7 d-g	4.6 g	26.6
Penncross	CB	5.0 e	1.0 i	1.8 h	2.8 j	5.6 d-g	2.8 h	67.4

[z]CB = creeping bentgrass, CF = Chewings fescue, Col B = Colonial bentgrass, KB = Kentucky bluegrass, PR = Perennial ryegrass, RB = Rough bluegrass, RT = Red top, TF = Tall fescue, VB = Velvet bentgrass.
[y]Color rated 1 to 9 where 1 = yellow-green and 9 = blue-green; quality rated 1 to 9 where 9 = best.
[x]Means within columns with the same letter are not significantly different (P = 0.05) using Waller-Duncan k-ratio *t* test.

'Yorktown II' had the best ground cover rates of 32%. Because of the cooler weather, it took 12 days of growth before these grasses attained 50% ground cover compared to the 7.5 days it took the other perennial ryegrasses in the first study. 'Penncross' creeping bentgrass had the poorest ground cover rate of 2% and it took 67 days to produce 50% ground cover. These plots were seeded with the same seed lot which had the poorest germination rate and total germination under ideal growing conditions in an incubator (Table 2). In the first study, there was no correlation between germination rate in an incubator and cover rate in the field ($r = 0.3146$, $p = 0.14$), but there was a highly significant correlation between incubator germination rate and field cover rate in the second study [$r = 0.7464$, $p = 0.001$). This was due to temperature differentials in the field between both studies.

'Marvelgreen'; 'Marvelgreen' and 'Jamestown'; 'Marvelgreen', 'Jamestown', and 'Laser'; and the ryegrass blend had the best average turf quality scores of 7.7 with an average C.V. of 13.2%. Although 'Tribute' Tall fescue was second best with a seasonal average turf quality score of 7.2, it had the lowest C.V. of 11.6%. The performance of 'Tribute' in this study and that of the 'Mustang-Rebel' blend in the first study warrants further studies with overseeded tall fescue in the future.

Highest dry matter production of shoot growth during

Table 8. Dry matter production of cool-season grasses overseeded 28 Dec. 1988 on Tifgreen Bermudagrass at Gainesville, FL.

Cultivar	Species[z]	Growtn Rate of Clippings 2 Feb.	22 Feb.	3 Mar.	17 Mar.	31 Mar.	Mean
		kg ha^{-1} d^{-1}					
Marvelgreen	PR	14.7 a[y]	12.2 a	13.6 a	14.5 c	14.2 b-g	13.8 a
Colt	RB	6.7 e	9.5 bc	13.5 ab	20.1 a	17.7 bc	13.5 a
Jamestown	CF	7.7 c-e	8.2 c-e	10.4 b-d	20.4 a	17.7 bc	12.9 ab
Jamestown/Laser	CF/RB	6.1 e	7.7 c-f	10.3 c-e	21.9 a	18.1 bc	12.8 ab
Marvelgreen/Laser	PR/RB	9.3 c	10.4 ab	12.8 a-c	15.6 bc	14.1 b-g	12.4 ab
Ryegrass blend	PR	13.4 ab	9.0 b-d	11.5 a-d	14.2 c	13.4 c-g	12.4 ab
Marvelgreen/Jamestown	PR/CF	11.7 b	8.7 b-d	8.9 d-f	13.4 cd	12.5 e-h	11.0 bc
Sabre	RB	2.4 f	5.8 f-h	8.3 e-g	19.5 ab	18.6 b	10.9 bc
Victory	CF	7.1 de	7.1 d-g	7.6 e-g	15.3 bc	17.4 b-d	10.9 bc
Streaker	RT	2.4 f	5.3 gh	5.6 gh	15.4 bc	25.8 a	10.9 bc
Marvelgreen/Jamestown/Laser	PR/CF/RB	11.6 b	8.1 c-e	9.8 c-e	12.0 cd	12.9 d-g	10.9 bc
Tribute	TF	9.2 cd	6.5 e-h	6.4 fg	11.3 cd	10.3 f-h	8.7 cd
Laser	RB	2.9 f	4.6 hi	6.2 f-h	13.2 cd	14.8 b-f	8.3 d
Laser/Southshore	RB/CB	2.5 f	4.5 hi	5.5 gh	12.9 cd	15.5 b-e	8.2 d
Columbia	KB	2.4 f	2.5 ij	3.2 hi	9.5 d	9.6 gh	5.4 e
Penncross	CB	1.5 f	0.6 j	0.9 i	3.8 e	8.1 h	3.0 f

[z]CB = creeping bentgrass, CF = Chewings fescue, Col B = Colonial bentgrass, KB = Kentucky bluegrass, PR = Perennial ryegrass, RB = rough bluegrass, RT = Red top, TF = Tall fescue, VB = Velvet bentgrass.
[y]Means within columns with the same letter are not significantly different (P = 0.05) using Waller-Duncan k-ratio *t* test.

the last two months of the study was associated with the perennial ryegrass blend, 'Marvelgreen,' 'Marvelgreen'-'Laser' mixture, 'Colt' rough bluegrass, 'Jamestown' chewings fescue, and the 'Jamestown'-'Laser' mixture. 'Penncross' creeping bentgrass never established to the point where it provided acceptable ground cover in this study.

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DRIS EVALUATION OF THE NUTRIENT STATUS OF BAHIA AND ST. AUGUSTINE TURFGRASSES

G. H. Snyder, C. A. Sanchez
Everlades Research and Education Center
University of Florida
Belle Glade, FL 33430

J. S. Alrichs
formerly of ChemLawn Corporation
Columbus, OH 43085

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Abstract. **The DRIS (Diagnosis and Recommendation Integrated System) approach to interpreting the mineral analysis of turf clippings from home lawns was investigated. Turf clippings were collected from 100 bahiagrass (*Paspalum notatum* (L.) Flugge) and 182 St. Augustine (*Stenotaphrum secundatum* (Walt.) Kuntze) home lawns. Visual ratings of turf color and density were made at the time of sample collection. Tissue samples were analyzed for N, P, K, Ca, Mg, Fe, Mn, Zn, and Cu. Conventionally calculated DRIS nutrient ratio norms were reasonably similar in value for the two grasses. Some norms appeared particularly important for turf quality, and many of these involved micronutrients. A computer program based on IBM-PC BASIC was developed to use the DRIS nutrient ratio means and SD's to calculate DRIS indices for identifying nutrient imbalances and to identify the most limiting nutrients. It appears that DRIS can be a useful tool for evaluating the nutrient status of the turfgrasses studied, and the accumulation of a larger data base for these grasses is warranted to further refine the DRIS analysis. The DRIS program herein has been written in such a way as to facilitate modification when additional data are available.**

The DRIS (Diagnosis and Recommmendation Integrated System) method of interpreting nutrient content of plant tissue was first detailed by Beaufils (1). DRIS is concerned with the balance of various nutrients within the plant (7), as opposed to the more common assessment of the concentration of individual nutrients. To develop a DRIS analysis, it is necessary to determine optimum ratios for all nutrient combinations. For a given species, there appear to be specific nutrient ratios for maximum crop performance that transcend local conditions such as soil and climate. Cultivar effects appear to be minimal. The system provides a means for comparing the degree to which various nutrients limit yield, either as a result of deficiencies or excesses.

Bahiagrass (*Paspalum notatum* (L.) Flugge) and St. Augustinegrass (*Stenotaphrum secundatum* (Walt.) Kuntze) are the two species of turfgrass most often grown in Florida. St. Augustinegrass is used for home lawns, and in commercial landscapes in which an attractive appearance is desired. Bahiagrass also is used in home lawns and commercial landscapes, but generally is considered less attractive than St. Augustinegrass. However bahiagrass has a lower maintenance requirement (irrigation, fertilization, mowing), and also is widely used along highways. Fertilizer recommendations have been developed for both of these grasses (5), but little information is available for using tissue analyses to aid in the diagnosis of nutritional problems of these grasses.

Turfgrasses in Florida generally are grown in very coarse textured soils that may have been drastically altered during the construction of adjacent structures. For this reason, it often is difficult to interpret soil analyses. Additonally, soil tests generally provide little information useful for detecting micronutrient problems. Plant tissue analyses may provide a better means of detecting nutrient deficiencies and/or excesses. The present study was designed to determine the potential for using DRIS to evaluate the nutrient status of turfgrasses.

Methods and Materials

In Sept. 1984, ChemLawn (Columbus, OH) personnel used grass shears to collect leaf blades from 100 bahiagrass and 182 St. Augustinegrass home lawns in four widely separated locations in Florida: Jacksonville, Tampa Bay, Sarasota, and Ft. Lauderdale/Miami. At the time of sampling, visual ratings of turf color were made using a 1 to 4 scale (4 = "best possible"), and density was rated on a 1 to 3 scale (3 = "best possible"). A "quality" score was calculated as the multiple of the color and density ratings. Samples with a quality score exceeding 5 arbitrarily were designated as "Superior", and the others were designated as "Inferior". The tissue samples were dried at 70 C and ground in a stainless-steel Wiley mill prior to H_2SO_4:H_2O_2 digestion (4). Nitrogen and P were determined in the digestates using a Technicon Autoanalyzer. Metal ions were determined by atomic absorption spectrophotometry.

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