

OVERSEED TRIALS ON FAIRWAY AND PUTTING GREEN BERMUDAGRASS

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Abstract. Thirty cool-season turfgrasses were overseeded on a 'TifSport' bermudagrass fairway on 21 October 1998 and on a 'Tifdwarf' bermudagrass putting green on 6 November 1998 at Gainesville, FL. Both studies terminated on 31 May 1999. On the fairway, grasses with best seasonal turf quality scores, which averaged 7.3 on a scale of 1 to 9 where 9 = best, included perennial ryegrass cultivars 'Blend 1', 'Brightstar II', 'Buccaneer II', 'Catalina', 'Charger II', 'Citation III', 'Gator II', 'Paragon', 'Quickstart', and 'Roadrunner'. On the putting green, grasses with best seasonal turf quality scores, which averaged 6.9, included creeping bluegrass cultivars, 'DW 42', 'DW 184', and 'DW 208' and rough bluegrass cultivar 'Winterplay'.

Throughout the southern United States, golf courses, sports turfs, and some home lawns are overseeded annually with cool-season turfgrasses during winter months. This practice results in green, turf ground covers and improves playing surfaces when bermudagrass or other warm-season turfgrasses go dormant (Turgeon, 1999). Turfgrass breeders and seed producers continue to develop new grasses resulting in numerous cool-season grasses for overseeding. In addition to new cultivars, seed producers also formulate new grass mixtures and blends. Timely trials are needed to evaluate performance and to provide information to potential users of these grasses (Anderson and Dudeck, 1995, 1996, 1997, 1998; Anderson et al., 1995). The object of these studies was to evaluate suitability of selected cool-season turfgrass species, cultivars, mixtures, and blends for winter overseeding of a bermudagrass putting green and a fairway in north Florida.

Materials and Methods

Two concurrent studies were conducted during the 1998-1999 winter period: one under fairway conditions, the other under putting green conditions. Thirty entries of cool-season grasses listed in Table 1 were overseeded on a 'TifSport' bermudagrass (*Cynodon* spp.) fairway on 21 October 1998. The same grasses were overseeded on a 'Tifdwarf' (*Cynodon* spp.) bermudagrass putting green on 6 November 1998. Studies were conducted at the University of Florida, Institute of Food and Agricultural Sciences, Turfgrass Field Laboratory, Gainesville, FL.

Table 1. Cool-season turfgrasses overseeded at Gainesville, FL during the 1998-1999 winter period along with their composition and seed source.

Turfgrass	Components			
	Mix/ Blend	Cultivar	Species ²	Source
	%			
Gulf	100	Gulf	AR	Pickseed West, Inc.
L-93	100	L-93	CB	Check
DW 184	100	DW 184	CrB	Peterson Seed Co., Inc.
DW 208	100	DW 208	CrB	Peterson Seed Co., Inc.
DW 42	100	DW 42	CrB	Peterson Seed Co., Inc.
Pick Lh R+	100	Pick Lh R+	IR	Pickseed West Inc.
2CB	100	2CB	PR	Pure-Seed Testing Inc.
30G	100	30G	PR	Pure-Seed Testing Inc.
Brightstar II	100	Brightstar II	PR	Pure-Seed Testing Inc.
Buccaneer II	100	Buccaneer II	PR	Western Valley Plant Breeders
Catalina	100	Catalina	PR	Pure-Seed Testing Inc.
Charger II	100	Charger II	PR	Pure-Seed Testing Inc.
Citation III	100	Citation III	PR	Pure-Seed Testing Inc.
Gator II	100	Gator II	PR	International Seeds, Inc.
Navajo	100	Navajo	PR	Pure-Seed Testing Inc.
Paragon	100	Paragon	PR	Turf Merchants Inc.
Quickstart	100	Quickstart	PR	Pure-Seed Testing, Inc.
Roadrunner	100	Roadrunner	PR	Pure-Seed Testing, Inc.
Vibrant	100	Vibrant	PR	Western Valley Plant Breeders
Fuzzy	100	Fuzzy	RB	Olsen-Fennell Seeds, Inc.
Snowbird	100	Snowbird	RB	Zajac Performance Seed
Winterplay	100	Winterplay	RB	Pennington Seed, Inc.
Blend 1	33.3	Imagine	PR	Olsen-Fennell Seeds, Inc.
	33.3	Lynx	PR	
	33.3	Ice	PR	
Futura 2500	33.3	Cutter	PR	Pickseed West, Inc.
	33.3	Sunshine	PR	
	33.3	Pick LR+	IR	
Platinum Mix	40.0	Prizm	PR	Zajac Performance Seed
	40.0	Saturn II	PR	
	20.0	Snowbird	RB	
Mix 1	80.0	Brightstar	PR	Pure-Seed Testing Inc.
	20.0	Winterplay	RB	
Mix 2	60.0	Stardust	RB	Turf Merchants Inc.
	40.0	Bavaria	VB	
Mix 3	50.0	Stardust	RB	Turf Merchants Inc.
	50.0	Barracuda	RT	
Mix 4	85.0	Paragon	PR	Turf Merchants Inc.
	15.0	Stardust	RB	
Mix 5	28.3	Imagine	PR	Olsen-Fennell Seeds, Inc.
	28.3	Lynx	PR	
	28.4	Ice	PR	
	15.0	Fuzzy	RB	

²AR = Annual ryegrass, CB = Creeping bentgrass, CrB Creeping Bluegrass, IR = Intermediate Ryegrass, PR = Perennial ryegrass, RB = Rough bluegrass, RT = Red top, VB = Velvet bentgrass.

Prior to seeding, the putting green site was topdressed with an Arredondo fine sand (loamy, silicious, hyperthermic Grossarenic Paleudult), which was identical to underlying soil. Topdressing rate was 7.4 ft³ per 1000 square feet (approximately one-eighth inch of soil). The fairway site was scalped to 0.5 inch with a mower and was not topdressed before overseeding.

Table 2. Cool-season turfgrass seed quality, bulk and pure live seed (PLS) number per pound, and seeding rate for 1998-1999 overseed trials at Gainesville, FL.

Turfgrass	Purity	Germ.	Seed		PLS Rate ^a	
			Bulk	PLS	Green	Fairway
	%		#/lb		lbs/1000 sq. ft.	
2CB	97.85	97.00	200,983	190,762	37.7	11.3
30G	99.09	97.00	191,497	184,062	39.1	11.7
L-93	97.00	95.00	7,000,000	6,450,500	2.2	0.7
Blend 1	97.00	95.00	233,089	214,792	33.3	9.9
Brightstar II	98.42	94.00	212,348	196,453	36.6	11.0
Buccaneer II	89.00	92.00	231,000	189,143	38.1	11.4
Catalina	98.93	97.00	273,165	262,135	27.5	8.2
Charger II	98.86	96.00	217,537	206,455	34.9	10.5
Citation III	98.62	96.00	231,397	219,076	32.9	9.9
DW 184	78.17	90.00	1,850,000	1,301,531	11.1	3.3
DW 208	95.00	85.00	1,850,000	1,493,875	9.6	2.9
DW 42	95.00	85.00	1,850,000	1,493,875	9.6	2.9
Futura 2500	97.80	86.50	227,500	194,458	37.5	11.1
Fuzzy	97.50	91.50	2,900,000	2,587,163	5.6	1.7
Gator II	98.29	96.75	234,486	222,986	32.3	9.7
Gulf	99.70	98.00	165,639	161,839	44.5	13.3
Mix 1	98.35	98.12	723,183	697,878	27.8	83.0
Mix 2	96.00	85.00	5,742,831	4,686,150	5.5	1.6
Mix 3	99.04	92.00	4,060,763	3,698,543	5.7	1.7
Mix 4	98.88	91.00	571,565	509,721	25.2	7.5
Mix 5	97.00	95.00	1,029,376	948,569	29.3	8.4
Navajo	98.80	88.20	246,337	214,662	33.5	10.1
Paragon	98.14	92.00	281,774	254,410	28.3	8.5
Pick Lh R+	99.60	91.75	187,348	171,204	42.1	12.6
Platinum Mix	98.43	92.50	770,974	701,954	27.2	8.1
Quickstart	98.06	98.25	263,420	253,789	28.4	8.5
Roadrunner	98.18	96.00	208,640	196,649	36.6	11.0
Snowbird	97.16	96.00	1,500,000	1,399,104	10.3	3.1
Vibrant	99.00	90.00	228,000	203,148	35.4	10.6
Winterplay	98.00	99.24	2,600,000	2,528,635	5.7	1.7

^aSee text for PLS seeding rate.

A shaker bottle was used to hand seed all plots accurately and uniformly within a 4 by 6 foot seeder box. Small seeded grasses such as bentgrass (*Agrostis* spp.) and bluegrass (*Poa* spp.) were diluted with a small amount of soil prior to hand seeding. Perennial ryegrass (*Lolium perenne*) entries were seeded at a rate of 15 pure live seed (PLS) per square inch on the fairway and 50 PLS per square inch on the putting green (Table 2). Bluegrasses (*Poa* spp.) were seeded at a rate of 30 PLS per square inch on the fairway and 100 PLS per square inch on the putting green. Bentgrasses (*Agrostis* spp.) were seeded at a rate of 45 and 150 PLS per square inch on the fairway and green, respectively. After seeding, both sites were topdressed at 7.4 ft³ per 1000 square feet with Arredondo fine sand to cover seed. Preventative fungicides and insecticides were applied throughout the study to minimize disease and insect problems. Light irrigation was applied twice daily for two weeks following seeding. This was then reduced to once per day to replace water loss from evapotranspiration (Penman, 1948).

The putting green was mowed five times a week at a height of 0.25 inch. Clippings were removed only from the putting green. The fairway was mowed five times a week at a height of 0.75 inch. Both studies were fertilized every two weeks at a rate of 0.5 pound of nitrogen per 1000 square feet with a granular fertilizer having a 3-1-2 ratio of N-P₂O₅-K₂O.

Data were gathered on rate of establishment, which was based on visual estimates of percent overseed cover by two to three independent observers. These ratings were taken every

Table 3. Average temperatures (°F) 32 days after planting and maximum, minimum, average, and departure from normal air and soil temperatures at 4-inch depth from Nov. 1998 to May 1999 at Gainesville, FL.^a

Month	Location	1998-1999			Departure from 29-year average		
		Max	Min	Mean	Max	Min	Mean
32 DAP ^b	Air	80.8	55.4	68.1	6.4***	4.7***	5.6***
	Soil	74.5	69.4	71.9	6.2***	5.8***	6.0***

Nov.	Air	80.3	56.5	68.4	4.6***	4.3***	4.5***
	Soil	75.4	70.6	73.0	5.5***	5.4***	5.5***
Dec.	Air	75.0	48.6	61.8	4.6**	2.2	3.4*
	Soil	69.0	63.9	66.5	5.5***	5.0***	5.3***
Jan.	Air	72.6	44.6	58.6	3.6	0.6	2.1
	Soil	62.6	58.0	60.3	1.7	2.1*	1.9*
Feb.	Air	73.9	45.1	59.5	2.9	-0.4	1.3
	Soil	68.0	63.6	65.8	5.2***	4.5***	4.8***
Mar.	Air	76.1	43.6	59.9	-0.7	-7.3***	-4.0***
	Soil	71.1	62.4	66.8	1.2***	-0.8*	0.2
Apr.	Air	86.6	58.2	72.4	4.1***	2.0	3.0*
	Soil	82.1	73.8	77.9	4.6***	3.8***	4.2***
May	Air	86.6	60.7	73.7	-1.0	-2.2**	-1.6*
	Soil	84.1	74.9	79.5	0.3	-1.2*	-0.5

^aRecorded at Agronomy Farm, University of Florida campus.

^b32 DAP = average temperature during 32 days after planting.

*, **, *** significant at the 0.05, 0.01, or 0.001 probability levels, respectively.

Table 4. Average weekly ground cover estimates, rate of establishment, and days to 50% cool-season grass cover after overseeding a 'TifSport' bermudagrass fairway on 21 October 1998 at Gainesville, FL.

	Cover @ day				
Turfgrass	7	14	21	Cover rate ^z	Cover ₅₀ ^y
	----- % -----			d	
Gulf	26.4 a*	95.5 a	87.7 a	14.8 a	8.8 ± 3.0
Pick Lh R+	18.5 bc	79.5 b	83.8 a-d	12.3 b	10.8 ± 3.0
Buccaneer II	19.1 b	74.0 bc	85.3 a-d	12.1 bc	11.2 ± 2.4
2CB	17.9 b-d	72.6 b-d	87.0 ab	11.9 b-d	11.4 ± 2.0
Futura 2500	18.9 bc	70.3 c-e	84.7 a-d	11.8 b-e	11.6 ± 2.3
Vibrant	16.5 b-f	70.7 b-e	84.1 a-d	11.4 b-f	11.8 ± 2.6
Roadrunner	15.1 b-g	71.2 b-e	84.7 a-d	11.3 b-g	11.8 ± 2.5
Navajo	16.5 b-f	68.0 c-f	84.1 a-d	11.2 b-g	12.0 ± 2.3
30G	16.5 b-f	67.5 c-f	84.1 a-d	11.2 b-g	12.1 ± 2.3
Gator II	16.1 b-f	67.1 c-f	83.5 a-d	11.1 b-g	12.2 ± 2.4
Citation III	15.5 b-h	66.1 c-f	85.3 a-d	11.0 c-g	12.2 ± 2.0
Charger II	15.1 b-g	65.7 c-f	85.9 a-c	10.9 c-g	12.3 ± 1.8
Quickstart	17.2 b-e	59.2 f-i	82.5 b-e	10.6 d-h	13.0 ± 1.5
Blend I	14.1 c-h	63.4 d-g	87.4 a-d	10.5 e-h	12.6 ± 1.9
Brightstar II	14.8 b-h	62.0 e-h	83.0 a-d	10.5 e-h	12.8 ± 2.0
Paragon	15.8 b-f	58.8 f-i	83.0 a-d	10.4 f-i	13.1 ± 1.5
Mix 5	13.4 d-h	59.7 f-i	81.9 b-e	10.1 g-j	13.2 ± 2.1
Catalina	11.9 f-i	53.3 g-i	81.9 b-e	9.4 h-j	14.0 ± 1.4
Mix I	12.6 e-h	52.4 h-i	80.8 c-e	9.4 h-j	14.1 ± 1.3
Mix 4	10.2 h-i	50.1 i	85.9 a-c	9.1 i-j	14.2 ± 0.6
Platinum Mix	10.5 g-i	51.0 i	76.6 e-g	8.8 j	14.7 ± 2.0
Snowbird	7.4 i-j	20.7 j	79.6 d-f	6.3 k	17.4 ± 1.2
Mix 3	7.4 i-j	17.9 j-k	72.9 g-h	5.8 k-l	18.2 ± 3.3
DW 42	2.8 j	11.0 k-l	74.4 f-h	4.7 l-m	18.6 ± 0.5
DW 208	4.2 j	9.6 k-l	70.2 g-i	4.6 l-m	19.0 ± 0.8
Fuzzy	4.2 j	7.3 l	69.8 h-i	4.4 m	19.2 ± 1.9
DW 184	3.5 j	6.9 l	71.2 g-i	4.4 m	19.2 ± 0.7
Winterplay	4.6 j	9.6 k-l	62.4 j	4.3 m	19.7 ± 1.0
Mix 2	3.5 j	6.4 l	65.1 i-j	4.1 m	19.7 ± 1.4
L-93	2.8 j	6.4 l	59.5 j	3.7 m	20.1 ± 6.4

^aCover rate is a sum of averages based on visual percent overseed ground cover divided by days after planting at day 7, 14, and 21. A total of 32 observations were averaged.

^bCover₅₀ values are days to 50% overseeded cover.

*Retransformed means within columns with same letter are not significantly different ($P = 0.05$) using Waller-Duncan k-ratio t-test.

Table 5. Monthly and seasonal mean values for turf quality of cool-season grasses overseeded on a 'TifSport' bermudagrass fairway from October 1998 to May 1999 at Gainesville, FL.

Turfgrass	Quality ^a							Season	
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Mean	CV ^b
	Rating - - - - -								%
Brightstar II	6.5	7.6	8.7	8.9	8.1	5.5	7.0	7.47 a*	16
Roadrunner	6.2	7.5	8.5	8.7	8.2	5.8	7.3	7.46 a	16
Paragon	6.3	7.2	8.5	8.9	8.4	5.6	7.1	7.43 a	17
Citation III	6.3	7.0	8.5	8.9	8.2	5.9	7.2	7.42 ab	15
Catalina	5.8	7.4	8.5	8.8	8.2	5.7	7.2	7.38 ab	17
Blend 1	5.9	7.1	8.5	8.6	8.1	5.4	7.2	7.26 a-c	17
Gator II	5.5	7.0	8.4	8.8	8.4	5.4	7.3	7.26 a-c	19
Charger II	5.7	7.0	8.4	8.7	8.1	5.8	7.2	7.25 a-d	17
Buccaneer II	5.6	6.9	8.4	8.5	8.2	5.7	7.4	7.24 a-e	17
Quickstart	5.4	6.9	8.5	8.8	8.2	5.7	7.2	7.23 a-e	18
Mix 1	5.8	7.2	8.6	8.8	7.9	4.9	6.8	7.16 b-f	20
Vibrant	5.3	6.8	8.2	8.6	8.2	5.5	7.2	7.10 c-f	19
2CB	5.7	6.6	8.2	8.8	8.1	4.9	6.9	7.02 c-g	20
Futura 2500	5.8	6.8	8.0	8.4	7.8	5.2	7.1	6.99 d-g	17
Navajo	5.5	6.6	8.1	8.5	8.1	5.3	6.8	6.98 e-g	19
Mix 4	6.0	7.1	8.1	8.2	7.6	4.6	7.2	6.95 f-h	18
Platinum Mix	5.6	6.5	7.6	8.1	7.5	5.2	7.0	6.79 g-i	16
Mix 5	5.5	6.6	7.5	8.0	7.5	4.8	7.2	6.71 h-j	18
DW 184	5.0	6.3	7.5	8.1	7.3	5.5	6.6	6.63 i-j	17
DW 42	5.9	8.4	7.9	8.0	7.4	4.6	3.9	6.59 i-k	27
DW 208	5.8	8.0	7.8	8.2	7.1	4.1	4.6	6.52 j-k	26
Pick Lh R+	4.8	5.9	7.1	7.9	7.2	4.8	6.6	6.34 k-l	19
Snowbird	4.2	5.7	7.3	7.8	7.1	4.2	7.2	6.20 l-m	24
Winterplay	3.4	4.4	7.5	8.0	7.2	5.7	7.2	6.20 l-m	28
Fuzzy	3.6	4.6	7.3	7.9	7.2	5.1	7.0	6.11 l-n	27
Mix 2	3.6	4.5	7.3	7.9	7.3	4.9	7.0	6.08 m-n	28
Mix 3	3.2	4.0	7.0	8.0	7.2	5.3	7.4	6.00 m-n	31
30G	4.1	5.5	7.0	7.3	6.8	4.1	6.4	5.88 o	23
L-93	2.5	3.7	5.6	7.0	7.0	6.2	7.6	5.66 o	34
Gulf	3.1	4.3	6.1	6.5	6.1	2.9	4.0	4.72 p	32
MSD ^c	0.7	0.7	0.3	0.3	0.4	0.8	0.7	0.26	—

^aQuality visually rated on a scale of 1 to 9 where 9 = best. Seasonal mean is an average of 144 observations.

^bCoefficient of Variation is a measure of relative variation around seasonal mean for turf quality.

^cMinimum Significant Difference ($P = 0.05$) using Waller-Duncan k-ratio t -test.

*Means with same letter are not significantly different ($P = 0.05$) using Waller-Duncan k-ratio t -test.

Table 6. Seasonal average genetic color of overseed grasses and ground cover components of 'TifSport' bermudagrass, overseed grass, and Brown patch disease during transition at Gainesville, FL.

Turfgrass	Color ^a	Transition ground cover ^a		
		Bermudagrass	Overseed grass	Disease
	Rating	----- % -----		
Brightstar II	8.57 a*	40 c-f	60 e-h	0 d
Paragon	8.57 a	43 b-e	57 e-h	0 d
Citation III	8.50 a	47 b-d	53 f-h	0 d
Roadrunner	8.48 a	44 b-e	56 f-h	0 d
Catalina	8.47 a	50 bc	50 f-h	0 d
Gator II	8.41 a	36 d-f	64 d-f	0 d
Charger II	8.38 ab	51 bc	49 gh	1 cd
2CB	8.37 a-c	42 b-e	58 e-h	0 d
Quickstart	8.37 a-c	45 b-e	55 f-h	0 d
Blend 1	8.35 a-c	49 bc	51 f-h	0 d
Mix 1	8.35 a-c	30 f-h	70 c-e	3 b-d
Buccaneer II	8.16 b-d	44 b-e	56 f-h	0 d
Navajo	8.16 b-d	53 b	47 h	0 d
Vibrant	8.13 cd	45 b-e	55 f-h	0 d
Futura 2500	7.99 d	42 b-e	58 e-h	0 d
Mix 4	7.21 e	21 hi	79 gh	9 b
Platinum Mix	7.13 ef	23 hi	77 b-d	5 b-d
Mix 5	6.98 e-g	16 i	84 b	4 b-d
Mix 2	6.90 f-h	24 g-i	76 b-d	1 cd
Mix 3	6.85 gh	16 i	84 b	1 cd
Winterplay	6.75 g-i	16 i	84 b	3 b-d

Table 6. (Continued) Seasonal average genetic color of overseed grasses and ground cover components of 'TifSport' bermudagrass, overseed grass, and Brown patch disease during transition at Gainesville, FL.

Turfgrass	Color ^a	Transition ground cover ^a		
		Bermudagrass	Overseed grass	Disease
Pick Lh R+	6.68 h-j	34 e-g	63 e-g	7 bc
Fuzzy	6.54 i-k	18 i	82 bc	1 cd
DW 208	6.44 j-k	0 j	81 bc	16 a
Snowbird	6.32 k-l	18 i	82 bc	3 b-d
DW 42	6.31 k-l	2 j	78 bc	16 a
DW 184	6.31 k-l	0 j	97 a	6 b-d
30G	6.10 l-m	41 b-j	59 e-h	0 d
L-93	5.87 m	15 i	85 ab	1 cd
Gulf	4.90 n	78 a	22 i	1 cd

^aGround cover components were visually estimated during last week in May 1999. A total of 12 retransformed observations were averaged for each component.

^bGenetic color visually rated on scale of 1 to 9 where 9 = dark green color. A total of 68 observations from Nov. through May were averaged.

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

three or four days for the first three weeks after seeding. Thereafter, they were taken at least twice a month. Rate of ground cover was calculated after Maguire (1962) as the sum

Table 7. Average weekly ground cover estimates, rate of establishment, and days to 50% cool-season grass cover after overseeding a 'Tifdwarf' bermudagrass putting green on 6 Nov. 1998 at Gainesville, FL.

Turfgrass	% Cover @ day			Cover rate ^a	Cover ₅₀ ^b
	7	14	21		
	----- % -----				d
Gulf	34.9 a*	94.4 a	99 a	16.4 a	8.3 ± 1.0
Charger II	24.0 ab	92.3 a-d	99 a	14.8 ab	9.2 ± 1.1
Pick Lh R+	20.4 bc	93.4 a-c	99 a	14.4 b	9.3 ± 1.3
Futura 2500	19.8 bc	94.6 a	99 a	14.3 bc	9.3 ± 1.4
Navajo	21.0 bc	88.5 b-g	99 a	14.0 b-d	9.8 ± 0.7
2CB	16.2 b-e	94.8 a	99 a	13.9 b-d	9.5 ± 1.6
30G	18.9 b-d	89.5 a-f	99 a	13.9 b-d	9.8 ± 0.9
Buccaneer II	16.6 b-d	94.6 ab	99 a	13.8 b-d	9.6 ± 1.5
Paragon	16.4 b-e	90.7 a-e	99 a	13.6 b-e	9.9 ± 1.1
Citation III	15.3 b-f	92.2 a-d	99 a	13.5 b-e	9.9 ± 1.3
Gator II	17.1 b-d	88.2 c-g	99 a	13.5 b-e	10.1 ± 0.8
Platinum Mix	15.9 b-e	88.4 c-g	99 a	13.3 b-e	10.2 ± 0.9
Catalina	14.3 b-g	90.9 a-e	99 a	13.2 b-e	10.1 ± 1.2
Brightstar II	15.8 b-f	87.5 d-g	99 a	13.2 b-e	10.3 ± 0.8
Mix 4	15.8 b-f	85.5 e-g	99 a	13.1 b-e	10.4 ± 0.6
Roadrunner	13.0 b-i	91.3 a-e	99 a	13.1 b-e	10.2 ± 1.3
Mix 5	10.9 c-j	90.0 a-e	99 a	12.7 c-e	10.4 ± 1.3
Vibrant	13.5 b-h	82.9 f-h	99 a	12.5 d-f	10.8 ± 0.3
Blend 1	10.2 c-j	86.8 d-g	99 a	12.4 d-f	10.8 ± 1.0
Quickstart	8.0 d-j	87.8 c-g	99 a	12.1 e-g	10.9 ± 1.3
Mix 1	3.1 h-j	82.2 gh	99 a	11.0 f-h	11.8 ± 1.7
DW 208	3.6 g-j	76.0 hi	99 a	10.7 gh	12.2 ± 1.0
Snowbird	5.4 e-j	72.3 ij	97 a	10.6 gh	12.2 ± 2.7
DW 42	4.8 f-j	71.9 i-k	96 a	10.4 h	12.3 ± 5.2
Mix 3	14.1 b-g	58.1 lm	87 b	10.4 h	13.1 ± 5.5
Winterplay	13.5 b-h	57.2 lm	86 b	10.1 h	13.3 ± 6.8
Mix 2	4.3 g-j	68.8 i-k	96 a	10.1 h	12.6 ± 4.1
Fuzzy	2.5 ij	66.4 j-l	95 a	9.6 h	12.8 ± 5.7
DW 184	3.7 g-j	63.2 kl	93 ab	9.5 h	12.9 ± 6.9
L-93	1.2 j	48.9 m	75 c	7.2 i	—

^aCover rate is a sum of averages based on visual percent overseed ground cover divided by days after planting at day 7, 14, and 21. A total of 20 observations were averaged.

^bCover₅₀ values are days to 50% overseed cover.

*Retransformed means within columns with same letter are not significantly different ($P = 0.05$) using Waller-Duncan k-ratio t -test.

of average weekly ground cover estimates for the first three weeks. Since many cover estimates had zero values, percentage data were first transformed using a square root transformation (Little and Hills, 1978). Visual estimates of annual bluegrass, *Poa annua*, infestation and transition ground cover components of overseed grass, bermudagrass, and Brown patch disease, *Rhizoctonia solani*, were also transformed using either square root or angular transformations. Data from square root or arcsine transformations were then retransformed back to percentages for tabular presentation. Cover₅₀ values, which indicate days to 50% overseed ground cover, were calculated with a 95% probability. From November through May, turf quality estimates were recorded every week or two by four to five different observers. These scores were summarized and presented in tabular form as monthly averages. A rating scale from 1 to 9 was used where 1 = poor and 9 = best turf quality. Genetic color was also visually rated on a scale of 1 to 9 where 1 = yellow green and 9 = dark green foliage. Transition was evaluated by three independent observers during the last week in May of 1999.

Both studies were randomized complete block designs with four replications. All data were subjected to analysis of variance. Means were separated using a Waller-Duncan k-ratio

Table 8. Monthly and seasonal average overseed cover on a 'Tifdwarf' bermudagrass putting green following planting on 6 Nov. 1998 at Gainesville, FL.

Turfgrass	Ground cover				
	Nov.	Dec.	Jan.	Feb.	Mean ^a
	----- % -----				
DW 208	39.8 hi*	82.2 a	99.0 a	96.1 ab	79.3 a
DW 42	38.2 hi	80.9 a	99.0 a	97.5 a	78.9 ab
DW 184	33.4 i	70.1 b	99.0 a	96.7 ab	74.8 a-c
Mix 4	50.7 c-f	65.9 b-d	95.4 bc	84.9 bc	74.0 bc
Snowbird	39.1 hi	68.0 bc	97.6 ab	86.6 a-c	72.5 cd
Mix 5	50.3 d-f	60.5 d-i	89.9 de	80.6 cd	70.2 c-e
Winterplay	35.5 i	64.7 b-g	95.4 bc	77.4 c-e	67.7 d-f
Platinum Mix	52.2 b-f	61.8 c-i	88.7 de	67.5 c-h	67.5 d-f
Mix 3	36.2 hi	61.1 d-i	91.5 cd	76.2 c-e	66.0 e-g
Fuzzy	34.4 i	63.5 b-h	87.4 de	70.8 c-g	63.8 f-h
Mix 2	36.4 hi	52.3 k	84.1 ef	75.6 c-f	61.3 g-i
Paragon	53.6 b-f	60.9 d-i	67.1 hi	64.2 d-i	61.2 g-i
Navajo	54.7 b-e	58.5 f-k	67.1 hi	57.4 ej	59.2 h-j
Brightstar II	51.5 c-f	60.5 d-i	69.5 hi	51.0 g-k	58.1 i-k
Mix 1	42.5 gh	56.8 h-k	79.9 fg	53.6 f-k	58.1 i-k
Blend 1	48.3 e-g	65.5 b-e	70.5 hi	47.4 h-k	57.7 i-k
Gator II	52.7 b-f	60.9 d-i	69.5 hi	47.4 h-k	57.7 i-k
Buccaneer II	55.3 b-d	58.9 e-k	70.4 hi	42.7 i-l	57.0 i-k
Futura 2500	57.2 bc	57.2 h-k	68.9 hi	42.9 i-l	56.5 i-k
Citation III	53.8 b-f	55.6 i-k	64.7 i-k	51.4 g-k	56.3 i-k
Roadrunner	52.1 b-f	58.4 g-k	62.3 i-k	50.3 g-k	55.8 i-k
Vibrant	47.8 fg	65.2 b-f	70.0 hi	38.4 j-m	55.5 jk
Charger II	58.2 ab	59.3 d-j	68.8 hi	32.5 k-m	54.9 jk
Quickstart	47.8 fg	56.8 h-k	57.1 j-l	58.0 e-j	54.8 jk
2CB	55.8 b-d	53.2 jk	64.1 i-k	45.7 h-k	54.8 jk
Catalina	52.5 b-f	61.0 d-i	77.4 gh	22.2 l-n	52.6 k
L-93	25.2 j	42.1 l	70.0 hi	40.5 j-m	44.5 l
30G	54.2 b-f	34.2 m	66.2 h-j	20.2 mn	43.8 l
Pick Lh R+	57.2 bc	20.2 n	56.3 kl	11.3 n	36.3 m
Gulf	64.6 a	20.5 n	48.3 l	7.2 n	35.2 m

^aSeason ground cover average of 64 visual observations.

*Retransformed means within columns with same letter are not significantly different ($P = 0.05$) using Waller-Duncan k-ratio t -ratio.

tio t -test at 5% level of probability. A paired t -test was used to test differences between air and soil temperatures with 29-year averages.

Results and Discussion

Seed number per pound varied widely among cultivars within species (Table 2). Seed number per bulk pound varied from 191,497 to 281,774 for '30G' and 'Paragon' perennial ryegrass, respectively. Similarly, reported seed number per bulk pound varied from 1.5 to 2.9 million for 'Snowbird' and 'Fuzzy' rough bluegrass, respectively. Therefore, PLS content was used to equate seeding rates within grass species.

The 1998-1999 growing season was most unusual (Table 3). Above average air and soil temperatures were recorded for most months during the study. Below normal temperatures in May favored overseed grasses causing major problems with spring transition.

Fairway Study

Rate of ground cover establishment varied widely between overseed grasses (Table 4). 'Gulf' annual ryegrass had best establishment rate of 14.8% compared to all other grasses having produced 50% overseed cover in 8.8 ± 3.0 days. Second

Table 9. Monthly and seasonal mean values for turf quality on cool-season grasses overseeded on a 'Tifdwarf' bermudagrass putting green from November 1998 to May 1999 at Gainesville, FL.

Turfgrass	Quality ^a						Season	
	Dec.	Jan.	Feb.	Mar.	Apr.	May	Mean	CV ^b
	Rating							%
DW 42	6.8	8.5	8.8	8.1	5.5	1.9	7.05 a*	39
DW 208	6.8	8.5	8.5	8.0	5.2	2.2	6.95 a	38
DW 184	6.3	8.6	8.6	8.2	5.1	1.6	6.83 a	43
Winterplay	5.1	7.1	7.6	6.9	6.5	4.9	6.60 ab	18
Mix 3	4.8	6.5	7.4	5.8	6.1	4.2	6.09 bc	20
Mix 4	5.4	7.0	7.6	6.2	4.2	3.6	6.06 bc	27
Snowbird	5.6	7.3	7.4	6.2	4.3	3.2	6.03 b-d	29
Platinum Mix	4.8	6.5	6.8	5.3	5.5	4.3	5.85 c-e	18
Mix 5	4.6	6.4	7.2	6.4	4.2	3.1	5.65 c-f	30
Mix 2	4.8	6.7	7.2	5.9	3.6	3.1	5.62 c-f	32
Fuzzy	4.9	6.5	7.2	5.5	3.1	2.4	5.39 d-g	38
Mix 1	4.5	5.8	7.0	5.6	2.8	3.4	5.23 e-h	32
Paragon	4.2	4.4	6.0	4.6	4.2	5.8	5.04 f-i	17
Navajo	3.6	4.6	6.0	4.7	4.5	4.4	4.86 g-j	16
L-93	3.9	4.7	5.2	4.4	5.1	5.3	4.85 g-j	12
Buccaneer II	4.1	4.8	5.7	4.8	3.7	4.6	4.84 g-j	15
Brightstar II	4.2	4.2	5.9	4.8	4.1	4.4	4.77 g-k	14
Gator II	4.1	4.4	6.0	4.3	3.7	3.8	4.68 h-k	19
Blend 1	4.2	4.5	5.4	4.4	3.8	4.6	4.66 h-k	12
Futura 2500	3.8	4.4	5.5	4.4	3.8	4.8	4.62 h-l	15
2CB	3.2	4.1	5.6	4.4	3.9	4.9	4.56 i-l	19
Catalina	4.2	5.1	5.2	3.8	3.2	3.8	4.50 i-l	18
Citation III	3.7	4.4	5.4	4.3	3.9	4.0	4.48 i-l	14
Vibrant	3.9	4.3	5.0	4.3	3.5	4.7	4.43 i-l	13
Quickstart	3.6	3.8	5.1	4.4	4.0	4.9	4.40 i-l	14
Roadrunner	3.8	4.1	5.3	4.7	3.8	3.8	4.39 j-l	15
Charger II	3.8	4.3	4.8	4.2	3.8	3.3	4.18 kl	13
30G	2.7	4.2	4.8	4.8	3.8	2.8	3.99 l	24
Pick Lh R+	1.8	3.2	3.6	3.6	2.8	3.6	3.13 m	23
Gulf	1.8	2.9	2.7	2.9	2.8	3.2	2.71 m	17
MSD ^a	0.6	0.7	0.8	0.9	2.1	1.9	0.64	—

^aQuality visually rated on a scale of 1 to 9 where 9 = best. Seasonal mean is an average of 128 observations.

^bCoefficient of Variation is a measure of relative variation around seasonal mean for turf quality.

*Minimum Significant Difference ($P = 0.05$) using Waller-Duncan k-ratio t-test.

*Means with same letter are not significantly different ($P = 0.05$) using Waller-Duncan k-ratio t-test.

best group of grasses having an average cover rate of 11.6% included 'Buccaneer II', 'Futura 2500', 'Gator II', 'Navajo', 'Pick Lh R+', 'Roadrunner', 'Vibrant', '2CB', and '30G' ryegrasses. This group of grasses produced 50% overseed cover in 11.7 ± 2.4 days.

Overseed grasses that produced best seasonal turf quality, which averaged 7.3, included 'Blend 1', 'Brightstar II', 'Buccaneer II', 'Catalina', 'Charger II', 'Citation III', 'Gator II', 'Paragon', 'Quickstart', and 'Roadrunner' (Table 5). Turf quality was poor for all grasses during April due to higher than normal air and soil temperatures (Table 3).

Overseed grasses that had darkest green foliage scores, which averaged 8.4, included 'Blend 1', 'Brightstar II', 'Catalina', 'Charger II', 'Citation III', 'Gator II', 'Mix 1', 'Paragon', 'Quickstart', 'Roadrunner', and '2CB' (Table 6).

During transition, overseed stand was negatively correlated ($r = -0.965$ $P = 0.001$) with 'TifSport' bermudagrass during the last week in May 1999 (Table 6). 'L-93' creeping bentgrass and 'DW 184' creeping bluegrass averaged 91% overseed grass with only 7% bermudagrass. Conversely, the poor per-

Table 10. Seasonal average genetic color of overseed grasses, annual bluegrass infestation, and ground cover components of 'Tifdwarf' bermudagrass, overseed grass, and Brown patch disease during transition at Gainesville, FL.

Turfgrass	Color ^a	Transition ground cover ^a			
		Annual bluegrass	Bermuda-grass	Overseed	Disease
	Rating				%
Paragon	8.55 a*	29 e-i	2 cd	89 a	1 k
Brightstar II	8.45 ab	38 c-i	2 cd	85 a-c	10 f-k
Citation III	7.93 bc	42 b-h	5 b-d	71 a-f	9 g-k
2CB	7.91 bc	47 a-f	2 cd	81 a-e	4 jk
Roadrunner	7.89 bc	38 c-i	2 cd	69 a-g	11 f-k
Gator II	7.80 cd	53 a-d	3 cd	78 a-e	13 e-k
Blend 1	7.77 c-e	40 b-h	2 cd	74 a-e	8 g-k
Quickstart	7.77 c-e	33 d-i	3 cd	81 a-e	3 jk
Catalina	7.71 c-e	75 a	2 cd	66 a-g	16 d-j
Navajo	7.43 c-f	23 f-j	7 b-d	76 a-e	4 jk
Futura 2500	7.38 c-g	45 a-g	2 cd	70 a-f	9 g-k
Mix 1	7.27 d-g	43 b-h	8 b-d	67 a-g	19 d-j
Charger II	7.18 e-h	60 a-d	3 cd	66 b-h	20 d-i
Vibrant	7.18 e-h	57 a-e	1 d	84 a-c	7 h-k
Buccaneer II	7.09 f-h	46 a-g	1 d	82 a-d	5 i-k
Mix 4	6.77 g-i	12 j	13 b-d	64 b-h	29 b-e
Platinum Mix	6.59 h-j	29 e-i	8 b-d	74 a-e	16 d-j
Mix 3	6.57 h-j	24 f-j	10 b-d	74 a-e	11 f-k
Winterplay	6.43 i-k	20 f-j	7 b-d	75 a-e	11 f-k
Mix 2	6.23 i-l	17 h-j	18 ab	57 e-i	31 b-d
Mix 5	6.12 j-m	17 h-j	9 b-d	70 a-f	24 c-g
DW 208	5.86 k-n	0 j	14 bc	44 f-i	45 ab
Pick Lh R+	5.79 l-n	65 a-c	17 ab	59 d-i	13 e-k
Snowbird	5.77 l-n	19 g-j	11 b-d	64 c-h	26 c-f
Fuzzy	5.66 l-n	29 e-i	18 ab	57 e-i	39 a-c
L-93	5.64 l-n	45 a-g	1 d	88 ab	12 e-k
DW 42	5.61 mn	0 j	12 b-d	39 hi	53 a
DW 184	5.45 no	1 j	11 b-d	35 i	52 a
30G	4.89 o	71 ab	10 b-d	64 b-h	21 d-h
Gulf	3.96 p	71 ab	30 a	43 g-i	8 g-k

^aGround cover components were visually estimated during last week in May 1999. A total of 12 retransformed observations were averaged for each component.

^bGenetic color visually rated on scale of 1 to 9 where 9 = dark green color. A total of 28 observations during Feb. 1999 were averaged.

*Annual bluegrass visually estimated during Feb. 1999. A total of 12 retransformed observations were averaged.

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

forming 'Gulf' annual ryegrass averaged 22% overseed grass with 78% bermudagrass at the same time. Brown patch disease was especially damaging on 'DW 42' and 'DW 208' creeping bluegrass (Table 6).

Putting Green Study

Rate of ground cover varied widely between overseed grasses on the putting green (Table 7). 'Gulf' annual ryegrass and 'Charger II' perennial ryegrass had best establishment rate of 15.6% compared to all other grasses. They produced 50% overseed ground cover in 8.8 ± 1.0 days. All overseed plots were fully established in 21 days (Table 7), yet overseed ground cover decreased during December to 52% for ryegrasses, 65% for rough bluegrasses, and 78% for creeping bluegrasses (Table 8). This decrease was not noticed in the fairway trial. Apparently, abnormally high air and soil temperatures during December along with stress of low mowing height and bermudagrass competition caused reduction in overseed stands on the putting green.

Creeping bluegrass cultivars, 'DW 42', 'DW 184', and 'DW 208' and rough bluegrass cultivar 'Winterplay' had best turf quality scores, which averaged 6.9 (Table 9). This is in spite of their poor turf quality scores during April and May, which was caused by Brown patch disease activity (Table 10) due to abnormally warm air and soil temperatures (Table 3).

Overseed grasses on the putting green that had darkest green foliage, which averaged 8.5, included 'Brightstar II', and 'Paragon' perennial ryegrass (Table 10). Annual bluegrass was a serious contaminant in most plots on the green and averaged up to 75% ground cover in 'Catalina' perennial ryegrass (Table 10). A new putting green site without annual bluegrass will be used in future trials.

During transition, overseed stand was negatively correlated ($r = -0.738$ $P = 0.001$) with 'Tifdwarf' bermudagrass (Table 10). Nineteen out of 30 overseed grasses averaged 76% live overseed cover with 4% 'Tifdwarf' bermudagrass and 20% dead overseed cover due to disease during the last week in May 1999.

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BAMBOOS: THE MONSTER GRASSES

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Abstract. Bamboos differ from other grasses in their long-lived culms which are strengthened by long fibers and the presence of silica. The morphology of the plant shows some specialized characters, and an understanding of the different forms of growth shown by the rhizomes, and the pattern of their activity during the year, will make propagation more successful.

Bamboos are members of the grass family, Gramineae or Poaceae, but differences in their structure set them apart. Their study is more the province of the general horticulturist or even the forester, rather than the agronomist.

The most obvious difference, even in those which are called dwarf bamboos, and which are no bigger than a regular grass, is that their stems live for more than one season. They are strengthened by the presence of silica associated with the long fibers in the cell walls, making them resistant to rot and useful as building and craft materials. They have been used for construction in both tropical and temperate regions, for houses and sheds, ceremonial halls, farm structures, fences and bridges. They can be the material for rafts, for paper making, fuel, food and even polo balls. David Farrelly's poetic

tribute to the subject, *The Book of Bamboo*, has a chapter entitled "1000 Things" that lists alphabetically items from acupuncture needles to zithers that feature bamboo—including the carbonized bamboo filaments that gave Thomas Edison some of his first successes in developing the light bulb.

Bamboos are native to all of the tropical, subtropical and mild-temperate regions of the world, covering Asia from India through China and Japan to Korea, Africa and the great species richness of Madagascar, Australia with three endemic species, and the New World from almost 40° North (Maryland) to 47°S in Argentina. It is no wonder that this strong, flexible and very available material has figured so largely in the cultures of so many peoples. Man's activities have spread many types around, and the disturbance of natural communities has allowed bamboos to invade; in some places to such a degree that the displaced flora will never be able to recolonise.

The plant body comprises more or less erect aerial shoots with side branches bearing leaves, all supported by a system of shallow rhizomes and an extensive, dense root system. Overall plant height ranges from a few inches to the soaring, 100 ft. or more tall, timber bamboos.

The aboveground part of the bamboo, the upright culm, is usually hollow with cross walls at the nodes. Development begins below ground some time before the shoots appear, forming a number of leaves around the growing point, which is producing the first several nodes of the shoot at the full diameter that the mature culm will have. When growth begins it may be so rapid that it is easy to believe the stories of executions by strapping the prisoner over the developing shoot.

The culm has root initials at the lowest nodes and buds which will form shoots at nodes higher up the stem. These