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Impact of cultural factors on weed populations in St. Augustinegrass turf

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Managing weeds in lawns using cultural practices such as mowing, irrigation, and fertilization may be important in integrated management. A field experiment evaluated the impact of cultural factors on weed populations in St. Augustinegrass turf. Irrigation treatments were daily to replace evapotranspiration ("Daily"), weekly to saturate the root zone only when wilted ("Conditional Weekly"), and as needed to saturate the root zone after severe wilt ("Severely Wilted"). Averaged over 3 yr, the Daily, Conditional Weekly, and Severely Wilted irrigation treatments resulted in 30, 6, and 2% dollarweed cover, respectively. Except for dollarweed and mat lippia, the largest cover of other weeds was under Severely Wilted irrigation. Fertilization rates were 0, 14, or 28 g N m^{-2} yr^{-1}; in 2002, the highest fertilization rate had the smallest cover of weeds other than dollarweed. Mowing heights were 64, 89, or 114 mm; in 2003, the shortest mowing height had the smallest cover and dry weight of weeds other than dollarweed. After 3 yr of cultural management, most plots were excessively weedy, and turfgrass quality for all cultural management-treatment combinations, in the absence of herbicides, was unacceptable.

Nomenclature: Dollarweed or water pennywort, *Hydrocotyle umbellata* L. HYDUM; mat lippia, *Phyla nodiflora* (L.) Greene LIPNO; St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze STPSE.

Key words: IPM, lawn.

There are few reports regarding the impact on weed populations in turf from cultural factors such as mowing, fertilization, irrigation, cultivation, planting, and turfgrass selection (Busey 2003). Irrigation amount decreases, increases, or has no effect on weed populations, depending on the species of weed and the situation (Busey 2003). For example, irrigation daily with 7.6 mm water vs. three times per week with an amount to replace 80% of evapotranspiration (a 67% reduction) has no effect on smooth crabgrass [*Digitaria ischaemum* (Schreber) Schreber ex Muhlenb.] or dandelion (*Taraxacum officinale* Weber in Wiggers) populations in perennial ryegrass (*Lolium perenne* L.) (Jiang et al. 1988). In contrast, more regular or larger amounts of irrigation are sometimes associated with denser infestation by annual bluegrass (*Poa annua* L.) (Gaussoin and Branham 1989; Qian and Engelke 1999; Youngner et al. 1981). Greater rates of N fertilization (100 to 300 kg N ha^{-1} yr^{-1}) and taller heights of mowing (40 to 80 mm, depending on turf species) are associated with smaller weed populations, particularly of crabgrass species (*Digitaria* spp.) in Kentucky bluegrass (*Poa pratensis* L.) and fescue (*Festuca* spp.) turf (Busey 2003).

St. Augustinegrass is the most widely used lawn species in Florida; in 1991 to 1992, it represented 1.2 million home lawns (Hodges et al. 1994). Dollarweed is a serious weed in St. Augustinegrass lawns. Regulation of lawn irrigation has been mentioned as a practice to reduce infestation of dollarweed, which thrives in continuously wet soils (Trenholm et al. 2000). If smaller amounts of irrigation reduce dollarweed infestation in turf, the practice might reduce herbicide use. The effect of varying cultural practices on weed populations in St. Augustinegrass has not been documented.

The objective of this study was to evaluate the impact of cultural factors on weed populations in St. Augustinegrass turf, with particular interest in the relationship of irrigation and dollarweed.

Materials and Methods

A field experiment was conducted at the University of Florida Fort Lauderdale Research and Education Center in Davie, Broward County. Soil was Margate fine sand (hyperthermic, Mollic Psammaquent), 94% sand with pH 7.3, 13 mg P kg^{-1}, 41 mg K kg^{-1}, and 5.5% wt/v organic matter (OM). A soil test for N was not conducted because N is mostly in the living turfgrass biomass. To ensure extensive weed distribution, the field area was planted in May 1999 with dollarweed rhizomes dug from a landscape bed and transplanted in rows spaced 1.4 m apart with 1.4 m between plants within the row. The nonselective herbicide glyphosate was applied selectively to remove crowfootgrass [*Dactyloctenium aegyptium* (L.) Willd. Ex Asch. & Schweinf. DTTAE], which germinated and grew around the dollarweed. Dollarweed was grown to 100% cover. The field area was interplanted in January 2000 with plugs of 'Floratam' St. Augustinegrass, cut by machete as 20 by 20-cm plugs from 46 m^2 sod, and transplanted in rows spaced 1.4 m apart with 1.4 m between plants within the row. To ensure commingled establishment of the two species, 2,4-D amine was sprayed over each plant of St. Augustinegrass to remove dollarweed, which grew around and had begun to shade the St. Augustinegrass. Dollarweed and St. Augustinegrass were grown together under periodic mowing, fertilization, and irrigation to encourage the growth of both species.

Irrigation treatments were in a randomized complete-block design, with three irrigation treatments in each of

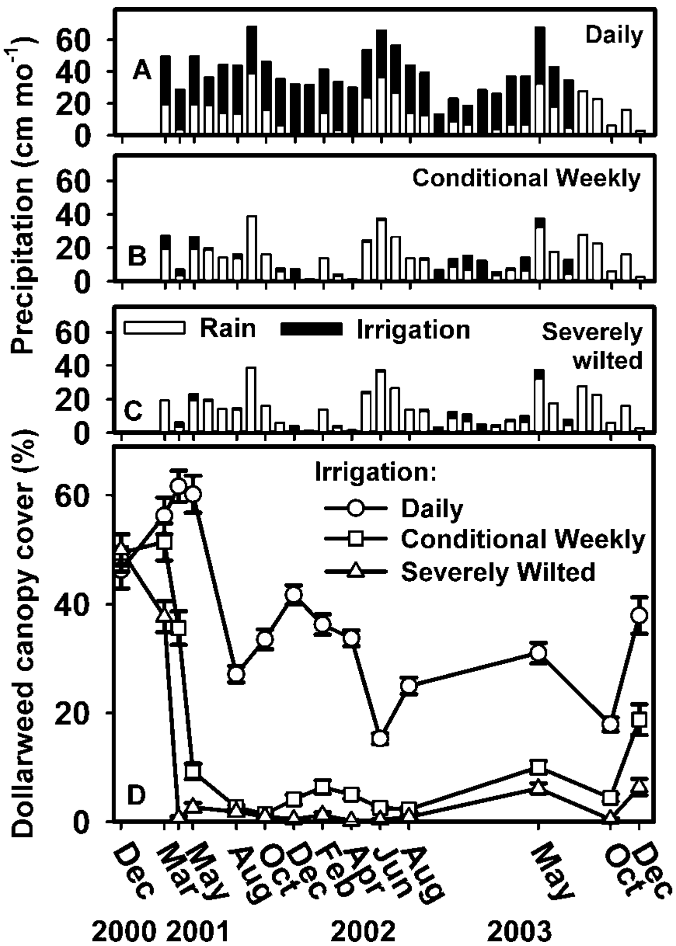

FIGURE 1. (A–C) Rain and irrigation by year and month of irrigation treatments, and (D) dollarweed cover in response to irrigation treatment and year and month. Error bars (D) are standard errors.

eight blocks. The resulting 24 irrigation main plots, 8.1 by 8.1 m, were controlled as separate irrigation zones, with four rotary sprinkler heads located on the corners of each plot, each providing a one-quarter arc precipitation with a radius of 8.1 m. Precipitation rate was 14.6 mm h^{-1}, and irrigation coefficient of uniformity (Christiansen 1942) was 83%. Irrigation treatments, initiated March 17, 2001, were daily with 9 mm of water to approximately replace the maximum St. Augustinegrass evapotranspiration ("Daily") reported for the area by Stewart and Mills (1967), weekly with 15 mm of water to saturate the root zone only when wilted ("Conditional Weekly"), and as needed with 15 mm water to saturate the root zone only under severe wilt based on leaf firing ("Severely Wilted"). Irrigation was applied for an average of 325 irrigation events yr^{-1} for Daily (accounting for periods when the irrigation system was under repair), 25 events yr^{-1} for Conditional Weekly, and 12 events yr^{-1} for Severely Wilted. Irrigation amount averaged 3.31 m yr^{-1} for Daily, 0.37 m yr^{-1} for Conditional Weekly, and 0.17 m yr^{-1} for Severely Wilted (Figure 1A, 1B, and 1C, respectively).

Three fertilization treatments, 0, 14, and 28 g N m^{-2} yr^{-1} were applied. The medium and high fertilization rates, which were applied every 2 mo, were the medium and high Extension Service recommendations for St. Augustinegrass lawns in Florida (Trenholm et al. 2000). Fertilization treatments were assigned randomly in strips as a split-block design across blocks (Little and Hills 1972), so that each block of three irrigation main plots had three fertilization splits of 2.7 by 8.1 m running through all three main plots. Fertilization treatments were initiated January 12, 2001, before irrigation treatments, and were applied six times per year.

The fertilizer source for 16 of 18 bimonthly applications during the experiment was LESCO Professional Turf Fertilizer,[1] which had a nutrient ratio of 26 : 1 : 9 (N : P : K), and macronutrients were derived from sulfur-coated urea, urea, ammonium phosphate, and potassium chloride, resulting in 9.75% slowly available N. The fertilizer source for the first two bimonthly applications was Long Lasting Lawn Fertilizer,[2] which had a nutrient ratio of 16 : 2 : 7 (N : P : K), and macronutrients were derived from potassium magnesium sulfate, ammonium sulfate, diammonium sulfate, sulfur-coated urea, and potassium chloride.

Three mowing-height treatments (64, 89, and 114 mm height, using a rotary mower) were initiated on May 19, 2001, and continued once per week, May through November, and once every 2 wk, December through April. Mowing heights were chosen as the low, medium, and high Extension Service recommendations for St. Augustinegrass lawns in Florida (Trenholm et al. 2000). Because of constraints of mowing equipment, i.e., the infeasibility of multiple turnarounds in a small area, it was not practical to perform mowing-height treatments individually in each main plot. Instead, within each half of the field, three sets of three mowing heights were assigned to randomized order and run crosswise to fertilization split-block treatments, each cutting equally across each block and each fertilization combination and across each irrigation main plot in the respective half of the field. Consequently, each irrigation treatment main plot had nine split-split plots of 2.7 by 2.7 m, consisting of all combinations of three fertilization treatments by three mowing heights. The three mowing-height treatments were interpreted as a separate, randomized complete-block experiment with six blocks superimposed on the irrigation and fertilization experiment.

Plots were evaluated visually to estimate St. Augustinegrass and dollarweed cover and turfgrass quality (1 = lowest and 9 = highest) on December 18, 2000, before treatments were started and periodically during treatments from March 30, 2001, to December 26, 2003 (Figure 1D). Data were pooled within years, and ANOVA was performed on annual means.

A core sample (10.2 cm in diameter) was harvested once in the center of each plot during the period April 15, 2002, through May 13, 2002, and once again in April 28, 2003, through May 6, 2003. Fresh harvested samples were separated by hand into three components (dollarweed, St. Augustinegrass, and other weeds), dried at 60 C for 48 h, and weighed. During the same periods, visual evaluations were made on the covers of St. Augustinegrass, dollarweed, and other weeds present in each plot, on April 22, 2002, and May 4, 2003. Also on May 6, 2003, the percentage cover of all weeds was recorded separately for each species in each split-split plot. The total cover of dollarweed plus other weeds was calculated as the sum of the "other weed" cover plus the dollarweed cover on April 22, 2002, and May 4, 2003.

The main-plot treatment (irrigation) and primary-split ef-

TABLE 1. Cover and dry weight of dollarweed by year, and mean squares from analysis of variance. Means of 72 observations.[a]

Cultural management factor	Dollarweed cover 2001	Dollarweed cover 2002	Dollarweed cover 2003	Dollarweed cover Mean	Dollarweed dry wt 2002	Dollarweed dry wt 2003	Dollarweed dry wt Mean
	%				kg ha^{-1}		
Irrigation treatment:							
Severely wilted	7.4 c	0.7 b	4.3 c	1.9 b	5 b	28 c	17 c
Conditional weekly	17.4 b	4.1 b	11.1 b	5.8 b	42 b	58 b	50 b
Daily	46.8 a	27.6 a	29.0 a	30.0 a	135 a	142 a	138 a
Fertilization rate (g N m^{-2} yr^{-1}):							
0	22.5 b	11.3	14.8	13.0	65	79	72
14	23.2 b	10.4	14.7	12.3	61	74	68
28	25.9 a	10.7	14.8	12.4	57	75	66
Mowing height (mm):							
64	24.4 a	8.9 b	13.6	11.7	58	65	62
89	24.1 a	12.0 a	15.5	13.4	61	89	75
114	23.1 b	11.4 a	15.3	12.5	63	74	69

Source of variation	df	Mean squares[b]						
Blocks (B)	7	269.9 **	51.5	178.8	78.9	2,255	2,042	1,876
Irrigation trt (I)	2	10,038.8 ***	5,145.9 ***	3,882.0 ***	5,544.8 ***	106,538 ***	84,397 ***	95,132 ***
B × I (error a)	14	57.2	51.1	87.9	45.3	5397	1339	1,633
Fertilization rate (F)	2	78.4 *	4.9	0.1	3.2	387	158	239
B × F (error b)	14	15.1	8.4	8.5	4.5	617	235	218
I × F	4	8.1	15.0	31.4 *	14.7	267	1,445	703
B × I × F (error c)	28	9.9	11.8	11.3	9.2	593	739	375
Mowing (M)	2	2.6 *	16.6 *	6.8	1.7	37	858	267
M × rows (error d)	10	0.6	3.9	8.1	2.6	96	341	157

[a] For each cultural management treatment factor, means in columns with a letter in common are not different by the prior-F LSD test (P = 0.05). Mowing treatments were not orthogonal with other treatments; therefore, they were analyzed as a separate experiment.
[b] Mean square significance at *, $P < 0.05$; **, $P < 0.01$; and *** , $P < 0.001$.

fect (fertilization) were analyzed as a split-block experiment, with the main effects and interactions tested against the appropriate error mean squares, that is, the appropriate treatment (or interaction) by block interaction. This was identical in treatment design and analysis to the split-block design of Little and Hills (1972), except that the present study did not use a Latin square. Means were separated according to Fisher's Protected LSD, $P = 0.05$ (Littell et al. 1996) using the corresponding error mean squares. Mowing-height treatments were analyzed as a separate experiment, but mowing-treatment interactions with other factors could not be analyzed because their placement in runs across blocks meant that they were confounded with the irrigation main-plot treatment effect.

Results and Discussion

Dollarweed

Before cultural management treatments, in December 2000, there was 48% dollarweed cover (Figure 1D). During irrigation treatments, from March 2001 through December 2003, more dollarweed cover ($P < 0.05$) occurred under Daily irrigation than under Conditional Weekly irrigation or Severely Wilted irrigation (Figure 1D); mean dollarweed cover over 3 yr was 30, 6, and 2%, respectively (Table 1). In 2001 and 2003, more dollarweed cover also occurred under Conditional Weekly irrigation than under Severely Wilted irrigation. Irrigation treatment strongly affected dollarweed dry weight in 2002 and 2003 (Table 1), which was largest for Daily irrigation (138 kg ha^{-1}), intermediate for Conditional Weekly irrigation (50 kg ha^{-1}), and smallest for Severely Wilted irrigation (17 kg ha^{-1}) ($P < 0.05$).

Fertilization rate did not affect dollarweed except in 2001, when dollarweed cover was largest in the highest fertilization rate, 28 g N m^{-2} yr^{-1}, compared with other fertilization treatments (Table 1). Mowing height had an inconsistent effect on dollarweed cover in 2002 compared with 2001, whereas dollarweed dry weight was not affected by fertilization or mowing. An interaction between irrigation treatment and fertilization rate in 2003 showed that the Daily irrigation treatment increased dollarweed cover more in the unfertilized treatment than in the fertilized treatments (Figure 2A).

Other Weeds

Irrigation treatment had an opposite effect (Table 2) on the additional weeds other than dollarweed compared with the effect on dollarweed (Table 1) ($P < 0.05$). The Daily irrigation treatment had the smallest cover and dry weight of weeds other than dollarweed, 6% and 169 kg ha^{-1}, respectively (means of 2002 and 2003), and the Severely Wilted treatment had the largest cover and dry weight of weeds other than dollarweed, 32% and 310 kg ha^{-1}, respectively.

Fertilization rate affected the cover of weeds other than dollarweed only during 2002, when the highest fertilization rate (28 g N m^{-2} yr^{-1}) had the smallest cover of other weeds (Table 2). This is consistent with other studies showing that

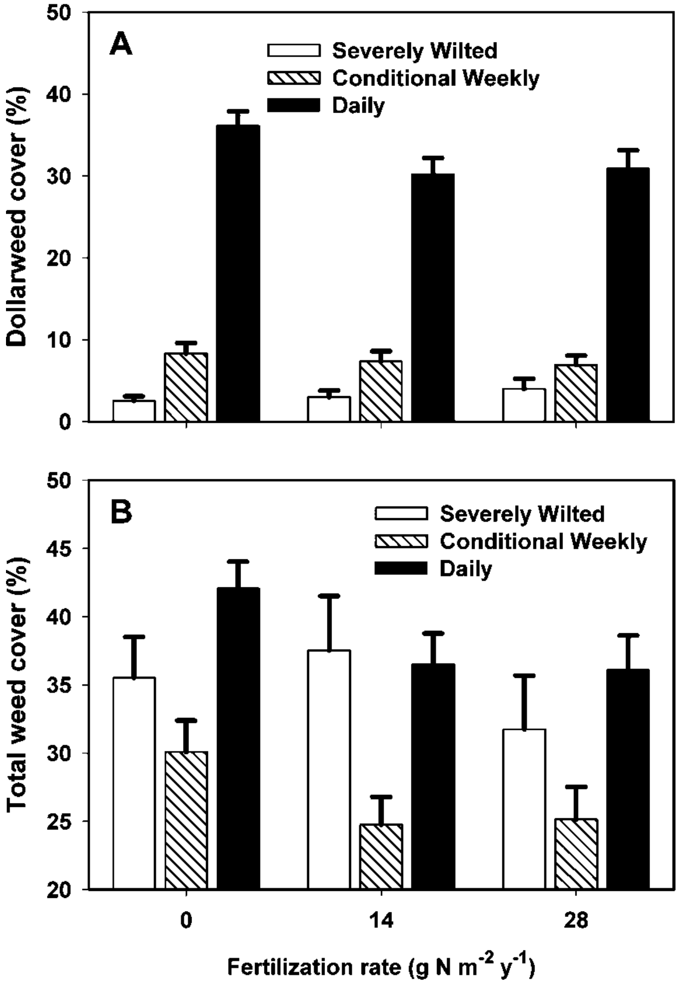

FIGURE 2. Effect of irrigation treatment on cover of (A) dollarweed and (B) all weeds on means in 2003.

a high rate of N fertilization (10 to 30 g N m^{-2} yr^{-1}) reduces populations of some weeds in cool-season grasses (Busey 2003).

Mowing height affected weeds other than dollarweed only in 2003, when "other weed" cover and dry weight were larger at the tallest mowing height, 114 mm, compared with the 64-mm mowing height. Although it is recommended that St. Augustinegrass lawns be mowed at 76 to 102 mm under moderate-to-low management, mowing at 64 mm is reported to be acceptable if mowing is at least weekly (Trenholm et al. 2000), as was done in the present study during 7 mo yr^{-1}. Crabgrass species, which have been shown in several studies to be more abundant under low mowing height in Kentucky bluegrass and fescue turf (Busey 2003), were infrequent in the present study.

In the order of cover, other weeds present in 2003 were southern sida (*Sida acuta* Burm f. SIDAC), Surinam sedge (*Cyperus surinamensis* Rottb. CYPSU), whitehead broom (*Spermacoce verticillata* L.), thin paspalum (*Paspalum setaceum* Michx. PASSA), mat lippia, largeflower Mexican clover [*Richardia grandiflora* (Cham. & Schltdl.) Schult. & Schult. F.], hairy beggarsticks [*Bidens pilosa* (L.) DC. BIDPI], pellitory-of-the-wall (*Parietaria judaica* L. PAIDI), creeping woodsorrel (*Oxalis corniculata* L. OXACO), lawn burweed (*Soliva sessilis* Ruiz & Pav. SOVSE), Carolina dichondra (*Dichondra carolinensis* Michx. DIORC), artilleryweed [*Pilea microphylla* (L.) Liebm. PILMI], poorjoe (*Diodia teres* Walt. DIQTE), southern crabgrass [*Digitaria ciliaris* (Retz.) Koeler DIGSP], rock fingergrass [*Eustachys petraea* (Sw.) Desv. ESTPE], heartleaf drymary [*Drymaria cordata* (L.) Willd. Ex Schult. DRYCO], red tasselflower [*Emilia sonchifolia* (L.) DC. Ex Wight EMISO], Florida pusley (*Richardia scabra* L. RCHSC), foxtail (*Setaria* sp.), American burnweed [*Erechtites hieraciifolia* (L.) Raf. Ex DC. EREHI], and Florida cinchweed (*Pectis linearifolia* Urb).

The cover of weeds other than dollarweed, evaluated individually in 2003 for the seven most common species, varied in response to cultural management (Table 3). Although mat lippia was more abundant ($P < 0.05$) under Daily irrigation compared with other treatments, other weeds were less abundant under Daily irrigation, most often significantly ($P < 0.05$). Hairy beggarsticks and thin paspalum were most abundant in the unfertilized treatment, but Surinam sedge was least abundant in the unfertilized treatment. Hairy beggarsticks and whitehead broom were most abundant under the highest, 114 mm, mowing height; both species are upright dicotyledonous plants.

In 2003, the cover of dollarweed plus other weeds showed interactions of irrigation and fertilization ($P < 0.05$) (Figure 2B). Furthermore, Conditional Weekly irrigation resulted in the smallest total weed population compared with Daily irrigation and Severely Wilted irrigation.

St. Augustinegrass and Turf Quality

St. Augustinegrass dry weight increased over time in all irrigation treatments during 2002 and 2003 (Table 4). In 2003, St. Augustinegrass cover and dry weight were reduced under Severely Wilted irrigation treatment compared with other irrigation treatments (Table 4). Turfgrass quality was worse in 2003 in the Severely Wilted irrigation treatment compared with the Daily irrigation (Table 4).

St. Augustinegrass cover and dry weight were affected by fertilization rate only in 2002, when there was less cover and dry weight in the unfertilized (0 g N m^{-2} yr^{-1}) treatment (Table 4) than the fertilized treatments. Turfgrass quality was affected by fertilization, with the medium- and high-fertilization rates (14 and 28 g N m^{-2} yr^{-1}) always causing greater turfgrass quality than the unfertilized treatment. St. Augustinegrass cover was increased in 2003 in response to the lowest (64 mm) mowing height, and in 2002 and 2003, turfgrass quality was greatest at the lowest mowing height.

Optimum Cultural Factors for Managing Weeds

Populations of different weed species in St. Augustinegrass turf were impacted differently in response to cultural management, especially irrigation. Although no irrigation treatment reduced all weeds, Conditional Weekly irrigation resulted in the smallest total weed cover (Figure 2B). The highest rate of fertilization, 28 g N m^{-2} yr^{-1}, sometimes reduced weeds other than dollarweed, and was associated with the highest turfgrass quality. In a few cases, the lowest mowing height of 64 mm reduced weed populations.

Differential response of weed populations to irrigation suggests that weeds can also be managed by distributing irrigation uniformly. For example, the distribution uniformity (DU) of irrigation in urban landscapes is most often

Table 2. Cover and dry weight of weeds other than dollarweed, by year, and mean squares from ANOVA. Means of 72 observations.[a]

Cultural management factor		Dollarweed cover			Dollarweed dry wt		
		2002	2003	Mean	2002	2003	Mean
		%			kg ha^{-1}		
Irrigation treatment:							
Severely wilted		32.4 a	31.1 a	31.8 a	384 a	237 b	310 a
Conditional weekly		21.2 a	17.1 b	19.1 b	406 a	162 ab	284 a
Daily		3.5 b	8.1 b	5.8 c	230 b	109 a	169 b
Fertilization rate (g N m^{-2} yr^{-1}):							
0		23.5 a	17.0	20.3	318	171	245
14		18.6 ab	20.2	19.4	401	182	292
28		15.0 b	19.1	17.1	301	155	228
Mowing height (mm):							
64		17.5	13.6 b	15.5	319	141 b	230
89		19.4	20.3 a	19.9	342	169 ab	256
114		20.3	22.3 a	21.3	360	197 a	278
Source of variation	df	Mean squares[b]					
Blocks (B)	7	778.8	653.8	611.2	63,638	49,168	25,066
Irrigation trt (I)	2	5,082.3 **	3,237.5 **	4,041.8 ***	221,528 **	99,031 *	135,014 **
B × I (error a)	14	430.5	327.2	330.8	28,751	21,759	16,648
Fertilization rate (F)	2	438.7 *	65.5	65.4	69,019	4,429	26,168
B × F (error b)	14	109.1	79.3	65.6	24,247	16,283	11,797
I × F	4	81.0	85.8	40.5	26,591	5,946	4,022
B × I × F (error c)	28	57.4	47.7	32.4	13,974	7,974	6,809
Mowing (M)	2	12.5	123.7 *	53.6	2,451	4,767 *	3,509
M × rows (error d)	10	67.5	23.1	36	6,127	795	2,143

[a] For each cultural management-treatment factor, means in columns with a letter in common are not different by the prior-F LSD test ($P = 0.05$). Mowing treatments were not orthogonal with other treatments; therefore, they were analyzed as a separate experiment.
[b] Mean square significance at *, $P < 0.05$; **, $P < 0.01$; and *** , $P < 0.001$.

Table 3. Cover of weeds other than dollarweed in 2003, by species, and mean squares from ANOVA. Means of 72 observations.

Cultural management factor		Cover[a] Hairy beggarsticks	Surinam sedge	Thin paspalum	Mat lippia	Largeflower pusley	Southern sida	Whitehead broom
		%						
Irrigation treatment:								
Severely wilted		1.4	6.1 a	3.4 a	1.3 b	3.3 a	10.0 a	3.4
Conditional weekly		0.9	2.9 b	2.8 a	1.0 b	1.3 b	3.7 b	2.9
Daily		0.5	0.7 b	0.4 b	2.9 a	0.3 b	0.0 b	1.8
Fertilization rate (g N m^{-2} yr^{-1}):								
0		2.0 a	0.7 b	4.2 a	1.3	1.8	3.9	1.2
14		0.5 b	4.3 a	1.4 b	2.1	1.9	4.7	3.7
28		0.3 b	4.8 a	1.0 b	1.8	1.2	5.1	3.2
Mowing height (mm):								
64		0.3 b	3.8	1.3	0.7	2.1	2.3	1.8 b
89		0.4 b	2.4	2.5	1.4	1.6	7.2	2.6 b
114		2.1 a	3.6	2.8	3	1.2	4.3	3.6 a
Source of variation	df	Mean squares[b]						
Blocks (B)	7	4.6	36.5	15.0	18.8 *	10.4	62.1	88.6 **
Irrigation trt (I)	2	5.0	177.9 **	60.9 *	25.3 *	57.5 **	616.4 *	16.3
B × I (error a)	14	5.1	25.3	10.6	6.5	5.6	95.0	10.3
Fertilization rate (F)	2	19.6 *	123.2 *	72.4 ***	4.2	3.5	9.2	40.8
B × F (error b)	14	3.7	22.2	4.3	9.6	3.8	17.1	18.5
I × F	4	1.1	29.1	11.7	7.9	9.3	12.7	11.7
B × I × F (error c)	28	1.8	12.1	8.5	4.6	3.5	17.7	6.0
Mowing (M)	2.0	6.0 **	3.4	3.8	8.5	1.1	36.2	5.0 **
M × rows (error d)	10	0.5	2.1	1.6	2.2	0.3	22	0.6

[a] For each cultural management-treatment factor, means in columns with a letter in common are not different by the prior-F LSD test ($P = 0.05$). Mowing treatments were not orthogonal with other treatments; therefore, they were analyzed as a separate experiment.
[b] Mean square significance at *, $P < 0.05$; **, $P < 0.01$; and *** , $P < 0.001$.

TABLE 4. Cover, dry weight, and quality of St. Augustinegrass turf by year, and mean squares from ANOVA. Means of 72 observations.[a]

Cultural management factor	df	St. Augustinegrass cover				St. Augustinegrass dry wt			Turf quality			
		2001	2002	2003	Mean	2002	2003	Mean	2001	2002	2003	Mean
		%				$kg\ ha^{-1}$			9 = highest			
Irrigation treatment:												
Severely wilted		48.4	63.8	44.7 b	56.2	539	671 b	605	4.5	4.6	3.9 b	4.2 b
Conditional weekly		47.3	71.9	64.7 a	66.1	594	981 a	788	4.6	5.1	4.5 ab	4.8 ab
Daily		36.8	66.4	64.8 a	61.5	686	918 ab	802	4.7	5.3	4.8 a	5.1 a
Fertilization rate ($g\ N\ m^{-2}\ yr^{-1}$):												
0		41.7	61.5 b	56.0	56.9	452 b	725	588 b	4.2 b	4.5 b	4.1 b	4.3 b
14		45.1	69.3 a	60.8	63.2	634 a	922	778 a	4.7 a	5.1 a	4.7 a	4.9 a
28		45.7	71.3 a	57.4	63.8	733 a	924	828 a	5.0 a	5.4 a	4.6 a	5.0 a
Mowing height (mm):												
64		45.6	72.7	66.3 a	66.7	599	879	739	4.9	5.5 a	5.2 a	5.2 a
89		44.0	64.6	54.4 b	59.0	601	869	735	4.6	4.8 b	4.2 b	4.6 b
114		42.9	64.8	53.4 b	58.1	619	822	720	4.4	4.6 b	4 b	4.4 b
	df	Mean squares[b]										
Blocks (B)	7	511.0	656.7	1,725.9 *	946 *	130,544	494,376 *	236,121	4.09 **	4.33 *	9.23 **	5.17 **
Irrigation trt (I)	2	978.4	405.2	3,232.7 **	591	131,150	644,489 *	288,885	0.40	2.78	22.40 ***	5.17 *
B × I (error a)	14	295.2	350.5	427.4	304	77,167	167,249	89,280	0.93	1.24	1.69 **	1.06
Fertilization rate (F)	2	112.7	642.0 *	150.7	355	488,441 **	313,117	384,246 **	4.41 **	5.15 ***	2.80 **	3.99 ***
B × F (error b)	14	104.6	119.0	170.6	100	72,809	90,269	45,417	0.50	0.37	0.34	0.31
I × F	4	33.9	37.2	19.6	5	26,085	29,686	3,602	0.02	0.12	0.77	0.04
B × I × F (error c)	28	26.1	66.6	58.4	43	24,736	34,380	17,414	0.19	0.16	0.16	0.13
Mowing (M)	2	10.5	128	308 *	125	692	5,562	583	0.4	1.3 *	2.4 **	1.2 *
M × Rows (error d)	10	21.9	73.4	45	55	26,407	8,612	14,415	0.3	0.2	0.2	0.2

[a] For each cultural management-treatment factor, means in columns with a letter in common are not different by the prior-F LSD test ($P = 0.05$). Mowing treatments were not orthogonal with other treatments; therefore, they were analyzed as a separate experiment.
[b] Mean square significance at *, $P < 0.05$; **, $P < 0.01$; and *** , $P < 0.001$.

fair or poor (DU < 69%) based on 292 lawns in Miami–Dade County (Anonymous 2001). Poor irrigation distribution could complicate weed management by encouraging infestation by different weed populations in different areas in the same landscape.

After 3 yr of cultural management and no herbicides, most of the 216 plots were excessively weedy. Turfgrass quality for all cultural management treatment combinations was unacceptable. Under these conditions, lawn managers would need to apply some herbicides to maintain a St. Augustinegrass lawn monoculture.

In summary, cultural management treatments reduced populations of some weed species in St. Augustinegrass turf and may reduce the use of herbicides, but no cultural management treatment, individually or in combination, reduced all weed species or provided an acceptable level of weed control.

Sources of Materials

[1] LESCO Professional Turf Fertilizer, LESCO, 722 Webster Turn Drive, Sebring, FL 33870.

[2] Long Lasting Lawn Fertilizer, Atlantic Florida East Coast Fertilizer and Chemical, 18375 SW 260th Street, Homestead, FL 33031.

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