creased quality, whereas quality of 'Floratam' was unchanged and 'Texas Common' showed a significant reduction in quality.

It had been reported that 'Floratam' St. Augustinegrass had improved low-temperature color retention in comparison with that of 'Texas Common' (2). In our study, 'Floratam' showed significantly lower quality than did 'Texas Common' following a 1- or 2-week exposure to chilling stress. Furthermore, there was not a positive response to GA_3 application on either St. Augustinegrass cultivar at the treatment rate used.

In fact, chilling-injury symptoms on both GA_3-treated St. Augustinegrasses proceeded more rapidly and were more pronounced than on the untreated turfs. Whitney et al. (11) found that the response to GA under low-temperature stress was rate-dependent. Pangolagrass did not respond to GA application in the range of 12 to 37 g ha^{-1} of GA; however, there was a significant response to 100 g ha^{-1} of GA (9). The fact that 'Texas Common' treated with GA_3 had a significantly lower visual rating than did the nontreated control following 2 weeks of chilling temperatures indicated a possible GA_3 toxicity effect at the rate applied. Thus, a lower rate could possibly give a positive color and/or growth response.

The data show that cultivars of the same species vary in their tolerance of chilling injury. Although the general symptoms and order of appearance were similar, the rate of progression varied among the cultivars within a species. GA_3 at 62.5 g ha^{-1} improved the color rating and growth of both bermudagrass cultivars but increased the severity and rapidity at which chilling-injury symptoms appeared in both St. Augustinegrasses. GA_3 may have potential use in extending the growing season of chill-sensitive turfgrasses, but rate responses should be developed for each turfgrass species.

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HortScience 18(1):97–99. 1983.

Thatch Accumulation in Kentucky Bluegrass Cultivars and Blends[1]

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Additional index words. *Poa pratensis*, total cell wall, verdure

Abstract. **Sixty Kentucky bluegrass (*Poa pratensis* L.) cultivars and experimental lines and 24 bluegrass blends were investigated for thatching tendency. Cultivars and experimental lines differed in thatch accumulation during the course of this 5-year study. Increasing N level from 10 to 20 g N m^{-2} season^{-1} had no effect on thatch accumulation. Thatch accumulation in cultivars and experimental lines was correlated (r = 0.87) to verdure, indicating vigorous cultivars had greater thatching tendency. Thatching tendency of cultivars was correlated (r = 0.74) to their total cell-wall content expressed on a mg dm^{-2} basis. Accumulation of thatch in blends approximated the mean accumulation for cultivars growing in pure stands. These results indicate a potential for reducing thatch accumulation in Kentucky bluegrass lawns through blending of appropriate cultivars.**

Thatch is a management problem on many turfgrass sites. Causes of thatch accumulation are not completely understood, but it is thought to be an imbalance of organic matter production vs. rate of decomposition (1, 2, 7). Turfgrass literature indicates that differences in species, cultivars, and cultural practices may influence thatch accumulation in turfs (1, 2, 4, 6, 7). Anything that stimulates organic matter production might enhance thatch buildup.

With these aspects in mind, 2 trials were established in Sept. 1976 at the University of Nebraska Turfgrass Research Facility located near Mead. The first trial was a Kentucky bluegrass evaluation involving 60 cultivars and experimental lines that received 2 fertilization rates. One-half of each plot received 10 and the other 20 g N m^{-2} season^{-1}. The second trial involved 24 Kentucky bluegrass blends maintained with 20 g N m^{-2} season^{-1}. Both trials were established from seed in randomized complete block design with 4 replications. Soil on each site was a Sharpsburg silty-clay loam (*Typic argiudoll*) with a pH of 7.1 and high soil P (89 ppm) and K (275 ppm) levels. Turfs were irrigated with 2.5 cm of water each week to prevent visual drought stress and were mowed weekly at 5.0 cm in spring and fall and 7.5 cm in summer. Clippings were removed.

In Aug. 1981 turfs were assayed for thatch accumulation. Turfs were watered uniformly 48 hr before sampling with 1.3 cm of water. Four turfgrass-soil cores (7.5 cm in diameter) were sampled from each treatment. Thatch on cores was measured (mm) for each of the 4 subsamples and averaged. Percent total cell wall (TCW) content was determined on 3 cultivars, using the Van Soest method (8). These cultivars were selected since they represented low, medium, and high thatch accumulation. Verdure measurements were made on 12 of the 60 cultivars indicated in the first

[1]Received for publication June 22, 1982. Published as Paper No. 6941 Journal Series, Nebraska Agric. Exp. Sta., Lincoln. This research was supported in part by funds from the Nebraska Turfgrass Foundation.

The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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Table 1. Thatch accumulation for 60 Kentucky bluegrass cultivars and experimental lines planted in Sept. 1976 and fertilized with 10 g N m^{-2} (2.0 lb. N/1000 ft^2) and 20 g N m^{-2} (4.0 lb. N/1000 ft^2) per growing season.

Cultivar or line	Thatch accumulation (mm)[z]	
	10 g N m^{-2}	20 g N m^{-2}
Glade	29	29
Touchdown	28	28
Cheri	28	28
P 104	28	26
Nugget	25	26
Baron	25	26
Victa	25	26
Galaxy	25	25
Bristol	25	25
Enita	24	24
EVB-2461	24	24
Bonnieblue	24	21
Birka	24	21
Plush	23	24
Bono	23	23
P-1925·War·Shade	23	22
Sydsport	23	21
N-408	22	23
EVB 3965	22	23
Merion	22	22
Enprima	22	22
Cougar	22	22
Banff	22	21
P-3N	22	22
WTN-A-20-6	22	21
Vantage	22	20
Fylking	22	20
Entopper	21	22
Bensun	21	22
Adelphi	21	21
Majestic	21	21
Newport	21	21
Enmundi	21	21
Geary	21	21
WWAg-452	21	21
FFR 9030	21	21
K3-160	21	19
WTN-A-20	21	19
Enoble	20	22
Parade	20	20
Aquila	20	20
S-21	20	20
Fanfare	20	20
TPE·523E·P148	20	20
South Dakota	20	19
K103 × Anh	20	19
K109 × Anh	20	19
P-59	20	19
K1-154	20	19
K1-157	20	18
Pennstar	20	18
Park	20	18
EVB-3702	19	20
WWAg 463	19	20
N135·P154	19	20
Delta	19	19
K1-150	18	19
Rugby	17	17
WWAg 436	16	17
NuDwarf	15	15
	22	21
LSD 5% =	3	3

[z]Values in a column are averages of 4 subsamples per cultivar and 4 replications.

Table 2. Percentage of total cell wall (TCW) content of top growth and thatch for 3 Kentucky bluegrass cultivars.

Cultivar	TCW (%)[z]	
	Top growth	Thatch
Glade	51 a	82 a
Majestic	49 ab	78 ab
NuDwarf	46 b	76 b

[z]Values are means of 2 subsamples per treatment and 4 replications. Mean separation by Duncan's multiple range test, 5% level.

Table 3. Thatch accumulation, verdure, and total cell wall (TCW) content for 12 Kentucky bluegrass cultivars.

Cultivar	Thatch accumulation[z] (mm)	Verdure[y] (g dm^{-2})	TCW[x] (mg dm^{-2})
Touchdown	28	4.3	544
Nugget	25	3.3	493
Baron	25	3.0	427
Victa	25	2.8	443
Sydsport	23	3.5	582
Fylking	22	2.8	384
Adelphi	21	3.0	476
Geary	21	2.5	348
Newport	21	2.5	419
Aguila	20	2.0	330
Park	20	2.0	296
Rugby	17	1.8	285
LSD 5%	3	0.8	34

[z]Thatch values are averages of 4 subsamples and 4 replications per treatment.
[y]Verdure values are averages of 4 replications.
[x]TCW values are averages of 2 subsamples and 4 replications.

trial, using the method described by Madison (3). TCW content was also determined for these 12 cultivars with values converted to TCW dm^{-2} to reflect amount of cell wall produced per unit area. 'Park' Kentucky bluegrass, which is widely used in the region, was selected as a standard cultivar for comparison purposes when least significant difference was used in mean separation tests.

Cultivars differed in their thatching tendency but N level did not influence thatch accumulation (Table 1). 'Glade', 'Touchdown', 'Cheri', and P104 had the greatest thatch accumulation. 'Nu Dwarf', WWAg 436, and 'Rugby' accumulated the least amount of thatch. 'Glade' accumulated nearly twice the amount of thatch as that of 'Nu Dwarf'. 'Park', the standard cultivar, accumulated nearly 40% less thatch than the more vigorous cultivars. Cultivars having greatest thatching tendency were those with highest quality ratings and vigorous growth rates (5). Mean thatch accumulation at 10 and 20 g N m^{-2} did not differ significantly.

'Nu Dwarf', 'Majestic', and 'Glade' were examined for cell-wall content in top growth and thatch (Table 2). TCW content of thatch was greater than that determined for cultivar top growth, indicating a relatively high degree of thatch decomposition. TCW in top growth and thatch was greatest for 'Glade', least for 'Nu Dwarf', while 'Majestic' was intermediate.

Twelve cultivars were evaluated for verdure and comparisons made on dry-weight basis (Table 3). Cultivars differed in verdure produced. Verdure was correlated (r = 0.87) with thatch accumulation. Since verdure was considered to be an indicator of cultivar vigor,

Table 4. Thatch accumulation for 24 Kentucky bluegrass blends measured 5 years after establishment.

Blend[z]	Thatch accumulation means[y] (mm)	
	Blend	Cultivars in pure sand
Victa, Baron, Nugget	25 a[x]	26
Victa, Baron	24 ab	26
Adelphi, Baron, Glade	24 ab	25
Fylking, Nugget, Sydsport	24 ab	23
Baron, Bonnieblue, Majestic	23 abc	23
Baron, Adelphi, Bonnieblue	23 abc	23
Enoble, Enmundi	23 abc	21
Fylking, Pennstar, Park	23 abc	20
Baron, Fylking, Pennstar	22 bc	22
Victa, Vantage, Bristol	22 bc	25
Parade, Aquila	22 bc	20
Enmundi, Enoble, Enprima	22 bc	21
Glade, Fylking, S-21	22 bc	23
Fylking, Pennstar, Sydsport	22 bc	20
Fylking, Pennstar, Nugget	22 bc	22
Fylking, Merion, Park	22 bc	21
Fylking, Pennstar, Merion	22 bc	21
Merion, Park	21 cd	21
Parade, Aquila, Adelphi	21 cd	20
Bonnieblue, Birka, Majestic	21 cd	22
Baron, Bonnieblue, Birka	21 cd	24
Victa, Adelphi, Baron	21 cd	24
Park, S.D. Certified, Newport	19 d	20
Fylking, Park, S.D. Certified	19 d	20

[z]Blends were seeded in Aug. 1976 at 10 g m^{-2}. Two-way blends comprised 0.5 g m^{-2} and 3-way blends comprised 3.3 g m^{-2} for each cultivar.
[y]Thatch accumulation measurements for cultivars and blends were made on Aug. 20, 1981. Values are averages of 4 subsamples and 4 replications per treatment.
[x]Mean separation by Duncan's multiple range test, 5% level.

these results infer that more vigorous, rapid-growing cultivars have a greater tendency to accumulate thatch. Differences in thatching tendency for cultivars between regions could be based on cultivar adaptation.

TCW content (Table 3) for cultivars expressed on a mg dm^{-2} basis was correlated ($r = 0.74$) with thatching tendency. TCW reflects amount of cellulose, hemicellulose, and lignin present. Ledeboer and Skogley (2) reported that these cell-wall constituents were primary components of turfgrass thatch. Turfgrass breeders could use TCW expressed as mg dm^{-2} to select and develop cultivars with reduced thatching tendency.

Blending Kentucky bluegrass cultivars is a commonly recommended practice (5). Blends are considered to have a broader genetic base and better adaptation to environmental and cultural extremes than any single cultivar. This study demonstrated that blends differed significantly in their thatching tendency (Table 4). Thatch accumulation for blends approximated the mean accumulation for cultivars comprising the blend when these cultivars were growing in pure stands. This suggests that blending could be used as a means for reducing thatch accumulation tendency, when appropriate cultivars are selected.

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HortScience 18(1):99–100. 1983.

Tree Trunk Growth and Wound Closure[1]

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Additional index words. *Fraxinus americana, Gleditsia triacanthos, Liriodendron tulipifera, Platanus occidentalis, Quercus palustris*

Abstract. **Five tree species, *Platanus occidentalis* L., *Fraxinus americana* L., *Quercus palustris* Muench., *Liriodendron tulipifera* L., and *Gleditsia triacanthos* L. f. *inermis* (L.) Zabel were wounded for 4 consecutive years. Four whorls of circular wounds or one whorl of elliptical wounds were cut into the trunk at widths of 10, 13, 17, and 25 mm. Tree growth was not measurably reduced by trunk wounding. Wound closure per unit of radial growth differed by species and annual growth.**

Certain nutritional, pathological, or entomological maladies of trees can be remedied by implantation or injection of chemicals into the trunks of trees (2). Trunk wounds are required prior to treatment, and wound size is a major factor in determining the method of treatment (1, 2). The time for wound closure has been correlated with wound width and tree growth (3, 4, 6). The objectives of this experiment were to determine whether or not intentional wounding over a period of years would result in reduced tree growth and to correlate tree growth and wound closure.

The plantation trees selected for this study at the Morton Arboretum west of Chicago, Ill., and at the Illinois Natural History Survey (NHS) arboretum south of Urbana had been used earlier in field fertilization trials (5). Four species were treated at each location. The species and average diameters, 1 m above the ground line in 1977, at the Morton Arboretum were *F. americana* (18.6 cm), *G. triacanthos* f. *inermis* (13.9 cm), *Q. palustris* (18.4 cm), and *L. tulipifera* (16.2 cm). At the NHS arboretum the species were *G. triacanthos* f. *inermis* (15.5 cm), *Q. palustris* (15.1 cm), *L. tulipifera* (11.8 cm), and *P. occidentalis* (12.9 cm). Twenty trees of each species at each site were selected, measured, and divided into 4 classes based on diameter. The trees were divided into 5 groups of 4 trees with each group containing trees from each class-interval. The selection of treatment for each group was random. One group served as untreated controls.

The wounds inflicted on the trees annually from 1977 through 1980 were of 2 types: circular and pointed elliptical. The circular wounds were of 3 sizes: 10, 13, and 17 mm in diameter. Each group of trees received only one size of wound, cut into the xylem with a wood bit at 8-cm intervals around the trunk. Four whorls at 30-cm intervals were cut each year. Another group of trees was treated each year with one whorl of elliptical

Table 1. Annual stem diameter increases (at 1-m height) of wounded and nonwounded trees of 5 species at 2 locations (avg., 1977–1980).

Original wound width (mm)	Increase in stem diam (mm)				
	Fraxinus	*Quercus*	*Liriodendron*	*Gleditsia*	*Platanus*
Morton					
25	7.1	5.5	14.8	5.5	
17	6.9	4.4	14.2	6.6	
13	8.4	6.1	15.4	6.4	
10	6.2	5.1	14.5	5.4	
0	8.0	5.0	12.9	5.6	
LSD (5%)	4.4	3.3	5.4	1.4	
Illinois Natural History Survey					
25		6.8	7.7	12.3	11.0
17		9.7	9.1	15.1	10.9
13		8.9	10.0	14.4	13.4
10		8.2	11.7	14.9	13.0
0		8.5	7.3	13.5	10.7
LSD (5%)		2.0	3.0	2.7	3.2

[1]Received for publication May 29, 1982

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