Chapter 6

Tiller production and dry matter accumulation in six creeping bentgrass entries grown in Manitoba.

ABSTRACT

Tiller production and dry matter accumulation were monitored in six creeping bentgrass (*Agrostis stolonifera* L.) entries maintained as a putting green. Core samples for tiller density and aboveground biomass determinations were collected at intervals between October 1987 and October 1989. Two experimental lines, UM84-01 and UM86-01, produced more ($P<0.05$) tillers and higher ($P<0.05$) aboveground biomass than commercial cultivars Penneagle, National, Emerald and Seaside. Both tiller density and aboveground biomass among entries were consistent over the study period. Although lower tillering entries had a significantly higher aboveground biomass tiller^{-1}, total aboveground biomass was influenced more by tiller density than by biomass tiller^{-1}. The relationship between density and tiller dry weight was expressed as, $\log c = \log_{10}$ tiller dry weight m^{-2} - 0.5 $\log_{10}$ tiller density m^{-2}, to determine potential wear stress resistance among entries.

Key words: creeping bentgrass, tillering, biomass accumulation

Introduction

Creeping bentgrass is used in Canada predominantly in putting green turfs and very rarely in lawns. An important characteristic among creeping bentgrass cultivars is tiller density (TD). Tiller density is positively related to wear stress recovery in bentgrasses (Hawes and Decker 1977), and wear stress resistance in Kentucky bluegrass (*Poa pratensis* L.) (Shildrick and Pell 1984), tall fescue (*Festuca arundinacea* Schrib.) (Shildrick and Peel 1983), and all bentgrasses (Lush 1990).

Greater wear stress resistance among turfgrass is often attributed to higher levels of aboveground biomass (AGB) or thatch (i.e., living and dead material above the soil surface) (Shildrick and Peel 1984). The mathematical relationship between TD and AGB has been proposed as a method for predicting potential wear stress resistance among bentgrass cultivars (Lush 1990). However, while high levels of AGB may be desirable for turfgrasses (Shildrick and Peel 1983; Lush 1990), higher levels of fertilisation may be required to maintain the integrity of the green (Shildrick 1985).

There is little information on tillering characteristics of creeping bentgrass cultivars grown on the Canadian prairies. Tillering in this species is affected by environmental factors such as temperature (Duff and Beard 1974; Hawes and Decker 1977). The performance of cultivars in the cold, dry prairie climate may be different from the performance in less severe environments. A greater knowledge of tiller dynamics in turfgrasses is also important since TD is becoming an increasingly useful characteristic in turfgrass breeding and management programs (Lush 1990). Information on AGB production among turfgrass cultivars is important, especially for determining the level of management required to maintain a good-quality playing surface. The objectives of this study were to monitor (1) tiller production and (2) AGB accumulation in a number of creeping bentgrass cultivars or lines grown on the Canadian prairies.

Methods and Materials

A creeping bentgrass (*Agrostis stolonifera* L.) putting green was established on a sand base (Beard 1983) at the Department of Plant Science Winnipeg Field Research Laboratory in the first week of September 1986. This study included four cultivars: "Penneagle", "Emerald", "Seaside" and "National", and two lines, "UM84-01" and "UM86-01". UM84-01 is a five clone synthetic (Registered as "Biska" and renamed "18th Green" (Cattani *et al.* 1992). UM86-

01 is a three clone synthetic. UM84-01 and UM86-01 were selected at the University of Manitoba. The experimental design was a randomized complete block with four replicates. Each plot was 1 m^2 in size.

Immediately prior to seeding, fertiliser (19-25-4) (N - P_2O_5 - K_2O) was broadcast applied at a rate of 21 g product m^{-2}, and incorporated to a depth of 5 cm. Seed was sown by means of broadcasting at a density of 15000 seeds m^{-2}. Immediately after seeding, the plot area was packed and then covered with fibreglass furnace filter material in order to reduce evaporative soil moisture loss and to prevent seeds from being splashed or blown into adjacent plots. This covering was removed 14 d after seeding. A second fertiliser application (rate similar to pre-plant application) was made on 16 October 1986.

The turfgrass plots were maintained similar to golf course putting greens. Beginning on 27 May 1987, the turf height in each plot was measured and grasses immediately cut to a 5 mm height. Cuttings during this and subsequent summers were conducted five times a week, except when the frequency was reduced to two times $week^{-1}$ in September and to once $week^{-1}$ in October. The plot area was irrigated regularly to prevent wilting and to promote vigorous turf growth. Turf plots were fertilised, aerated and topdressed as shown in Table 6.1. Plots were aerated with a hollow-core aerator with 1 cm dia. tines. Topdressing consisted of spreading a sand mixture onto the plot area and sweeping it into the turf (Beard 1982).

Core samples (6.25 cm diameter x 7.5 cm depth) for TD and AGB determinations were taken at intervals between October 1987 and October 1989. Sample number consisted of one core $plot^{-1}$ and sampling procedures followed those described by Madhi and Stoutemeyer (1953). TD and AGB were measured on the entire core sample and were expressed as functional tiller number and AGB m^{-2}, respectively (Madison 1962). AGB was determined as follows: The core was cut off at the original soil level and dried at 85 °C for 48 hours to determine total above ground dry weight. Samples were then placed in an ashing oven (Sybron Thermolyne Model 10500 Furnace) at 560 °C for 5 h to determine weight of non-organic aboveground matter. AGB was then calculated as: total aboveground dry weight minus non-organic aboveground dry weight. AGB $tiller^{-1}$ was calculated from AGB and TD values. Dry weight live $tiller^{-1}$ was measured on 100 tillers $plot^{-1}$ from samples taken on 12 July 1989. The tiller density and live AGB measurements of July 12 were used to calculate log C (an estimate of wear stress resistance) using Equation 1 (Lush 1990).

$$\log_{10}B = \log_{10} C - 0.5 \log_{10} N \qquad (1)$$

where B is dry weight of live tillers m^{-2}, N is tiller density m^{-2}, and $\log C$ is an estimate of turf wear stress resistance.

RESULTS AND DISCUSSION

Plant height before first cut (27 May 1987) was 7.9 cm for Seaside, 3.5 cm for each of National and Emerald, 2.8 cm for Penneagle, 1.8 cm for UM86-01 and 1.4 cm for UM84-01 (LSD 0.05 = 1.4). After the initial cut, all entries exhibited a more horizontal growth habit, similar to the trend observed by Duff and Beard (1974).

TD measurements were consistently highest for the two experimental lines, UM84-01 and UM86-01, and consistently lowest for Seaside (Table 6.2). Within entries, TD

Table 6.1. Fertilisation and aeration schedule for creeping bentgrass trial; 1987 to 1989.

Date	Fertiliser formulation	Rate (g product m^{-2})	Aeration and Topdressing
1987			
05 May	22 - 0 - 16	20.5	
12 June	22 - 0 - 16	20.5	
13 August	22 - 0 - 16	20.5	
17 September	22 - 0 - 16	20.5	
1988			
16 May	22 - 0 - 16	20.5	
20 June	22 - 0 - 16	20.5	Yes
18 August	22 - 0 - 16	20.5	
14 September	30 - 0 - 14	15.0	
1989			
08 May	15 - 0 - 0	30.0	
02 June	27-14 - 0	16.7	Yes
03 August	22 - 0 -16	20.5	
07 September	22 - 0 -16	20.5	

measurements were relatively stable over time. For example, mean TD across all sampling dates varied by less than 30% while late-season TD levels (October samples) varied by less than 20%. Slight increases in TD levels between May and July 1989 (Table 6.2) may be attributed to increasing day length and average daily air temperature (Hawes and Decker 1977). Penneagle had a similar TD (P>0.05) to the UM lines on two sampling dates. Tiller density levels in this study are similar to those reported for bentgrasses by Madison (1962) and Cattani and Clark (1991).

Levels of AGB closely reflected TD for all six entries. For example, UM84-01 and UM86-01 always had the highest (P<0.05) AGB, followed by Penneagle, Emerald, National and Seaside (Table 6.3). Similar to results for TD, AGB for Seaside was consistently lower than all other entries. Ranking among entries was also similar over sampling dates suggesting that phenotypic variation in TD and AGB expressed early in the stand life was maintained throughout the three-year test period.

Similar to observations for other turfgrasses (Lush 1990), total biomass per tiller was consistently highest for the low tillering entries (Table 6.4). Interestingly, entries with the highest AGB tiller^{-1} also achieved the greatest height prior to initial cutting. However, while entries with the lowest TD had the highest AGB tiller^{-1}, they still had the lowest total AGB (Table 6.3). This observation is similar to Shildrick and Peel (1984) and suggests that TD was more important than AGB tiller^{-1} in determining total AGB. Correlation coefficients for AGB and TD across genotypes ranged from 0.93 to 0.98 ($P<0.01$: $n=6$).

By the end of the study period (October 1989), the highest AGB producing entry, UM86-01, had accumulated 113, 131, 124 and 154% more AGB than Penneagle, Emerald, National and Seaside, respectively (Table 6.3). These data suggest that UM86-01 should provide the most wear stress resistance. Potential wear stress resistance was calculated using 12 July 1989 TD and live AGB measurements (Eq. 1). Results showed that the UM lines had significantly higher log *c* values than the other entries (Table 6.2), further supporting the conclusions that these lines should provide the greatest wear stress resistance of any of the entries tested in this study. However, because these lines yielded the highest levels of AGB, they may require additional management to ensure turf quality.

Results from the 12 July 1989 sampling date also show that the dry weight live tiller^{-1} was approximately 25% as high as the total AGB tiller^{-1} (Tables 6.2 and 6.4, respectively).

Table 6.2. Tiller density m^{-2} (x 1,000) (TD) for six creeping bentgrass entries, 1987-1989; plus dry weight live tiller^{-1} (DWT) and log *c* (Equation 1) for 12 July, 1989 sampling date.

	Date											
	15 Oct. 1987	27 July 1988	14 Oct. 1988	31 May 1989	21 June 1989	12 July 1989			02 Aug. 1989	23 Aug. 1989	13 Sep. 1989	04 Oct. 1989
	TD						DWT	log *c*	TD			
Cultivar	-------	-------	-------	-------	-------	-------	(mg)		-------	-------	-------	-------
UM84-01	138 a[z]	142 a	156 a	125 b	170 a	181 a	1.23 b	4.97 a	168 a	189 a	186 a	171 a
UM86-01	125 ab	138 a	143 b	145 a	148 b	165 b	1.19 b	4.89 a	147 b	189 a	189 a	172 a
Penneagle	114 bc	117 b	138 b	100 c	107 c	118 c	1.38 b	4.47 b	109 c	148 b	134 b	128 b
Emerald	94 cd	90 d	99 c	87 d	97 c	95 d	1.68 a	4.69 bc	93 c	125 c	113 b	100 c
National	88 d	105 c	102 c	77 d	94 c	100 d	1.42 b	4.63 c	108 c	121 c	118 b	98 c
Seaside	63 e	68 e	66 d	59 e	71 d	63 e	1.83 a	4.44 d	67 d	76 d	76 c	77 d
Mean	104	110	117	99	115	120	1.46	4.73	115	141	136	124
LSD (0.05)	23	11	13	11	18	14	0.25	0.09	20	18	22	12
CV (%)	15.0	6.4	7.6	7.6	10.2	7.5	11.4	1.4	11.6	8.3	10.5	6.6

[z] Values within column followed by the same letter are not significantly different using Fisher's Protected Least Significant Difference (P=0.05).

Table 6.3. Aboveground biomass (g m^{-2}) for six creeping bentgrass entries, 1988 and 1989.

	Date								
Entry	27 July 1988	14 Oct. 1988	31 May 1989	21 June 1989	12 July 1989	02 Aug. 1989	23 Aug. 1989	12 Sept. 1989	04 Oct. 1989
UM84-01	613 a[z]	722 a	822 a	827 a	890 a	809 a	984 a	1043 a	1064 ab
UM86-01	577 a	658 b	805 a	766 ab	890 a	764 a	961 a	1064 a	1139 a
Penneagle	487 b	588 c	740 b	703 bc	725 b	670 b	918 ab	942 bc	1047 b
Emerald	402 bc	531 d	668 bc	656 cd	703 b	612 b	775 c	856 cd	871 c
National	426 bc	531 d	663 c	621 d	692 b	600 b	810 bc	812 d	861 c
Seaside	366 c	410 e	541 d	509 e	555 c	489 c	598 d	689 e	695 d
CV (%)	10.0	4.9	7.1	6.5	8.8	7.8	8.7	7.8	5.8

[z] Values within columns followed by the same letter are not significantly different using Fisher's Protected Least Significant Difference (P=0.05).

Table 6.4. Aboveground biomass $tiller^{-1}$ (mg) for six creeping bentgrass entries, 1988 and 1989.

	Date								
Entry	27 July 1988	14 Oct. 1988	31 May 1989	21 June 1989	12 July 1989	02 Aug. 1989	23 Aug. 1989	12 Sept. 1989	04 Oct. 1989
UM84-01	4.0 b[z]	4.5 cd	6.4 cd	4.7 b	4.8 d	4.7 c	5.2 c	5.6 c	5.6 c
UM86-01	4.1 b	4.5 cd	5.4 d	5.1 b	5.3 cd	5.1 bc	5.1 c	5.6 c	6.5 b
Penneagle	4.1 b	4.1 d	7.2 c	6.4 a	6.0 bcd	6.0 ab	6.3 b	7.2 bc	8.0 a
Emerald	4.5 ab	5.3 b	7.5 bc	6.6 a	7.2 b	6.1 ab	6.3 b	7.7 ab	8.6 a
National	3.9 b	5.0 bc	8.4 a	6.5 a	6.8 bc	5.6 bc	6.8 b	6.9 bc	8.5 a
Seaside	5.3 a	6.1 a	8.9 a	7.1 a	7.2 a	7.2 a	7.9 a	9.5 a	8.7 a
CV (%)	13.4	9.5	9.7	11.6	16.6	14.7	10.5	19.2	7.5

[z] Values within column followed by the same letter are not significantly different using Fisher's Protected Least Significant Difference (P=0.05).

This relationship between live tiller and other organic material suggests that for all six entries, approximately three-quarters of the AGB on that sampling date consisted of plant material other than functional tillers. Part of this would have consisted of stolon internodes which were between functional tillers (a functional tiller is subtended by a root system) and would account for a large portion of the AGB.

In the present study, all entries received similar amounts of nitrogen fertiliser. While low tillering entries such as Seaside performed poorly in terms of TD and AGB production, results may have been different if different nitrogen levels had been tested. Madison (1962) observed dramatic increases in TD in Seaside due to high rates of nitrogen fertiliser (approximately twice the rate used in this study). However, given the negative effects of high nitrogen rates in turfgrasses, such as the invasion by annual bluegrass (*Poa annua* L.) (Kohlmeier and Eggens 1983) and increased incidence of disease (Beard 1983), plus the additional cost and environmental hazards associated with high nitrogen rates, achieving a superior and more wear resistant playing surface by genetic means appears to be a more practical approach.

LITERATURE CITED

Beard, J.B. 1982. Turf management for golf courses. USGA, Burgass Publ. Co., Minneapolis, MN.

Cattani, D.J. and K.W. Clark 1991. Influence of wear stress on turfgrass growth components and visual density ratings. Can. J. Plant Sci. 71:305-308.

Duff, D.T., and J.B. Beard 1974. Supraoptimal temperature effects upon *Agrostis palustris*. Part 1. Influence on shoot growth and density, leaf blade width and length, succulence and chlorophyll content. Physiol. Plant. 32:14-17.

Hawes, D.T., and A.M. Decker 1977. Healing potential of creeping bentgrass affected by nitrogen and soil temperature. Agron. J. 69:212-214.

Kohlmeier, G.P. and J.L. Eggens 1983. The influence of wear and nitrogen on creeping bentgrass growth. Can. J. Plant Sci. 63:189-193.

Madhi, Z. and V.T. Stoutemeyer 1953. A method of measurement in dense turf. Agron. J. 61:514-515.

Madison, J.H. 1962. Turfgrass ecology. Effects of mowing, irrigation and nitrogen treatments of *Agrostis palustris* Huds., 'Seaside'and *Agrostis tenuis* Sibth., 'Highland' on population rooting and cover. Agron. J. 54:407-412.

Shildrick, J.P. 1985. Thatch: A review with special reference to U.K. golf courses. J. Sports Turf Res. Inst. 61:8-25.

Shildrick, J.P. and C.H. Peel 1984. Shoot numbers, biomass and sheer strength in smooth-stalked meadowgrass (*Poa pratensis* L.). J Sports Turf res. Inst. 60:66-72.

Shildrick, J.P. and C.H. Peel 1983. Football-stud wear on turf-type cultivars of tall fescue. J. Sports Turf Res. Inst. 59:124-132.