DEVELOPMENT OF MANAGEMENT PRACTICES FOR SUPINA BLUEGRASS (*POA SUPINA* SCHRAD.)

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Introduction

Supina bluegrass (*Poa supina* Schrad.) is a stoloniferous bluegrass native to Europe where it has been cultivated as a golf course, lawn, and athletic turf for over twenty years (Berner, 1984; Nonn, 1994). Supina bluegrass is well adapted to cold temperatures and is found commonly in the sub-alpine regions of the German and Austrian Alps (Berner, 1984; Köck and Walch, 1977; Skirde, 1971). In Germany, the common name is Lägerrispe, which means "where the cows lay". The name is a reflection of the ability of Supina bluegrass to persist and even thrive on cattle trails, even in shaded woodland areas (Berner, 1984; Pietsch, 1989). Research in Germany has even noted the ability of Supina bluegrass to crowd out annual bluegrass (*Poa annua* L.) (Pietsch, 1989). Another attractive asset is the apparent resistance of Supina bluegrass to many diseases which results in fewer fungicide applications (Nonn, 1994).

Due to the need to develop better turf systems for high wear areas on golf courses and athletic fields a research program was started at Michigan State University in 1994 to development management practices for Supina bluegrass in Michigan. A preliminary report has been published on the comparison of Supina bluegrass, Kentucky bluegrass, and perennial ryegrass (*Lolium perenne* L.) sods for sand based athletic fields (Rogers et al., 1996). Although Supina bluegrass has been used extensively in certain areas of Europe, little published research exists to recommend specific management practices. In 1995 two plot areas were established to satisfy the following research objectives: 1) Determine the appropriate mowing height range and 2) Determine the fertility requirements on sandy loam soil. In both plots simulated sports traffic was applied to half the area while the other half of the area was left as a check.

Materials and Methods

Experiment 1: Fertility requirements of Supina bluegrass

Supina bluegrass 'Supra' was established on a sandy loam soil at the Hancock Turfgrass Research Center, Michigan State University, MI, during summer 1995. The plot area (40 ft x 40 ft) was seeded with 1.5 lb/1000 ft^2 seed on 21 June 1995 using a drop spreader. Starter fertilizer (13-25-12) was applied at time of seeding to supply approximately 1 lb N and 1 lb P/1000 ft^2. The area was hydromulched and an automated irrigation system used to maintain sufficient moisture levels for germination, establishment, and subsequent maintenance. All plots were fertilized equally during 1995 with approximately 2.75 lb additional N/1000 ft^2 with approximately 1 lb/1000 ft^2 additional P and 1.5 lb/1000 ft^2 additional K. On 17 Nov. 1995 a dormant application of 1 lb/1000 ft^2 N was applied using SCU (40-0-0). Beginning July 1995 all plots were mowed with a triplex riding mower at approximately 1.25" cutting height. Clippings were returned in both 1995 and 1996.

A factorial experiment was developed to test individual fertility treatments beginning spring 1996. Both total N (2, 4, and 6 lb/1000 ft^2/year) and N to K ratios (2:1 and 1:1) were investigated. The experimental design was a split-plot, randomized complete block with three replications. Main plots were fertility treatments which were split for traffic (no traffic and simulated athletic traffic). Fertility treatment dates were as follows (Table 1), with 1 lb N/1000 ft^2 and ½ (treatments 1-3) or 1 lb K/1000 ft^2 (treatments 4-6) applied on each date. Urea (46-0-0) was used as the N source and sulfate of potash (0-0-50) was used as the potassium source.

Table 1. Treatment dates and rates on Supina bluegrass fertility study, East Lansing, MI, 1996.

Treatment (N:K)	Application dates
2:1	10 May, 16 Sept.
4:2	10 May, 3 June, 16 Aug., 16 Sept.
6:3	10 May, 3 June, 28 June, 16 Aug., 16 Sept., 11 Nov.
2:2	10 May, 16 Sept.
4:4	10 May, 3 June, 16 Aug., 16 Sept.
6:6	10 May, 3 June, 28 June, 16 Aug., 16 Sept., 11 Nov.

Lightweight athletic traffic (i.e., soccer-type) was applied as a split-plot treatment using a Brinkman Traffic Simulator (BTS) with empty rollers from 28 May to 9 July for a total of an estimated 11 games. Beginning 9 Aug., the rollers on the BTS were filled with water and used to simulate one to three football games per week ending 18 November.

Turf color, density, and quality were evaluated on a regular basis. An Eijkelkamp shear vane apparatus was used to determine turf shear resistance. Dollar spot disease ratings were collected on 17 September.

Experiment II: Mowing height study

Supina bluegrass 'Supra' was established on a sandy loam soil at the Hancock Turfgrass Research Center, Michigan State University, MI, during summer 1995. The plot area (40 ft x 40 ft) was seeded with 1.5 lb/1000 ft^2 seed on 21 June 1995 using a drop spreader. Starter fertilizer (13-25-12) was applied at time of seeding to supply approximately 1 lb N and 1 lb P/1000 ft^2. The area was hydromulched and an automated irrigation system used to maintain sufficient moisture levels for germination, establishment, and subsequent maintenance. All plots were fertilized equally during 1995 with approximately 2.75 lb additional N/1000 ft^2 with approximately 1 lb/1000 ft^2 additional P and 1.5 lb/1000 ft^2 additional K. Fertilizer was applied on six dates between June through October with no more than 0.6 lb N/1000 ft^2 applied at any date. On 17 Nov. 1995 a dormant application of 1 lb/1000 ft^2 N was applied using SCU (40-0-0). During 1995 and early spring 1996 all plots were mowed with a triplex riding mower set at approximately 1.25" cutting height. Clippings were returned in both 1995 and 1996.

On 24 May a factorial experiment was started to test the effects of three mowing heights (9/16", 1.25", and 2.25") on Supina bluegrass characteristics. The experimental design was a randomized complete block, split-plot, with three replications. All plots (each 10 x 10 ft^2) were split into trafficked and non-trafficked areas. Simulated athletic trafic was applied using a Brinkman Traffic Simulator (BTS). Lightweight athletic traffic (i.e., soccer-type) was applied as a split-plot treatment using a Brinkman Traffic Simulator (BTS) with empty rollers from 28 May to 9 July for a total of an estimated 11 games. Beginning 9 Aug., the rollers on the BTS were filled with water and used to simulate one to three football games per week ending 18 November.

Plots were fertilized with 5 lb N/1000 ft^2 and 3.5 lb K/1000 ft^2 in 1996. Fertilizer (18-3-18) was applied at 0.5 lb N/1000 ft^2 on 10 May, 24 May, 14 June, 12 Aug., 3 Sept., and 24 September 1996. On 28 June, 1 lb N/1000 ft^2 using sulfur coated urea (40-0-0) was applied plus 1 lb K/1000 ft^2 using sulfate of potash (0-0-50). On 16 November 1 lb N/1000 ft^2 was applied as a dormant application using urea (46-0-0). Plots were irrigated as needed to prevent moisture stress.

Turf color, density, and quality were evaluated on a regular basis. An Eijkelkamp shear vane apparatus was used to determine turf shear resistance. Dollar spot disease ratings were collected on 17 September.

Results and Discussion

Experiment 1: Fertility requirements of Supina bluegrass

Supina bluegrass responded positively to nitrogen fertilization (Table 2). Turf color and quality were consistently significantly greater at 4 and 6 lb N/1000 ft^2/year compared to 2 lb N/1000 ft^2/year. The ratio of N:K had little or no effect on turf color, density, or quality. Fertility levels had less of an effect on turf density although on 21 Aug. and 17 Sept. the 4 and 6 lb N rates provided significantly denser turf. Traffic treatments significantly enhanced turf color (darker green) but decreased turf density and quality (Table 2). There were no interactions between traffic and fertility rate on turf color or quality. On two dates (17 Sept. and 8 Nov.) there were interactions between traffic and fertility rate (Table 3). On 17 Sept., after 5 simulated football games, traffic did not affect turf density at any fertility rate except for apparently increasing the turf density at the 4:4 (lb N:K) treatment. The highest fertility rate (6:6 lb N:K, respectively) increased turf density compared to the next highest fertility rate (4:4 lb N:K) in the absence of traffic although results were similar between the medium and high fertility levels in trafficked conditions. On 8 Nov., after 26 simulated football games, traffic significantly reduced turf

Table 2. Effects of fertility rate and traffic on Supina bluegrass, East Lansing, MI, 1996.

Treatment	13 June	12 July	14 Aug.	21 Aug.	17 Sept.	8 Nov.
	Color †					
Fertility (#N:#K yr^{-1}) ‡						
2:1	5.9	4.0	5.4	4.1	5.0	5.2
4:2	6.4	5.0	5.8	7.2	6.4	5.5
6:3	6.3	5.5	6.1	7.1	6.4	5.4
2:2	6.2	4.8	5.7	4.4	5.2	5.0
4:4	6.2	4.6	5.9	6.9	5.9	5.4
6:6	6.1	6.3	6.4	7.2	6.8	5.6
LSD (0.05)	ns	1.0	0.6	0.6	1.0	0.3
Traffic						
no	6.1	4.9	5.8	6.0	5.8	5.2
yes	6.3*	5.2**	5.9	6.3**	6.1**	5.5*
Fertility (#N:#K yr^{-1})	Density (% turf cover)					
2:1	99.1	91.4	97.0	96.2	87.9	91.0
4:2	99.6	89.5	97.2	98.5	97.0	92.6
6:3	99.1	93.5	98.4	99.5	96.0	91.5
2:2	99.2	94.6	98.0	97.5	88.4	90.5
4:4	99.4	94.6	97.5	98.5	92.9	92.0
6:6	99.4	92.9	98.5	99.2	97.8	90.8
LSD (0.05)	ns	ns	ns	1.6	4.5	ns
Traffic						
no	99.4	94.7	98.3	98.2	92.9	96.4
yes	99.2	90.8*	97.2**	98.2	93.7	86.4**
Fertility (#N:#K yr^{-1})	Quality §					
2:1	8.4	6.2	7.2	6.8	4.6	5.1
4:2	8.5	7.0	7.8	8.1	7.5	5.5
6:3	8.5	7.8	8.1	8.4	7.5	5.6
2:2	8.5	7.7	7.7	6.8	4.8	5.0
4:4	8.5	8.2	7.9	8.3	6.1	5.8
6:6	8.5	7.8	8.1	8.1	7.6	5.5
LSD (0.05)	ns	1.1	ns	0.6	1.1	0.5
Traffic						
no	8.5	8.1	7.9	7.7	6.1	6.4
yes	8.5	6.8**	7.6**	7.8	6.6*	4.4**
No. games simulated ¶	3	11	1	2	4	25

*,** Significant at the 0.05 and 0.01 probability levels, respectively; ns = not significant at p=0.05.
Table 2. cont.

† Color was rated visually on a 1-9 scale; 1=100% brown, 9=dark green.
‡ Nitrogen was supplied as urea (46-0-0) and potassium was supplied as sulfate of potash (0-0-50). 1 lb N and ½ lb K per 1000 ft² were applied to the following treatments (**bold**) on the following dates: **2:1**,10 May, 16 Sept.; **4:2,** 10 May, 3 June, 16 Aug., 16 Sept.; **6:3**, 10 May, 3 June, 28 June, 16 Aug., 16 Sept., 11 November. 1 lb N, 1 lb K per 1000 ft² were applied to the following treatments on the following dates: **2:2**, 10 May, 16 Sept.; **4:4**, 10 May, 3 June, 16 Aug., 16 Sept.; **6:6**, 10 May, 3 June, 28 June, 16 Aug., 16 Sept., 11 Nov.
§ Quality was rated visually on a 1-9 scale; 1=100% necrotic turf/bare soil, 9=dense, uniform turf; 5=minimum value for acceptable quality.
¶ A Brinkman Traffic Simulator (BTS) with empty rollers was used to simulate soccer traffic from 28 May - 9 July. Beginning 9 Aug., a BTS with rollers filled with water was used to simulate football traffic, approximately 3 games per week, until 18 Nov. 1996; two passes with the BTS was equivalent to the amount of traffic between the hashmarks at the 40 yd line of a football field.

Table 3. Interaction of traffic and fertility rates on density of Supina bluegrass on a sandy loam soil, East Lansing, MI, 1996.

	17 Sept. 1996		8 Nov. 1996	
	Traffic†			
Fertility rate (lb N:K/1000 ft²/yr)	None	5 games	None	26 games
	Density (% turf cover)			
2:1	88.8	87.0	93.5	88.5
4:2	97.0	97.0	98.5	86.8
6:3	95.8	96.2	97.5	85.5
2:2	87.0	89.8	92.8	88.2
4:4	90.5	95.2	97.5	86.5
6:6	98.5	97.0	98.5	83.0
LSD (0.05)				
between traffic treatments	3.5		6.0	
between fertility rates	5.6		7.2	

† A Brinkman Traffic Simulator (BTS) was used to simulate the amount of traffic in football games between the hashmarks at the 40 yd line.

density at both medium and high fertility rates, regardless of N to K ratio, compared to the low fertility rates. However, at no time did low fertility rates result in greater turf density.

Shear resistance values were generally lower at the high fertility rates compared to low fertility treatments although the results were significant only on one of three dates tested (Table 4). The medium fertility rates (4 lb N/1000 ft²/year) resulted in intermediate shear resistance values. As with turf color, density, and quality, there were no interactions between traffic and fertility rate. Dollar spot severity was significantly decreased at the medium and high fertility rates compared to the lowest fertility rates (2 vs. 4 lb N/1000 ft²/year).

Table 4. Effects of fertility and traffic on the shear resistance and dollar spot severity of Supina bluegrass maintained at 1.25" height, East Lansing, MI, 1996.

	Shear resistance (N m) †			Dollar spot severity		
				21 Aug.	17 Sept.	
Treatment	23 July	17 Sept.	8 Nov.	No. spots m^{-2}	No. spots m^{-2}	% area
Fertility (#N:#K per 1000 ft^2/year)‡						
2:1	19.2	16.6	13.6	2.0	8.8	9.1
4:2	17.8	14.6	12.4	0.3	1.3	1.4
6:3	19.1	14.4	11.6	0.2	0.9	0.8
2:2	19.8	16.6	13.4	1.7	7.3	11.0
4:4	19.7	16.5	12.3	0.8	2.8	2.6
6:6	16.9	14.4	12.2	0.4	0.5	0.4
LSD (0.05)	ns	1.7	ns	1.0	2.3	3.4
Traffic						
no	19.6	16.8	17.9	1.1	4.7	5.2
yes	17.8*	14.3**	7.3**	0.6**	2.5**	3.2**

*,** Significant at the 0.05 and 0.01 probability levels; ns = not significant at p=0.05.
† An average of two shear resistance values per plot were used for analysis.
‡ Nitrogen was supplied as urea (46-0-0) and potassium was supplied as sulfate of potash (0-0-50). Plots were fertilized according to the following schedule:

#N:#K		Application dates
2:1	1 lb N, 1/2 lb K/1000 ft^2:	10 May, 16 Sept.
4:2	1 lb N, 1/2 lb K/1000 ft^2:	10 May, 3 June, 16 Aug., 16 Sept., 11 Nov.
6:3	1 lb N, 1/2 lb K/1000 ft^2:	10 May, 3 June, 28 June, 16 Aug., 16 Sept., 11 Nov.
2:2	1 lb N, 1 lb K/1000 ft^2:	10 May, 16 Sept.
4:4	1 lb N, 1 lb K/1000 ft^2:	10 May, 3 June, 16 Aug., 16 Sept., 11 Nov.
6:6	1 lb N, 1 lb K/1000 ft^2:	10 May, 3 June, 28 June, 16 Aug., 16 Sept., 11 Nov.

Experiment II: Mowing height study

All three mowing heights provided acceptable turf color, density, and quality (Table 5). Initially the color, density, and quality of the 9/16" height was lower than the other mowing heights due to the sudden decrease in mowing height from 1.25 to 9/16" but recovery was good. Traffic reduced turf density and quality as mowing height was decreased but had little effect at the high mowing height (2.25") (Table 6). Turf maintained at the highest mowing height went off-color (foliage turned brown) much earlier in the year compared to turf at the two lower mowing heights, particularly the 9/16" height which stayed relatively green through 13 December 1996.

Turf shear resistance was significantly decreased as mowing heights decreased (Table 7). The greater mass of foliage as mowing height increased provided a firmer surface and perhaps increased rooting compared to the lower mowing heights. Mowing height did not affect dollar spot severity. Traffic reduced the number of dollar spot patches but the area affected was greater in trafficked plots compared to non-trafficked plots, possibly due to slower recovery rates resulting from traffic.

Conclusions

Experiment 1: Fertility requirements of Supina bluegrass

Four to six lbs N/1000 ft^2/year resulted in significantly superior turf color, density, and quality compared to two lbs N/1000 ft²/year. The ratio of N:K, whether 2:1 or 1:1, did not affect the turf. Shear resistance, indicative of the degree of rooting and turf strength, was occasionally decreased by high N fertility. The four lb N/1000 ft²/year rate of fertilizer with either two or four lbs K/1000 ft²/year appeared to provide the best combination of turf color, density, quality, shear resistance, and dollar spot disease severity reduction compared to either two or six lb N/1000 ft²/year.

Experiment II: Mowing height study

Supina bluegrass maintained acceptable turf characteristics at 9/16" height to make it a viable candidate for further testing as fairway turfgrass for golf courses in Michigan. The 9/16" height was too short for it to be used for aggressive athletic traffic such as football. Supina bluegrass performed well at 1.25" height although more than 20 simulated football games caused excessive damage. At 1.25", Supina bluegrass would be expected to perform well in less aggressive traffic situations (e.g., soccer fields). At the 2.25" height, Supina bluegrass could perform well as a lawn turf although the foliage would become nearly totally necrotic by mid to late autumn. Spring green up will be evaluated at all heights in 1997.

Table 5. Effects of mowing height and traffic on the color, density, and quality of Supina bluegrass, East Lansing, MI, 1996.

Treatment	12 June	18 July	14 Aug.	17 Sept.	8 Nov.	13 Dec.
	Color †					
Mowing height (inches)						
9/16	4.2	5.0	6.5	6.5	5.5	5.6
1¼	5.8	6.2	7.2	6.7	5.2	4.2
2¼	5.8	5.5	5.3	7.3	2.7	2.4
LSD (0.05)	0.9	ns	ns	0.6	2.0	0.4
Traffic						
no	5.2	5.4	6.3	6.8	4.6	3.1
yes	5.3	5.8	6.3	6.8	4.3	5.0**
Mowing height (inches)	Density (% turf cover)					
9/16	87.5	96.5	99.8	97.3	96.8	79.5
1¼	99.2	98.0	99.3	97.5	97.0	88.7
2¼	100	95.5	99.7	99.7	99.0	96.5
LSD (0.05)	1.9	ns	ns	ns	ns	2.6
Traffic						
no	97.2	98.1	99.8	98.3	96.9	99.0
yes	93.9*	95.2**	98.8	98.0	98.3	77.4**
Mowing height (inches)	Quality ‡					
9/16	6.3	6.5	8.2	6.8	4.6	4.8
1¼	9.0	8.1	8.8	7.6	4.5	4.5
2¼	8.2	6.3	5.8	7.0	4.2	5.2
LSD (0.05)	0.5	0.9	0.5	ns	ns	0.5
Traffic						
no	7.8	7.1	7.7	7.0	5.6	6.2
yes	7.9	6.9	7.5	7.3	3.3**	3.4**
No. games simulated §	4	12	1	5	24	26

*,** Significant at the 0.05 and 0.01 probability levels, respectively; ns=not signficant at p=0.05.

† Color was rated visually on a 1-9 scale; 1=100% brown, 9=dark green

‡ Quality was rated visually on a 1-9 scale; 1=100% necrotic turf/bare soil, 9=dense, uniform turf; 5=minimum value for acceptable quality

§ An empty Brinkman Traffic Simulator (BTS) was used to simulate soccer traffic 30 May-9 July. The rollers of the BTS were filled with water to simulate football traffic from 9 Aug.-18 Nov.

Table 6. Interaction of cutting height and traffic on color, density, and quality of Supina bluegrass, East Lansing, MI, 1996.

	8 November		13 December	
	Traffic †			
	None	26 games	None	26 games
Mowing height (inches)	Color ‡			
9/16	5.7	5.3	5.3	5.8
1.25	5.3	5.0	3.0	5.3
2.25	2.8	2.5	1.0	3.8
LSD (0.05)				
between traffic treatments	ns		0.8	
between heights	ns		0.7	
Mowing height (inches)	Density (% turf cover)			
9/16	95.3	98.3	99.0	60.0
1.25	96.3	97.7	99.0	78.3
2.25	99.0	99.0	99.0	94.0
LSD (0.05)				
between traffic treatments	ns		2.6	
between heights	ns		2.3	
Mowing height (inches)	Quality §			
9/16	6.8	2.3	7.3	2.2
1.25	5.7	3.3	6.3	2.7
2.25	4.2	4.2	5.0	5.5
LSD (0.05)				
between traffic treatments	0.8		0.7	
between heights	0.3		0.7	

ns = not significant at p=0.05.

† A Brinkman Traffic Simulator was used to simulate the amount of traffic between the hashmarks at the 40 yd line during the specified number of football games

‡ Color was rated visually on a 1-9 scale; 1=100% brown, 9=dark green.

§ Quality was rated visually on a 1-9 scale; 1=100% necrotic turf/bare soil, 9= dense, uniform turf with acceptable color (≥ 5).

Table 7. Effects of mowing height and traffic treatments on shear resistance and dollar spot on Supina bluegrass, East Lansing, MI, 1996.

	Shear resistance (N m)			Dollar spot severity, 17 Sept.	
Treatment	19 July	17 Sept.	8 Nov.	No. spots m^{-2}	% area
Mowing height (in.)					
9/16	17.0	15.6	11.6	7.4	2.3
1¼	19.7	17.8	15.2	4.1	3.0
2¼	18.6	19.4	20.4	2.1	1.3
LSD (0.05)	ns	1.7	4.0	ns	ns
Traffic					
none	19.3	19.4	20.1	5.3	1.7
yes	17.6*	15.7**	11.3**	3.7ns	2.8ns
No. of games †					

*,** Significant at the 0.05 and 0.01 probability levels, respectively; ns=not significant at p=0.05.

† Between 30 May-9 July soccer traffic was simulated using the Brinkman Traffic Simulator (BTS) with empty rollers. From 9 Aug. -18 Nov. football traffic was simulated using the BTS with rollers filled with water.

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