1996 SPORTS TURF MANAGEMENT PROGRAM UPDATE

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1996 was a busy year for the Sports Turf Management Program at Michigan State University. We concentrated our research efforts in three major areas:

1) Sod establishment on plastic
2) *Poa supina* management for sports turf
3) Sand selection and crumb rubber effects on SportGrass™

Each of these areas will be reviewed in some detail in this paper and/or in subsequent papers within these proceedings.

I. Refined Wood Fiber Mat (Ecomat™) as an Establishment Media for Turfgrass

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Sodding is a method of turfgrass establishment providing an instant turfgrass cover. Conventional sodding methods involve strips of turfgrass with the adhering soil. This adhering soil layer has often been attributed to causing water movement and rooting problems when the soil of the newly laid sod does not match the soil type on the site where it is placed. This problem is accentuated when the turf is subjected to traffic during suboptimal growing conditions. Washing the soil off of the sod pieces during harvesting is a procedure that helps eliminate any potential soil layering problems. However, the use of washed sod is limited to turfgrasses with stoloniferous and rhizomatous growth habits. Stoloniferous turfgrasses have a tendency to perform better than rhizomatous turfgrasses because the stolons are less likely to be sheared and washed during sod harvesting. Washed sod without an adhering soil layer and/or intact root system is vulnerable to wilting in a shorter time than a non washed sod.

Sod production on plastic is a unique method of turfgrass establishment that provides many benefits compared to conventional sod production. For instance, root shearing is eliminated when sod is grown on plastic as a result of the roots inability to penetrate the plastic. Instead, the roots become intertwined with the other roots and the growth media that they are growing within; which allows for the establishment of bunch type turfgrasses for sod. Sod production on plastic allows for the sod to be produced on a number of contrived growth media. Currently, commercial sod production on plastic uses sewage sludge, wood mulch, and sand as the growth media for turfgrass establishment. The ability to select a particular growth media eliminates the potential for soil layer problems commonly associated with sod produced by conventional methods. Using a soil less growth media also provides a more light weight sod thus, enabling larger pieces of sod to be harvested.

Ecomat™ is a refined wood fiber mat consisting of fine strands of shredded wood fiber supported by a thin woven polyethylene backing. Manufactured in New Westiminster, British Columbia, by Canadian Forest Products Ltd., Ecomat™ is used extensively as an erosion control mat along roadsides. Another use for Ecomat™ is as a basket liner for hanging plants. Available enpregnated with turfgrass seed (Take Home Turf), Ecomat™ provides a combination of grass seed and mulch making turfgrass establishment easy to apply and grow. Ecomat™, in rolls 135 feet by 4 feet, is light weight and has the potential for very large pieces of sod to be harvested, when used as a growth media for sod production on plastic.

II

Turfgrass Establishment on Plastic Utilizing Contrived Growth Media

J. C. Sorochan and J. N. Rogers III

Introduction

Turfgrass establishment is as important a practice as any other method of turfgrass management. Today, high quality turfgrass stands on athletic fields and golf courses are in greater demand than ever before. Not only does the quality of turfgrass have to be acceptable, but the pressures of providing a playable turfgrass stand for immediate use also exists. Sodding is a method of turfgrass establishment that has a demonstrated ability to provide an instant turfgrass cover. However, conventional sodding only provides an instant turfgrass cover, and depending on environmental conditions, the newly sodded area, like a soccer field, will only be ready for play once the root systems have regenerated. Sod establishment on plastic is a unique method of turfgrass establishment that posses the ability to provide an instant turfgrass cover with immediate pliability versus conventional sodding. Root shearing is eliminated when sod is produced on plastic which enables the newly laid sod to establish in a much shorter period of time than conventional sodding. Another advantage of sod production on plastic is the ability to grow turfgrasses on a wide variety of growth media. Selecting a specific growth media for turfgrass establishment on plastic possesses many advantages. For instance, selecting a soil less growth media eliminates potential soil layering problems commonly associated with conventional sodding practices. The selection of the growth media can also be cost effective. Refined wood fiber erosion mats, and pine bark mulches are relatively cheap materials that can be used as a growth media for turfgrass establishment on plastic. The objective of this study is to determine what growth media produces the best sod for two turfgrass species. The two turfgrass species selected were *Poa supina* var. 'Supranova' and *Poa pratensis* var. 'Touchdown'. Both species are cool season turfgrasses used for athletic fields. *Poa pratensis* has a rhizomatous growth habit, and *Poa supina* has a stoloniferous growth habit; which, makes them excellent turfgrasses for sod production. The four growth media selected for this study are: pine mulch, sand, refined wood fiber mat, and SportGrass™ back filled with sand. The pine mulch consists of shredded wood pieces that have a relatively low water holding capacity. Wood mulch is a growth media currently used for sod production on plastic. The second media is sand, and is very unstable on the plastic when there is no established turfgrass for support. The refined wood fiber mat (Ecomat™) provides a light weight and stable surface for turfgrass establishment. Finally, SportGrass™ is a woven polyethylene mat with synthetic strands intended to provide additional support for the turfgrass. The four different media were selected because of the current and potential use for athletic fields. A future experiment will be done to compare the effects of the four growth media under athletic field conditions.

Material and Methods

The experimental design was a 2 by 4 factorial randomized complete block design with three replications. Each of the 24 plots were 9 feet by 12 feet, and were set up on 6 mil polyethylene sheeting at the Hancock Turfgrass Research Center, on the campus of Michigan State University. The seeding rate for both turfgrass species was 1.6 lbs seed per 1000 ft^2. The plots were prepared and seeded on 3 June 1996. The sand and pine mulch were applied at at 0.75 inch depth, and the SportGrass™ was back filled with 1 inch of sand. Lebanon Country Club 13-25-12 starter fertilizer was applied at 1 lb. N. per 1000 ft^2 on 3 and 10 June 1996. Unfortunately, 2.8 inches of rain on 17 June 1996 washed out the entire study. The experiment was reestablished on 12 August 1996, using the same procedure as the first experiment. Fertilizer applications were made at the beginning of each week for the first four weeks using the 13-25-12 starter fertilizer at 1 lb. N. per 1000 ft^2. Three fertilizer applications beginning on 13 Sept. 1996 and ending on 11 October 1996, were applied every two weeks using Lebanon Country Club 18-3-18 fertilizer at 0.5 lbs. N. per 1000 ft^2. Irrigation was applied as needed using an automatic irrigation system, and by hand watering. The hand watering was required because, the four growth media each had a different watering requirement. Density ratings (% turfgrass cover) was measure 2, 3, 5, and 10 weeks after seeding. This experiment will be repeated again in the summer of 1997.

Results and Discussion

Table 1 is an ANOVA table indicating the significance of the two treatment effects, for percent turfgrass cover, at 2, 3, 5, and 10 weeks after seeding. The *Poa supina* showed slightly higher turfgrass density at 2, 3, 5, and 10 weeks after seeding; however, the difference in percent cover was only significant at 5 weeks (table 2.). The stoloniferous growth habit of the *Poa supina* may be the reason why it had a greater percent cover after 5 weeks. The spreading by stolons compared to the rhizomes exhibited by the *Poa pratensis* was more visible on the surface of each growth media thus, giving the *Poa supina* a more dense appearance. There was no significant difference between the two turfgrass species after 10 weeks.

Table 3 describes the significance of the growth media for percent turfgrass cover. The greatest differences were caused by the sand and SportGrass™ media. The pine mulch and Ecomat™ showed similar growth. The sand did the poorest of the four media selected probably because of it was very unsatabile on the plastic surface where, it was easily washed when it rained or irrigated. The SportGrass™ did much better than the other three media selected. The one inch sand top layering on the SportGrass™ provided an adequate growing surface for the establishing turfgrass. However, unlike the sand media alone, the synthetic strands of the SportGrass™ provided the necessary support during establishment. After 10 weeks the SportGrass™ had almost 100% cover (97.6) and was mature enough to be moved. The pine mulch and Ecomat™ after 10 weeks only had 35.8 and 36.7 percent cover, respectively. However, the areas with turfgrass were very dense while, the rest of the media had little or no growth. The areas where there was little or no growth were most likely a result of two extremes. The first extreme being washed by excessive rain and irrigation, and the second by drying out too fast during establishment. In order to keep one of the four media at the optimum moisture level for turfgrass establishment meant that the other three would be affected by either too much or too little water, from either the irrigation system or by rain. As a result, the SportGrass™ proved to be the most adaptable media with the varying water levels.

Table 1. Significance of Treatment Effects for Turfgrass Cover

	Weeks after seeding			
Source	2	3	5	10
Turf species (T)	n/s	n/s	*	n/s
Growth media (G)	*	**	**	**
T x G	n/s	n/s	n/s	n/s
$LSD_{(0.05)}$				

*, ** Significant at the 0.05, 0.01 probability levels, respectively

Table 2. Turfgrass Density of 2 Turfgrass Species (Averaging Growth Media)

	Weeks after seeding			
Turfgrass sp.	2	3	5	10
	Pecent cover (%)			
Poa pratensis	2.1	5.3	30.6	42.8
Poa supina	2.2	6.9	37.9	51.8
$LSD_{(0.05)}$	n/s	n/s	5.6	n/s

Table 3. Turfgrass Density on 4 Growth Media (Averaging Turf species)

Growth media	Weeks after seeding 2	3	5	10
	Percent cover (%)			
Pine mulch	1.8	5.0	15.2	35.8
Sand	1.3	2.8	12.0	18.8
Ecomat™	2.0	3.3	19.5	36.7
SprotGrass™	3.3	13.2	90.3	97.8
$LSD_{(0.05)}$	n/s	2.4	7.9	14.4

Effect of seeding ratio of Supina bluegrass and Kentucky bluegrass and fertility on turf subjected to simulated sports traffic.

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Introduction

Supina bluegrass (*Poa supina* Schrad.) has been recognized for its exceptional wear tolerance, disease resistance, and aggressive competitive ability for many years in Germany and other areas of Europe (Berner, 1980; Pietsch, 1989). Unfortunately the cost of Supina bluegrass seed is quite high, approximately \$25/lb, so the practicality of seeding monostands of the grass is often economically unfeasible. Evidence from Germany suggests relatively low rates (e.g., less than 10%) of Supina bluegrass seed can be mixed with other cool season grasses and after several years of heavy traffic the stand will be predominantly Supina bluegrass, providing superior cover compared to stands without Supina bluegrass. The objective of this project was to determine the effect of seeding ratios of Supina bluegrass:Kentucky bluegrass on turf characteristics. A long-term objective is to determine the changes in stand composition over time.

Materials and Methods

Plots were established June 1995 on a sand based root zone (80:10:10, sand:peat:soil). Individual plots (10 x 18 ft) were seeded by hand (1.25 lb seed/1000 ft^2) and the seed was raked lightly into the surface. Plots were covered with hydromulch and kept moist during the germination and establishment processes. Following establishment all plots were mowed at 1.25" height with a riding triplex mower; clippings were returned. Plots were irrigated daily, or as needed in the spring and fall, using an automated irrigation system to prevent moisture stress. All plots were fertilized equally during 1995 with approximately 2.75 lb additional N/ 1000 ft^2, 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).

A factorial experiment was used to evaluate the effect of seeding mixtures and monostands of Supina bluegrass (SB) 'Supra' and Kentucky bluegrass (KB) 'Touchdown' on turf characteristics and eventually, changes in stand composition over time. The experimental design was a split-plot, randomized complete block with three replications. Main plots were the six seeding treatments: Trt 1=100% SB, Trt 2=50%SB:50% KB, Trt 3=75% SB:25%KB, Trt 4=10% SB:90%KB, Trt 5=5% SB:95% KB, and Trt 6=100% KB. Plots were split to evaluate the effects of low (4 lb N/1000 ft^2/year) and high (6 lb N/1000 ft^2/year) fertility levels. Nitrogen was applied at approximately a 1:1 ratio with potassium on most dates using an 18-3-18 fertilizer (Table 1).

Table 1. Fertility schedule and rates for Supina bluegrass:Kentucky bluegrass seeding ratio study.

Low fertility (4 lb N/1000 ft²/year)	High fertility (6 lb N/1000 ft²/year)
10 May 0.5 lb N, 18-3-18	10 May 0.5 lb N, 18-3-18
	24 May 0.75 lb N, 18-3-18
3 June 0.5 lb N, 18-3-18	14 June 0.5 lb N, 18-3-18
28 June 1.0 lb N, 40-0-0 SCU	28 June 1.0 lb N, 40-0-0 SCU
	2 Aug. 0.5 lb N, 18-3-18
16 Aug. 0.5 lb N, 18-3-18	16 Aug. 0.75 lb N, 18-3-18
5 Sept. 0.5 lb N, 18-3-18	5 Sept. 0.5 lb N, 18-3-18
	1 Oct. 0.5 lb N, 18-3-18
16 Nov. 1.0 lb N, 46-0-0 urea	16 Nov. 1.0 lb N, 46-0-0 urea
TOTAL ANNUAL N = 4 LB/1000 FT²	TOTAL ANNUAL N = 6 LB/1000 FT²

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.

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. Changes in stand composition will be determined by spring 1997 and spring 1998 by collecting plants at random from each plot using a point quadrat and determining the percentages of Supina bluegrass and Kentucky bluegrass.

Results and Discussion

Kentucky bluegrass displayed significantly darker green color compared to any mixture or the monostand of Supina bluegrass (Table 2). Mixtures containing between 75 to 95% Kentucky bluegrass had significantly darker green color compared to either the 50:50 mixture or pure Supina bluegrass both of which had a relatively similar light green color.
Turf density and quality of all mixtures were similar to one another. Kentucky bluegrass alone had similar density compared to all mixtures. Turf quality of the 100% KB stand was initially lower than any mixture or the monostand of Supina bluegrass although by autumn the 100% KB turf quality was equivalent to all mixtures and superior to the monostand of Supina bluegrass. Lack of sufficient irrigation in the autumn may have caused a decline in quality of the monostand of SB. Mixtures containing 75-95% KB resulted in a mottled turf early in the spring although this effect declined towards autumn, presumably as the SB comprised an ever greater proportion of the turf stand.

As expected, both species responded positively to the higher fertility rate initially although by 13 Dec. the high fertility rate caused a significant decline in turf density and quality, perhaps due to decreased root:shoot growth and increased succulence of the turf. There were no interactions between fertility rate and seeding ratio on turf density or quality at any time in 1996.
Shear resistance values were not significantly different among any seeding treatments although there was a trend toward decreased shear resistance values as the percentage of SB was increased (Table 3). This may have been due to lack of adequate moisture in the autumn to sustain root growth of SB. KB may be less affected than SB by lower soil moisture levels. SB has been reported to have relatively poor drought tolerance (Berner, 1980; Leinauer, 1991). In addition, KB may have inherently greater shear resistance compared to SB due to the presence of rhizomes which SB lacks. Previous research has noted the low shear resistance of SB compared to

KB (Shildrick and Peel, 1985). The high fertility rate did decrease shear resistance values by October, probably due to decreased root:shoot growth.

Dollar spot severity was not significantly different among any seeding treatments although there was a trend towards decreased severity as the percentage of KB increased (Table 3). However, in no instance could dollar spot damage be considered severe. Previous research and observations have indicated good disease resistance of SB to many diseases (Berner, 1980; Shildrick and Peel, 1985). The low fertility treatment resulted in significantly more dollar spot damage compared to the high fertility treatment which had negligible dollar spot (Table 3).

Conclusions

Within one year a 50:50 mixture of SB:KB displayed similar color compared to 100% SB although density and total quality were significantly superior and equivalent to mixtures containing 75-95% KB. Plots of 100% SB were always lighter green compared to KB regardless of fertility rates although higher fertility levels did enhance color of both species. High fertility rates decreased turf quality, density, and shear resistance of both species, although turf quality and density was only decreased by December and the differences for practical purposes were small. Consequently, the high fertility rate was deemed superior to the low fertility rate for general management. This is an ongoing project and changes in stand composition and their effects on turf characteristics will be investigated over the next several years.

Table 2. Effects of Supina bluegrass (SB) and Kentucky bluegrass (KB) seeding ratios and fertility rates on turf subjected to simulated sports traffic, East Lansing, MI, 1996.

	13 June	16 July	14 Aug.	14 Oct.	13 Dec.
Treatment			Color†		
Seeding mixture ‡					
100 % SB	5.1	5.2	4.9	4.5	4.1
50% SB:50% KB	5.8	5.4	4.9	4.8	3.6
25% SB:75% KB	5.9	5.8	5.1	5.4	3.5
10% SB:90% KB	6.2	6.0	5.6	5.5	4.3
5% SB:95% KB	7.1	6.4	6.4	6.0	5.0
100% KB	8.6	8.2	8.5	7.9	4.8
LSD (0.05)	0.6	0.6	0.6	0.9	ns
Fertility §					
low	6.5	6.1	5.5	4.8	3.1
high	6.4 ns	6.2 ns	6.3	6.6**	5.3**

cont.

Table 2. cont.

Seeding mixture			Density (% turf cover)		
100 % SB	99.7	97.0	97.8	86.8	65.0
50% SB:50% KB	99.7	97.3	97.5	92.3	79.8
25% SB:75% KB	98.5	97.3	98.2	92.7	80.3
10% SB:90% KB	99.0	97.5	99.2	95.2	81.2
5% SB:95% KB	98.2	97.0	99.2	95.5	84.8
100% KB	99.2	98.7	99.7	81.5	84.8
LSD (0.05)	ns	ns	ns	ns	11.8
Fertility					
low	98.7	97.3	97.6	91.7	82.4
high	99.3 ns	97.6 ns	99.6**	89.6 ns	76.3*

Seeding mixture	Quality¶				
100 % SB	8.9	8.5	6.9	4.5	2.1
50% SB:50% KB	8.8	8.6	6.8	6.0	3.6
25% SB:75% KB	8.6	8.2	6.7	6.0	3.4
10% SB:90% KB	8.5	7.6	6.8	6.9	3.4
5% SB:95% KB	8.3	7.7	6.6	6.7	3.8
100% KB	8.0	8.7	8.4	7.0	4.0
LSD (0.05)	0.3	0.4	ns	0.6	ns
Fertility					
low	8.6	8.1	6.2	6.1	3.6
high	8.5 ns	8.3 ns	7.9**	6.3 ns	3.1*
No. games simulated#	6	14	1	17	29

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

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

‡ Plots were seeded with Supina bluegrass 'Supra' and/or Kentucky bluegrass 'Touchdown' at 1.5 lb seed/1000 ft^2 in June 1995. Mixtures were on a weight:weight basis.

§ Low fertility: ½ lb N/1000 ft^2 using 18-3-18 on 10 May, 3 June, 16 Aug., and 5 Sept., plus 1 lb N/1000 ft^2 using sulfur coated urea (40-0-0) on 28 June and 1 lb N/1000 ft^2 using urea on 16 Nov. 1996. High fertility: ½ lb N/1000 ft^2 10 May, 14 June, 2 Aug., 5 Sept., 1 Oct.; ¾ lb N/1000 ft^2 24 May, 16 Aug., all using 18-3-18, plus 1 lb N/1000 ft^2 using sulfur coated urea (40-0-0) on 28 June, and 1 lb N/1000 ft^2 using urea on 16 Nov.

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

A Brinkman Traffic Simulator (BTS) with empty rollers was used to simulate soccer games from 14 May- 9 July; afterwards, the rollers were filled with water and the BTS was used to simulate football games from 9 Aug. - 18 Nov.

Table 3. Effects of Supina bluegrass and Kentucky bluegrass seeding ratios on turf shear resistance and dollar spot severity of turfgrass subjected to simulated sports traffic, East Lansing, MI, 1996.

	Shear resistance (N m)		Dollar spot, % area affected
Treatment	23 July	16 Oct.	14 Aug.
Seeding mixture †			
100 % SB	17.5	9.9	1.7
50% SB:50% KB	19.7	11.6	1.7
25% SB:75% KB	19.2	12.0	1.5
10% SB:90% KB	21.2	13.3	0.3
5% SB:95% KB	21.2	13.7	0.5
100% KB	20.3	14.9	0.2
LSD (0.05)	ns	ns	ns
Fertility ‡			
low	20.4	14.3	1.6
high	19.3 ns	10.8*	0.3*
No. games simulated§	14	18	1

* Significant at the 0.05 probability level; ns = not significant.

† Plots were seeded with Supina bluegrass 'Supra' and/or Kentucky bluegrass 'Touchdown' at 1.5 lb seed/1000 ft^2 in June 1995. Mixtures were on a weight:weight basis.

‡ Low fertility: ½ lb N/1000 ft^2 using 18-3-18 on 10 May, 3 June, 16 Aug., and 5 Sept., plus 1 lb N/1000 ft^2 using sulfur coated urea (40-0-0) on 28 June and 1 lb N/1000 ft^2 using urea on 16 Nov. 1996. High fertility: ½ lb N/1000 ft^2 10 May, 14 June, 2 Aug., 5 Sept., 1 Oct.; ¾ lb N/1000 ft^2 24 May, 16 Aug., all using 18-3-18, plus 1 lb N/1000 ft^2 using sulfur coated urea (40-0-0) on 28 June, and 1 lb N/1000 ft^2 using urea on 16 Nov.

§ A Brinkman Traffic Simulator (BTS) with empty rollers was used to simulate soccer games from 14 May- 9 July; afterwards, the rollers were filled with water and the BTS was used to simulate football games from 9 Aug. - 18 Nov.

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Effects of Crumb Rubber and Sand Selection on Surface Characteristics of SportGrass™.

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Introduction

SportGrass™ consists of natural grass grown into and in-between fibrulated synthetic strands intended to protect the crown and roots of the turfgrass plant and provide stability. Rice Stadium at the University of Utah was the first field established with this new technology. While this first installation has largely been considered successful, there have been concerns raised by players and other experts regarding the field hardness and traction. The lack of information on the effects of the shallow sand layer on top of the synthetic surface on surface characteristics (impact absorption and traction) warrents investigation. Previous studies with sports turf surface characteristics indicated a relationship between field hardness and injury potential. One solution concerning this problem is the use of crumb rubber from ground up car tires as a topdressing. This is a recently new tool introduced for maintaining turfgrass under trafficked conditions. Crumb rubber is an athletic field amendment, researched at Michigan State University. One objective of this research was to determine the effect of crumb rubber applications above and below the SportGrass™ layer in terms of surface hardness, turfgrass wear, and traction.

Another criteria for the performance of a SportGrass™ field is the selection of the SportGrass™ top layer. A second objective was to evaluate different sands as SportGrass™ top layer for their ability in providing turfgrass growth and performance. A comparison of five different sand types varying in particle size analysis was studied. The five sand types are: sport mix, 2NS, coarse to very coarse sand, TDS 21/50, and a USGA mix. The 2NS sand possesses a wide distribution in particle size analysis. Developed by the Michigan Department of Transportation, 2NS is primarily used for subsurface support on newly paved roads. TDS 21/50 is a dune sand from the Grand Haven area of Michigan, and is commonly used as a topdressing sand on golf course putting greens, and has been used to construct several PAT fields. TDS 21/50 is a uniform sand with round particles, just the opposite of the 2NS sand, making it rather unstable. The coarse to very coarse sand is simply sieved sand, from 2NS, mostly within the 0.5 mm to 2 mm particle size analysis. The USGA mix is a sand that meets specifications suggested by the United States Golf Association, to be used for constructing golf course putting greens. Finally, the sport mix is similar to the USGA sand with a slightly higher soil content (silt and clay) for increased stability. Selecting sand types with differing particle size analysis is important in determining their effects on surface hardness, wear potential, and stability.

Materials and Methods

Experiment 1.

Experiment one was a 2 by 3 factorial randomized complete block design (RCBD) with three replications for a total of eighteen 4 foot by 4 foot wooden boxes. The plots were established in the covered stadia simulator facility at the Hancock Turfgrass Research Turfgrass Center at Michigan State University under light conditions necessary for turfgrass growth and development. Factor one was the base soil mix: 1) 6 inches of sand 2) 5 inches of sand below 1 inch of crumb rubber. The crumb rubber used beneath the SportGrass™ and as a topdressing was 2 - 4 mm in diameter. The base soil was the USGA sand mix described in Experiment 2. It was also used as the top layer. The SportGrass™ fiber was laid on all eighteen boxes and filled with three levels of sand (Factor 2: 1.125, 0.75, and 0.5 inches). The plots were seeded on 23 February 1996 with *Lolium perenne* (perennial ryegrass) at 7 lbs seed/1000 ft^2. Fertility was applied at the beginning of each week for six weeks using a 13-25-12 starter fertilizer at 1 lb. N/1000 ft^2. Beginning on week eight (12 April 1996) the plots were fertilized with 0.5 lbs. N/1000 ft^2 every three weeks, using a 18-3-18 fertilizer. Fertility concluded on 18 October 1996. On 13 May 1996 the established plots were moved outside where, they remained for the remainder of the test. On 15 May 1996 crumb rubber was topdressed into the SportGrass™ at rates of 0, 0.375, and 0.625 inches respectively. Research has shown crumb rubber can inhibit establishment of turfgrass, particularly in the spring when temperatures are rising; thus, it was important to let the turfgrass establish before topdressing. The treatment consisting of base soil with sand only and no crumb rubber topdressing was comparable to the SportGrass™ field in Rice Stadium in terms of construction. Plot evaluations consisted of impact absorption characteristics, turfgrass density, and turfgrass shear strength. Water was applied on a as needed basis. Beginning 1 July 1996 traffic treatments were applied everyday (Monday through Friday) until 2 August 1996. Traffic applications were made by people, wearing 0.75 inch studded cleats, running back and forth over the plots for a total of 50 passes per application. Traffic resumed 26 August 1996 (Monday, Wednesday, and Friday) until 15 November 1996. Final evaluations of surface characteristics were taken upon completion of the last traffic treatment. Data collected from each surface were impact absorption characteristics, density ratings, and shear strength. Impact absorption characteristics were taken measured with the Clegg Impact Soil Tester and the Brüel and Kjaer 2515 Vibration Analyzer measuring G_{max} (gravities). Density ratings were an estimated percent turfgrass cover (0 - 100%). Turfgrass shear strength was measured in Newton meters (Nm) using the Eijkelkamp apparatus (Eijkelkamp, Geisbeek, The Netherlands).

Experiment 2.

Experiment two was a 1 factor randomized complete block design of five top layer sands with three replications for a total of fifteen 4 feet by 4 feet plots of SportGrass™. The plots were established in the covered stadia simulator facility at the Hancock Turfgrass Research Center at Michigan State University under light conditions necessary for turfgrass growth and development. The five sands were: 1) sport mix, 2) 2NS, 3) coarse to very coarse sand, 4) TDS 21/50, and 5) USGA mix (Table 2.0). The base sand used was the USGA mix. *Lolium perenne* (perennial ryegrass) was seeded at 7 lbs seed/1000 ft^2. The SportGrass™ plots were established on plastic with no soil medium below the SportGrass™. During establishment the turfgrass roots bound to the SportGrass™ fabric making it possible to transport the individual plots as pieces of sod. These plots were then transplanted to prepared 4 feet by 4 feet boxes with a 6 inch sand subgrade. Data collected from each surface were impact absorption characteristics, density ratings and Shear Vane. Fertility, irrigation and traffic applications were done in accordance to experiment one.

Data, for both experiments, were analyzed for statistically significant differences between treatments using the MSTAT program.

<u>Results and Discussion</u>

Experiment 1.

Table 1.1 shows the results obtained at the end of the crumb rubber experiment after 36 fall traffic applications, for a total of 3600 passes on each treatment. Statistical analysis shows that there was a significant difference in surface hardness in both factors and their interaction. Density ratings and turfgrass shear resistance showed significant differences when crumb rubber was used as a topdressing material. On 8 November 1996 there was a G_{max} interaction between the crumb rubber topdressing and the layer of crumb rubber beneath the SportGrass™. The application of crumb rubber reduced G_{max} greater in plots where there was no rubber beneath the SportGrass™. This shows that topdressing with 0.375 inches of crumb rubber is all that should be necessary and that the 1 inch layer of crumb rubber beneath the SportGrass™ did not affect surface characteristics. Turfgrass shear resistance showed the same significance as the surface hardness and turfgrass density results when the crumb rubber was used as a topdressing material. However, in contrast, the plots receiving no crumb rubber topdressing had the greatest shear resistance. These results may be somewhat misleading, since the plots with no crumb rubber topdressing had a much lower turfgrass density but, still showed greater shear resistance. This may be a combination of two occurrences. First the worn turfgrass areas on the plots with no crumb rubber topdressing are showing shear resistance as a result of the SportGrass™ adding support. The second factor may be that the crumb rubber used as a topdressing material is preventing the shear resistance apparatus (shear vane) from penetrating into the turfgrass surface fully, thus causing reduced resistance values.

Table 1.2 illustrates the progression of surface hardness characteristics on the crumb rubber study. The first two dates are G_{max} values prior to receiving the crumb rubber topdressing applications. The 21 June 1996 data are G_{max} values prior to traffic applications, and after receiving the crumb rubber topdressing application on 15 May 1996. The final two dates are G_{max} values after traffic applications have been applied. As discussed in the previous paragraph, the interaction on 8 November is what is significant.

Experiment 2.

Table 2.1 shows the results obtained at the end of the sand top layer study. Statistical analysis showed that there are no significant differences between the five sands selected for surface hardness or turfgrass density. However, there is a significant difference in the turfgrass shear resistance for the five sands tested. The only statistical difference in the sand top layer study occurred in the turfgrass shear resistance. Only the coarse to very coarse sand had a significant difference in turfgrass shear resistance versus the other five sand types tested. No other significant differences occurred in surface hardness or turfgrass density.

Table 3.0 shows for both experiments how turfgrass density remained high during traffic applications while the turfgrass was actively growing. However, turfgrass densities began to decline as the turfgrass growth declined. The use of crumb rubber as a topdressing was effective in maintaining turfgrass density. It should be considered with future SportGrass™ applications. The rate of 0.375 inches is appropriate, and the 1 inch of rubber immediately below the SportGrass™ reduced impact, but is probably not necessary.

Table 2.0
Experiment 2 Top Layer Sand

Particle size	Sport mix	2NS	Coarse to v. coarse	TDS 21/50	USGA mix†
> 2 mm	1.1	15.4	0.4	0	0.8
1 - 2 mm	3.3	23.3	41.1	0.1	4.5
0.5 - 1 mm	33.7	31.6	43.0	2.3	30.4
0.5 - 0.25 mm	49.7	23.1	15.2	72.6	38.7
0.25 - 0.1 mm	11.8	5.9	0.2	24.7	24.3
0.1 - 0.05 mm	0.4	0.7	0.1	0.3	1.3

† note the USGA mix is the same sand used as the base sand, and in the top layer for experiment 1.

Table 1.1
Surface Characteristics on SportGrass (SG) Crumb Rubber Study After Final Traffic Treatment

	Turfgrass performance characteristics		
Soil Base (SB) beneath SG (inches)	$G_{max\ (g)}$†	Density‡ $_{(\%)}$	Shear Vane§ $_{(Nm)}$
6 inches of sand	66.6	70.4	14.4
5 inches of sand & 1 inch rubber	58.2	76.9	14.8
significance	**	n/s	n/s
Rubber Depth (RD) in SG (inches)			
0	68.4	57.5	19.5
3.375	62.5	78.7	11.8
3.625	56.3	84.7	12.5
$LSD_{(0.05)}$	4.1	10.0	5.7
SB x RD			
6, 0	75.7	53.3	18.3
5 + 1, 0	61.1	61.7	20.7
6, 0.375	65.2	75.0	12.3