Growing Natural Turf Indoors:

Prototype Looks Promising

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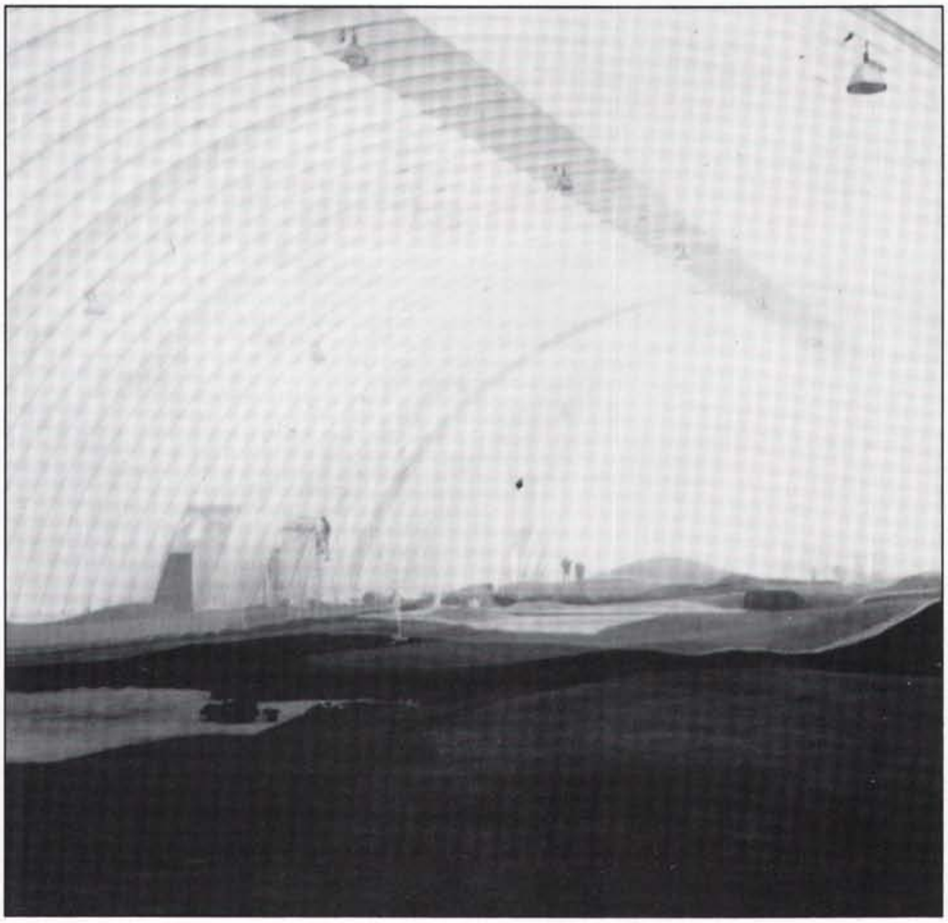

Indoor par 3 golf course which opened in January 1991 in Flint, MI.

One of the limitations of turfgrass is its inability to recover in cold weather. When air and soil temperatures fall below 50 degrees, cool-season turfgrass activity declines quickly and recovery from traffic ceases.

We can't change the weather. Instead, the logical question is how to feasibly grow natural grass indoors. Although the question has been posed by many researchers, it has been difficult to answer because there are few sufficient testing facilities.

When Michael Thompson, an Englishman now living in Detroit, announced plans to build a golf course under a dome, his question was not "Can it be done?" but "What will it take to do it?" In November 1989, he met with Michigan State University turfgrass researchers Dr. Paul Rieke, Dr. John (Trey) Rogers III, and Dr. Bruce Branham.

We were skeptical initially, but willing to pursue a project. After all, we had wanted to try something like this for a long time, and here was someone who was willing to build a facility to carry out the experiment! We discussed the idea at length and Thompson agreed to build a prototype at the Hancock Turfgrass Research Center on the Michigan State University campus to answer questions on growing grass indoors.

Naturally, there were several important questions to be answered, but the problem was there were more questions than square footage in the translucent facility. We boiled down these questions to an outline of major objectives.

The first objective was to determine the effects of cutting height, fertility, and traffic on grass grown under a translucent cover. The second objective was to determine the effects of the cover on light intensity. The final objective was to observe possible disease or soil moisture problems.

The Tent Takes Shape

In January 1990, a half-cylinder domed facility was erected over a two-year-old stand of Pennlinks creeping bentgrass *(Agrostis palustris)* that had frozen to a depth of 12 to 18 inches. The 20-x-40-x-nine-foot facility had a double layered cover to provide insulation, and the air in this space between the layers was continually exchanged with air inside the facility. The outside layer was a fabric from Dupont, which was translucent yet strong enough to prevent damage from wind and rain. The inside cover was a polyvinyl transparent material for insulation only.

The facility was heated by three- to 10-kilowatt heaters at each end. Five feet above the ground, the air temperature was maintained at 68 degrees F (20 C).

Because of the frozen turf and soil, mowing did not begin until mid-January. The whole area was first clipped at .375 inch. On February 2, the west half was cut and maintained at .188 inch so that separate but identical experiments were carried out on both cutting heights.

The design, a complete randomized block, included four fertility levels with two traffic levels (high and low), and a split plot on fertility levels. There were three replications. The fertility levels were .375 lb. N and .375 lb. K/1000 square feet, .375 N and .75 lb. K/1000 square feet, .75 N. and .375 lb. K/1000 square feet, and .75 lb. N. and .75

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Traffic is applied to plots inside structure at Hancock Turf Research Center.

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lb. K/1000 square feet. Fertility treatments were applied on January 23 and February 16. The individual plots measured 1.22 by .53 m (four-x-1-3/4 feet). Traffic was applied by individuals walking on the plots in tennis shoes. High traffic equaled 100 passes per week and low traffic equaled 50 passes a week for the period of January 22 through February 4. For the remainder of the experiment, February 5 through March 16, these trips were doubled.

Visual ratings for turfgrass quality and color were taken on February 9 and 26 and March 9 and 30. Turf quality and color were on a scale of 0 to 10, with 0 equaling bare ground and 10 equaling ideal turf. Impact absorption measurements were taken with a Clegg Impact Tester and a 2.75 kg. hammer on the plot maintained at .19 inch on March 6. Light intensity measurements were taken for a four-day period, February 20-23, inside the dome along the south wall, in the center of the dome, and outside the dome. Carbon dioxide measurements were made on February 15-20 at ground level in the center of the dome, seven feet above the ground, and outside the facility.

The areas were mowed three times per week throughout the experiment. The clippings were removed. Individual plot clippings were not recorded.

Results

Fertility treatments had no significant effect on turfgrass color ratings or impact absorption measurements (g. max.). At the .19 inch cutting height, the fertility treatment of .375 lb. N/.75 lb. K had the highest quality rating during the wear period. The need for potassium to provide more wear-tolerant turf is extremely important for high-traffic areas. It is just as critical in light-restricted environments to maintain

Table 1. The effects of fertilizer and traffic on turf color and quality of 'Pennlinks' creeping bentgrass maintained under a translucent structure. Michigan State University - 1990.

	Cutting height (inch)														
	0.19								0.38						
	Color[1]			Quality[2]				g_{max}[3]	Color			Quality			
Fertility Treatment (kg)	2/9	2/26	3/9	2/9	2/26	3/9	3/30		2/9	2/26	3/9	2/9	2/26	3/9	3/30
1. 0.17N 0.17K	6.0	6.2	4.5	5.3	5.5	4.7	4.3	121	7.5	7.7	6.5	6.5	7.1	5.2	6.2
2. 0.17N 0.34K	6.0	6.5	4.8	4.7	5.5	4.7	3.8	126	7.0	7.0	6.5	6.8	7.0	5.7	6.7
3. 0.34N 0.17K	5.8	5.7	4.3	4.7	3.7	3.2	3.2	125	7.2	7.1	6.8	7.0	5.2	5.8	7.0
4. 0.34N 0.34K	6.2	5.8	4.7	5.3	4.7	4.2	3.3	125	6.8	7.7	7.0	7.0	6.3	5.3	6.7
LSD (0.05)	NS	NS	NS	NS	1.6	0.7	0.7	NS	NS	NS	NS	NS	1.9	NS	NS
Traffic															
1. High	5.6	5.8	4.7	4.5	4.2	3.5	3.3	127	6.6	6.8	6.5	6.3	5.5	4.8	6.4
2. Low	6.4	6.3	4.5	5.5	5.5	4.8	4.0	122	7.7	8.0	6.9	7.3	7.3	6.3	6.8
Sig. diff. (0.05)	*	NS	NS	*	*	*	NS	NS	*	NS	*	*	*	*	NS

[1]Color rating on a scale of 0-10 with 0 = brown and 10 = darkest green (6 = acceptable color).

[2]Quality rating on a scale of 0-10 with 0 = bare ground and 10 = ideal turf (>7 = acceptable quality)

[3]g_{max} measured with 2.25 kg hammer and Clegg Impact Soil Tester.

Table 2. Fertility x traffic interaction quality ratings of 'Pennlinks' creeping bentgrass maintained at 0.38 inch under a translucent structure. Michigan State University - 1990.

Fertility Treatment (kg)	Date: 2/9 Traffic High	Date: 2/9 Traffic Low	Date: 2/26 Traffic High	Date: 2/26 Traffic Low
0.17N/0.17K	6.3[1]	6.7	6.0	8.3
0.17N/0.34K	7.0	6.7	6.0	8.0
0.34N/0.17K	6.3	7.7	5.0	5.3
0.34N/0.34K	5.7	8.3	5.0	7.7
LSD (A)[2]	1.0		1.2	
LSD (B)	1.0		1.3	

[1]Quality rating on a scale of 0-10 with 0 = bare ground and 10 = ideal turf (>7=acceptable quality).

[2]LSD (A) =least significant difference at 0.05 level between traffic treatments on same fertility level.

LSD (B) =least significant difference at 0.05 level between fertility levels on same traffic treatment.

adequate levels of nitrogen, without excess growth. These effects of fertility on turf quality were more apparent at lower cutting height (.19 inch).

As expected, the amount of traffic directly affected turfgrass quality, regardless of the cutting height. General observations indicated that effects of traffic on turf quality were less severe at the greater height. For the .19 inch height, there was a significant difference in turfgrass quality between traffic treatments at all fertility schemes, except at .375 lb. N/.75 lb. K. This same trend was evident at .38 inch height on the February 9 rating. For the February 26 rating on the .38 inch height, the interaction was caused by the lack of difference of quality levels between the traffic treatments for .75 lb. kg. N/.75 lb. K fertility plots. The reaction of the turf under the cover was not far from that of a turf grown under the partial shade of a tree. Potassium and nitrogen must be monitored closely under shaded conditions, including translucent covers.

Inside and outside light measurements were taken for both sunny and cloudy days. Peak light levels were reached at 2 p.m. for the sunny day measurement and 1 p.m. for the cloudy day measurement. The amount of light measured inside the facility at 2 p.m. was only 44 percent of that light measured outside the facility. The amount of light inside the facility at this time was 52 percent of the light saturation point for photosynthesis. The proportional difference between inside and outside the dome was less for cloudy days than sunny days. It should be noted that the duration of light during the winter in mid-Michigan is very short. Light levels were not appreciable until 9:30 a.m. and dropped to near-zero by 5 p.m. Also, because of mid-Michigan's proximity to large bodies of water, cloud cover is more normal during the winter months than sunny days.

Carbon dioxide levels averaged 385 ppm at ground level inside the dome, 378 ppm at seven feet above the surface inside the dome, and 366 ppm outside the dome. Carbon dioxide is critical in the photosynthetic process. An increase in carbon dioxide might partially offset the absence of light. Further studies are needed in this area. No irrigation was required to maintain the turfgrass during this study. (The fertilizer was watered in following both application dates.) There were no visual disease symptoms throughout the period.

From this study, it appeared that fertility requirements are similar to that of turf in partially shaded environments. While more research is needed in the area of light quality, species adaptation, and carbon dioxide effects in any attempt to grow turfgrass indoors, *light* is the limiting factor and other conditions such as soil type, fertility, and turf species must be optimized.

In January 1991, Thompson opened a Par 3 golf course under a translucent cover near Flint, MI. For the first time, Michigan golfers were able to test their playing prowess in mid-winter, indoors on natural grass.