Simulated traffic on turfgrass topdressed with crumb rubber

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Topdressing performs many functions in enhancing the turfgrass environment. Benefits include thatch control, a smoother surface, modified surface soil and winter protection.(1)

Goss defined topdressing as a surface application of any growth medium intended to perform on or more of the following functions: correct uneven putting surfaces; develop firmer, drier surfaces; increase infiltration rates of water; help relieve hard, compacted surfaces; increase air porosity (noncapillary pore space); aid thatch decomposition; prevent surface puddling; provide cover for overseeding; supply nutrients and modify topsoils.

Putting greens and sports fields benefit from topdressing primarily because they are high-traffic areas and a smooth and uniform playing surface is essential. Topdressing has been called the most important practice under high-traffic conditions (3) due to the aforementioned qualities. Davis in 1983 reported that sports fields tend to become heavily trafficked and the need for heavy topdressing was important. (4)

In sports such as football and soccer, however, by mid season the most intensively worn areas are often past the point of repair in terms of turf regeneration, and topdressing will generally not alleviate the problem. Sand is a popular choice for topdressing material, but it is abrasive and can lead to scarification of the plant. Gibeault found that topdressing applied too frequently and/or at heavy rates can produce a hard layer that is abrasive to the turfgrass plant (5). The abrasive action of sand can be detrimental to turfgrass if the plant is weak and not actively growing, or is in areas under low light conditions (i.e., shade) and with subsequently reduced growing and recuperative conditions. This effect is magnified on high- to medium-use sports fields. In the absence of turf, the playing quality and aesthetics are dramatically reduced by sand topdressing, which can ultimately lead to player injuries (6,7,8).

Ball roll and ball bounce can be directly influenced by the smoothness and resiliency of the playing surface (9).

The crown tissue of the turfgrass plant is the area where leaves, roots, stolons and/or rhizomes regenerate. Damage to the crown tissue can adversely affect growth and regeneration. Thurman and Pokorny found that damage to the crown tissue in Bermudagrass [Cynodon dactylon (L) Pers.cv. Tifgreen] was proportional to the intensity of the traffic applied. (10)

Shearman and Beard were able to quantify wear tolerance among seven species of cool-season grasses, citing verdure (% cover) as the preferred method to quantitatively assess wear tolerance. (11)

Ward investigated the use of chipped tires (1-6mm) as a soil amendment for improving turfgrass areas, but did not include crumb rubber as a topdressing material (12). Rogers et al. also reported on the use of crumb rubber amended into the soil profile (13).

Our objective was to investigate the use of crumb rubber from recycled tires as a topdressing into turfgrass under simulated athletic field traffic. Our hypothesis was that, by reducing surface hardness and decreasing the susceptibility of wear injury and turfgrass abrasion with the use of crumb rubber topdressing, the playing field would be improved in playability and turfgrass quality, potentially reducing surface-related injuries.

Materials and methods

Experiments were conducted at the Hancock Turfgrass Research Center at Michigan State University, East Lansing, Mich., July 29, 1993. Crumb rubber was topdressed in a 2x5 factorial randomized complete block design with three replications on an 80% sand/20% peat (v/v) soil. Particle size in the rootzone was primarily coarse to medium (1.0-0.25 mm particle size; see Table 1).

Plot sizes were 3.0 by 3.6 m. Two crumb rubber sizes were evaluated: the large size had 93.3% of particles between 2.0 and 6.0 mm in diameter and the small size had 79.3% of particles between 2.0 and 0.25 mm (Table 1). The five crumb rubber topdressing rates were 0.0, 17.1, 34.2, 44.1 and 88.2 t ha -1.

The corresponding depth for these rates are: 0.0; 3.8; 7.6; 9.5; and 19.1 mm.

A crumb rubber bulk density of 0.48 g cm -3 was used to make this conversion.

Each rate was split into three applications made on July 29, September 11 and October 5 , 1993. Crumb rubber was topdressed with a rotary spreader and raked for as even distribution as possible on a one-year old turfgrass stand seeded with 85% Kentucky bluegrass (Poa pratensis L.cv. Argyle, Rugby and Midnight) and 15% perennial ryegrass (Lolium perenne L. cv. Dandy, Target and Delray).

The plots were mowed three times per week at a height of 38 mm, with clippings returned, using a Ransomes triplex mower in 1993 and a Toro rotary deck mower (1.5 m deck) in 1994. Irrigation was applied to insure turfgrass was actively growing.

Turf was fertilized with 49 kg N ha-1 (25-0-25/N-P-K) in May, June, July, August and October of 1993 and 1994, for a total of 245 kg N ha-1.

Simulated traffic was applied across plots with the Brinkman traffic simulator (12). The simulator weighs 336 kg and has two heavy, studded rollers geared to move at different speeds and impose both compactive and tearing forces on the turf. Traffic was applied from August 26 to November 14 in 1993 and from September 5 to November 15 in 1994. Eight to 10 passes were made per week in twice-weekly applications, for a total of 96 passes. On May 16, 1994, areas trafficked within plots were slit-seeded with Dandy perennial ryegrass at 53.9 kg ha-1.

Surface data was collected in 1993 and 1994. Data included: surface hardness; impact absorption characteristics, peak deceleration and impact duration, surface and soil temperatures and ball bounce measurements using a FIFA soccer ball.

Clipping yields and turf cover ratings were also recorded.

Results and discussion

In 1993 there were no statistically significant differences in peak deceleration values between crumb rubber sizes, except on September 20. There were significant differences in peak deceleration among crumb rubber rates in 1993 (Table 1). Peak deceleration values were 10 to 20% lower than the control at the highest crumb rubber rate (88.2 t ha-1, 19.1 mm).

In 1994 there were no significant differences in peak deceleration values between crumb rubber sizes. There were also no significant differences among crumb rubber rates, except on December 30, 1994. One possible explanation for the lack of peak deceleration value differences in 1994 is that the crumb rubber particles were more fully integrated into the turf surface after a year. there was no additional topdressing in 1994 and it is assumed that the crumb rubber fully settled into the turf surface. (Peak deceleration is the measure of the impact energy absorbed by the surface. The higher the peak deceleration value the more energy being returned to the object contacting the surface, or the harder the surface.)

For all dates in 1993 and 1994, shear resistance values for the turfgrass topdressed with the small crumb rubber size were higher than the larger crumb rubber size. Three of these dates were statistically significant. There were significant differences among crumb rubber rates for every testing date.

In 1993, as crumb rubber rates increased, shear vane values decreased by as much as 40% less than the control plots, a potential indication of poor footing, as lower shear vane values have been associated with poor field conditions (15).

In 1994 however, as crumb rubber rates increased, the trend of 1993 was reversed and shear vane values increased up to 10 to

TABLE 1. EFFECTS OF CRUMB RUBBER PARTICLE SIZE AND TOPDRESSING RATE ON PEAK DECELERATION (G-MAX) ON A TRAFFICKED KENTUCKY BLUEGRASS/PERENNIAL RYEGRASS STAND, EAST LANSING, MI

	GMAX						
	1993			1994			
Treatment	Sept. 20‡	Oct. 22	Dec. 3	Sept. 15	Oct. 17	Nov.10	Dec. 30
	g						
Rate, t ha^{-1}							
0	71	69	67	66	67	58	193
17.1	70	72	72	68	70	60	160
34.2	72	71	73	67	71	62	136
44.1	68	66	70	67	69	61	114
88.2	63	56	60	63	68	62	78
LSD (0.05)	**3**	**3**	**5**	**NS**	**NS**	**NS**	**18**
Particle size							
large (2-6 mm)	67*	67	68	66	69	60	139
small (2.0-0.05 mm)	70	67	69	67	69	62	133
	Soil water, kg kg^{-1}						
	0.174	0.218	0.202	0.163	0.121	0.123	0.132

*Significant at the 0.05 probability level.
‡ On Sept. 20 1993, crumb rubber rates were 0.67 times the listed rate

20% over the control plots. In 1993, crumb rubber particles were still in and around the turf canopy and still had not reached the soil surface. After a full growing season, the crumb rubber particles had reached the soil surface. The assumption is that the wide range of particle sizes of crumb rubber (especially with the small crumb rubber size) offered additional strength. Those subjecting turfgrass to heavy traffic after topdressing with crumb rubber should be aware of this phenomenon. Although not statistically significant in this study, small rubber particles should be considered under these conditions.

The differences in soil temperatures provided by crumb rubber sizes were minimal in this study and there were no consistent trends regarding differences among crumb rubber rates. Surface temperatures were not affected by crumb rubber size. As crumb rubber rates increased from 0.0 to 88.1 t ha-1 in October 1993 and 1994 there was a 2° C increase in surface temperature. This could be significant in terms of providing a favorable growing environment for turfgrass in early spring and late fall in cool regions, a dilemma for turf managers of fields used for season specific sports. Conversely, in other experiments the authors have noticed adverse effects with crumb rubber in terms of surface temperatures, particularly with spring seedings.

This study was trafficked to simulate fall athletic field wear, so summer stress from crumb rubber was not noted as the turf canopy moderated surface temperatures.

Nutrient analysis was done on clippings taken on October 2, 1993 and April 20, 1994. In 1993, there were no significant differences in nutrient concentrations of clippings between particle sizes or rates treatments except for Cu, with levels directly related to rubber rates. In 1994, there were no significant differences between particle sizes, nor among crumb rubber treatments, for any nutrient tested.

Summary

Our results suggest that crumb rubber from used tires has the potential to alter surface characteristics and subsequently increase wear tolerance of turfgrass exposed to traffic. These positive effects were best noted at rates of 44.1 and 88.2 t ha-1. It is likely that the best crumb rubber rate for cutting heights above 18mm is between these two values, perhaps 60 t ha-1. The small size was more effective than the large size immediately after application, and therefore it appears the size of the rubber is critical if utility of the area under traffic is immediate. Shearing values the first season after applications were low before the crumb rubber worked down to the turf surface.

The effectiveness of crumb rubber appeared to increase as growing conditions became suboptimal. One possible explanation is that the rubber particles are generally non abrasive.

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