TOPDRESSING WITH CRUMB RUBBER FROM USED TIRES IN TURFGRASS AREAS

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INTRODUCTION

In 1991, 234 million tires were discarded in the United States, many of them in landfills. While more and more of these landfills are refusing these tires for health and spatial reasons, the used tire has proven itself a difficult, if not impossible, product to recycle and therefore has to be reused. This usually means the tire must be broken down into very small pieces and subsequent uses for these parts sought out. While the metal/steel in the tire are easily sold, finding a market for crumb rubber particles (1/4" and less) has been more challenging. One idea researched at Michigan State University, since 1990, is the use of crumb rubber as a soil amendment in different turfgrass situations. The theory is that the crumb rubber particles introduced to the turf/soil system will reduce soil compaction, increase turfgrass wear tolerance, and subsequently reduce turf system inputs and potential surface-related injuries.

Original studies of incorporating crumb rubber into the soil profile have proven it to be an ideal soil amendment for high trafficked areas. However, it required taking a field out of play for three or four months. Thus the objective of this research is to provide an incorporation method which is less disruptive and easier than tilling crumb rubber into the soil profile. Topdressing provided one avenue for this goal to be accomplished. The benefits of topdressing as practiced will be reviewed with the concept of crumb rubber as a topdressing woven in as it applies to heavy trafficked areas.

Topdressing plays many roles in enhancing the turfgrass environment. Among these benefits include thatch modification, a smooth playing surface, modification of the soil surface, and winter protection (1). Putting greens and sports fields profit from this maintenance practice, primarily because they are intense traffic areas with high quality standards and the games played rely on the importance of a smooth and uniform surface. Specifically, soccer and football fields are subject to more abrasive action due to the nature of the games played on them. In most cases, a sand/organic matter mix or 100% sand is used to promote the forementioned qualities. However, the most intensively worn out areas usually by mid-season are past the point of repair in terms of turfgrass cover, and topdressing will not alleviate the problem. This can be detrimental for the playing field due to the intense traffic areas on the field becoming the most sparse areas or the least dense turf stand (Soccer and football fields are most vulnerable to wear in between the hashmarks and the goal mouth and mid-field portions, respectively). This effect is magnified especially on low to medium maintenance sports fields. With the absence of turf, the aesthetics and playing quality are dramatically reduced which can ultimately lead to player injuries. Additionally, sand has more abrasive edges, leading to scarification of the crown tissue area particularly those areas under stress and poor environmental conditions for recovery. The abrasive action of the sand can also be detrimental to any high traffic turf area as well as those under reduced light conditions (e.g. shade) and subsequently reduce growing and recuperative conditions (ie. cooler weather).

The hypothesis was that topdressing crumb rubber, applied in the same manner as any other topdressing, can dramatically reduce the abrasive action caused by the nature of the athletic activity. With an increase in surface area and rounder edges, (in comparison to sand), the crumb rubber is able to cushion the crown tissue while still providing a smooth and uniform surface, improve overall turf quality and reduce compaction. Inevitably, this improves the playability and aesthetics of the playing surface. Further, if areas that are reseeded or established on an annual or frequent basis are not worn substantially because of topdressing with crumb rubber, one can logically assume a reduction in inputs for turfgrass management and subsequent dollar savings.

MATERIALS AND METHODS

A trial plot was established on an 80% sand : 20 % peat mix (Table 1) at the Hancock Turfgrass Research Center (HTRC) at Michigan State University, East Lansing, Michigan on 29 July 1993 to determine optimum topdressing rates for high trafficked areas, specifically targeting high school athletic fields and playgrounds. Crumb rubber was topdressed in a 2x5 randomized complete block design with three replications. There were two levels of crumb rubber (10/20 mesh and 1/4" size) and five treatment amounts (0", 0.05", 0.10", 0.125" and 0.25" of crumb rubber added to the surface on 29 July, 11 September and 5 October in 1993. Crumb rubber treatments reached final levels at 0.0", 0.15", 0.30", 0.38", and 0.75". Crumb rubber was not applied in 1994.) (Table 1). Crumb rubber was topdressed with a Scott's rotary spreader and then dragged in for as even distribution as possible on a Lolium perenne (Perennial ryegrass var. Dandy, Target, and Delray) and Poa pratensis (Kentucky bluegrass var. Argyle, Rugby, and Midnight) turfgrass stand. On 16 May, 1994 trafficked lanes were slit-seeded with Lolium perenne var. Dandy at 1.1 lbs./1000ft^2. Treatment areas were 10ft x 12ft. The rubber particles eventually settles down to the soil surface because of being lighter or having a lower particle density: (rubber's particle density is 1.2 g/cc versus soil particle density being 2.65 g/cc). During the study, measurements were made on the treated plots as to the crumb rubber's effectiveness in reducing impact absorption (surface hardness measured with the Clegg Impact Tester) (2), reducing compaction (thereby providing a favorable environment for growth and recovery), improving turfgrass color, and sustaining turfgrass density.

In 1994, impact absorption was collected by the Clegg Impact Soil Tester (2.25kg hammer). Impact absorption values were recorded with the Brüel and Kjaer 2515 Vibration Analyzer, replacing the read-out box. This instrument allowed for further evaluation of surface hardness characteristics as described by Rogers and Waddington at The Pennsylvania State University (3). The values recorded was an average of four measurements. Shear resistance was measured with the Eijkelkamp Shearvane (4). The value recorded was an average of three measurements. Surface temperature was read by the Barnant 115 Thermocoupler Thermometer. Soil moisture recordings were provided by the Gravimetric method (5). Three soil samples (7.6 cm) per treatment were used for this method. Density and color ratings were observed on 27 October and 4 December.

In 1993, wear treatments were initiated on 26 August and ended 14 November and in 1994, wear treatments were initiated on 6 September and ended 15 November, for a total of 48 games simulated each year. Wear treatments were applied by the Brinkman Traffic Simulator (BTS) (6). Two passes by the BTS is equivalent to the traffic experienced in one football game between the forty yardlines between the hashmarks (7).

RESULTS AND DISCUSSION

While our data were collected throughout the 1993 and 1994 seasons, our purpose is to only highlight the trends we observed in 1994. Therefore results from only one date will be presented. The amount of crumb rubber used as a topdressing played an important role in affecting surface characteristics. Impact absorption values (G_{max}) were significantly lower at high crumb rubber rates in 1993. While this phenomenon did not continue in 1994, the surface characteristics, duration of impact (Tt), time to peak (Tp), and rebound ratio(%) showed the effectiveness of crumb rubber (0.75") in providing a softer surface (Table 2). Tp, Tt, and rebound ratio values increased at the high rates of crumb rubber. These characteristics are important parameters as they further define critical elements of surface hardness, such as, duration and severity of impact. When an object is in contact with a surface the longer the time of impact the more resilient and **likely** safer the surface will be in terms of injury. Particle size was not significant in regards to these surface hardness characteristics.

In 1993, shear values decreased significantly as crumb rubber levels increased. In 1994, as crumb rubber levels increased, shear values increased significantly (Table 2). However, differences between particle sizes were not significant. To help explain this scenario, crumb rubber was topdressed in 1993 but not 1994. In 1993, the crumb rubber had not settled down to the crown tissue area, when the shear vane apparatus was applied to take a measurement, the teeth or fins could not grip the surface as well. One possible correlation to this is when a player digs his cleat into the surface and it slips out from underneath. However in 1994, after a growing season and the crumb rubber settled to the soil surface and stabilized, shear values increased significantly as crumb rubber levels increased. This settling process, in part, also explains the lack of significant differences in impact absorption values in 1994 as compared to 1993.

In 1993, surface temperatures were significantly higher as crumb rubber levels increased. Although data was not significant on 10 November, the effect of crumb rubber on surface temperatures was significant due to the relationship between turfgrass growth and soil temperatures. As surface temperatures drop below 50°F the growth and recovery of turfgrass slows. These falling temperatures directly coincide with the football season and can lead to playing quality problems. Keeping temperatures higher can lead to increased playing quality conditions. This also holds true in the spring time as well. For instance on 7 April (data unpublished), there was a 7.5°F from the check treatment to the highest crumb rubber treatment. The exposure of crumb rubber at the surface heats the turf surface and revitalizes dormant turfgrass. Thus translating to a quicker spring green-up, and quicker use of the fields earlier in the year. As the density of the turf stand increases during the growing season the effect of crumb rubber on surface temperatures moderates due to the shading effect of the turfgrass.

Color and density ratings provide even more substantial evidence of improving playing field conditions, both from an aesthetic and uniformity standpoint. In 1993, color ratings were significant among crumb rubber levels as well as density ratings. Differences between particle sizes were not significant for either color or density ratings. Use of crumb rubber is helpful due to an instant response in turfgrass color and an increase in turfgrass density. Although it is uncertain what triggers the response in color, an increase in density can be attributed to the crumb rubber particles protecting the crown tissue area of the plant. The crown tissue area or the "heartbeat" of the plant becomes extremely vital in high traffic areas. Once this area is damaged, the plant will die and density decreases. Consequently, bare soil will result leading to poor overall turfgrass quality and an increase in surface hardness thus increasing the potential for surface-related injuries. In 1994, color ratings were not significant among crumb rubber levels (Table 3). Differences between particle sizes were not significant as well. However, density ratings increased significantly as crumb rubber levels increased (Table 3). Although color ratings decreased slightly towards the end of 1994, density ratings were close to 90% at the highest crumb rubber level.

Although crumb rubber is an excellent tool, it is not a "cure-all". Therefore the use of crumb rubber cannot be an exclusive means for maintaining turf in any high traffic turfgrass area, and must be used as a tool integrated into the management program. It should also be noted that the turf manager must have a 100% turfgrass stand, or as close to this as possible, before making any applications. Therefore, our research does conclude that depending on your target area (inside the hashmarks of a football field vs the sidelines) topdressing between 3/8" and 3/4" would be a turf managers's goal. Bearing in mind the importance of spreading out the applications throughout the year : Rome was not built in one day! Thus, the "Take Home Message" in this case is that, crumb rubber will not resurrect the turfgrass, but it will **protect** the crown tissue area of the plant which becomes vital in improving the longevity and quality of a high traffic turfgrass stand.

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Table 1. Crumb Rubber Sieve Analysis for the Crumb Rubber Topdressing Study at the Hancock Turfgrass Research Center, 1993.

Category(Size range)	Sand(%)[1]	1/4" size(%)	10/20 mesh(%)
Gravel(> 2mm)	0.9	93.3	16.6
Very Coarse(1-2mm)	8.8	3.7	39.4
Coarse(1-.50mm)	44.3	1.5	17.5
Medium(.50-.25mm)	39.6	1.3	22.4
Fine(.25-.10mm)	5.8	0.2	3.8
Very Fine(.10-.05mm)	0.6	0.0	0.3
Total Percentage	100	100	100

Note All particle size figures are averaged over three samples.

[1] The sieve analysis of the sand used for the modified rootzone for the Crumb Rubber Topdressing Study at the Hancock Turfgrass Research Center.

Table 2. Effects of crumb rubber size and topdressing rates on a variety of field measurement values measured on a Kentucky bluegrass/perennial ryegrass stand after 28 football games simulated Hancock Turfgrass Research Center, Michigan State University, East Lansing, MI, on 10 November 1994.

Crumb Rubber Particle Size	Impact absorpt. (G_{max})	time of duration (Tt)	time to peak (Tp)	Rebound Ratio	Soil Moisture (%)	Shear resist. (Nm)	Surface Temp. (°F)
1/4"	60	10.3	5.7	0.216	16.3	14.2	47.5
10/20 mesh	62	10.2	5.8	0.236	16.6	14.7	47.8
Significance[+]	-NS-	-NS-	-NS-	-NS-	-NS-	-NS-	-NS-
Crumb Rubber Topdressing Depth							
0.00"	58	10.1	5.6	0.168	16.2	11.9	47.6
0.15"	60	9.7	6.1	0.181	16.5	15.3	47.6
0.30"	62	9.9	5.5	0.210	16.3	13.7	47.6
0.38"	61	10.5	5.7	0.257	16.8	16.0	47.7
0.75"	62	11.1	5.8	0.314	16.4	15.4	47.8
Lsd (0.05)	-NS-	1.0	0.4	0.03	-NS-	2.1	-NS-

Table 3. Effects of crumb rubber size and topdressing rates on color and density ratings on a Kentucky bluegrass\perennial ryegrass stand under trafficked conditions at the Hancock Turfgrass Research Center, East Lansing, MI. 1994.

	Color Ratings		Density Ratings	
Crumb Rubber Particle Size	27 Oct	4 Dec	27 Oct	4 Dec
1/4"	5.9	4.6	67.7	60.0
10/20 mesh	5.9	4.4	72.1	64.0
Significance+	-NS-	-NS-	-NS-	-NS-
Crumb Rubber Topdressing Depth				
0.00"	5.7	4.7	53.3	41.7
0.15"	6.0	4.7	61.7	50.8
0.30"	5.9	4.6	71.7	63.3
0.38"	5.7	4.6	73.3	65.8
0.75"	6.2	4.1	89.5	88.3
Lsd (0.05)	-NS-	-NS-	11.0	14.3

****Note**** Scale for Color Ratings: 1-9; 1-Brown, 9-Best, 6-Acceptable

+ indicates a significant difference at the 0.05 level.