Stretching Your Dollars with Crumb Rubber

By Dr. J.N. Rogers III and J.T. Vanini

Crumb rubber particles topdressed into turf can reduce compaction and wear in high-traffic areas, thereby saving maintenance dollars and improving overall turf quality. Those are the conclusions we reached after conducting studies in 1993 and 1994 at Michigan State University (MSU). Because crumb rubber is made from discarded tires, it also has the advantage of recycling a difficult-to-reuse product that takes up landfill space.

Since 1990, MSU has investigated crumb rubber as a soil amendment in different turfgrass situations. Original studies of incorporating crumb rubber into the soil by tilling proved it to be an ideal soil amendment for high-traffic areas. However, it required taking an area out of play for three or four months, an often impractical task for a turf manager.

The objective of our 1993-94 research was to explore an incorporation method, topdressing, that is less disruptive and easier than tilling crumb rubber into the soil profile. When topdressed, crumb rubber particles eventually settle down to the soil surface. However, crumb rubber will not transgress through the soil profile because it is lighter, having a lower particle density (rubber's particle density is 1.2 g/cc; soil particle density is 2.65 g/cc). Unlike a sand topdressing, which moves into the soil profile, crumb rubber remains on top of the soil, where it surrounds the crowns of turfgrass plants.

Additionally, sand has sharper, more abrasive edges than crumb rubber, leading to scarification of the crown tissue area. The abrasive action of sand can be detrimental to any high-traffic turf area as well as areas under reduced light, growing and recuperative conditions (i.e., cooler weather). If environmental conditions are not conducive to regrowth and the crown is thrashed and mangled — either by sand particles or play on the field — the plant can very easily die, thus resulting in bare soil. Consequently, aesthetics and playability are reduced, and the potential for surface-related injuries increases.

The hypothesis of our study was that topdressing crumb rubber in the same manner as sand can reduce the abrasive action caused by athletic activity, which is especially severe in soccer and football. With a greater surface area and more rounded edges than sand, crumb rubber is better able to cushion the crown tissue area while still providing a smooth and uniform surface.

Although we collected data throughout the 1993 and 1994 seasons, space allows us to focus mainly on the trends we observed in 1994.

Color and Density

Turfgrass density and color are important to the turf manager as indicators of good playing conditions. Turfgrass color and density ratings taken during our study provided substantial evidence that turfgrass conditions had been maintained despite intense traffic. They were attributed to the crumb rubber particles protecting the crown tissue area of the plant.

During the 1993 season, the density ratings depended on the amount of rubber used as well as the size of rubber. We had higher turfgrass densities where we used the smaller rubber size (10/20 mesh) and high rates. We believe this occurred because the smaller particles were able to work down to the surface faster, thus protecting the plant. When this relationship did not occur in 1994, it was evident the larger particles had also worked to the surface during the winter and were now providing protection to the turfgrass plant.

While there were no significant turfgrass color responses in 1994, we did see an increase in color immediately after putting the rubber down in 1993. This response was positively correlated to crumb rubber rate, but we still do not have the exact reason for the response.

Impact and Shear Values

Impact absorption values were significantly lower (better) at high crumb rubber rates in 1993. While this phenomenon did not continue in 1994, other surface characteristics — duration of impact (Tt), time to peak (Tp), and rebound ratio (rr%) — increased at the high rates of crumb rubber and showed the effectiveness of crumb rubber (0.75 inch) in providing a softer, more resilient surface.

TABLE 1. EFFECTS OF CRUMB RUBBER ON FIELDS*

Particle Size	Impact absorp.	Time of duration	Time to peak	Rebound ratio	Shear resist.	Soil moisture	Surface temp.
1/4"	60	10.3	5.7	0.216	14.2	16.3	47.5
10/20 mesh	62	10.2	5.8	0.236	14.7	16.6	47.8
Significance	NS	NS	NS	NS	NS	NS	NS
Topdressing Depth	Impact absorp.	Time of duration	Time to peak	Rebound ratio	Shear resist.	Soil moisture	Surface temp.
0.00"	58	10.1	5.6	0.168	11.9	16.2	47.6
0.15"	60	9.7	6.1	0.181	15.3	16.5	47.6
0.30"	62	9.9	5.5	0.210	13.7	16.3	47.6
0.38"	61	10.5	5.7	0.257	16.0	16.8	47.7
0.75"	62	11.1	5.8	0.314	15.4	16.4	47.8
LSD (0.05)	NS	1.0	0.4	0.03	2.1	NS	NS

*Effects of crumb rubber size and topdressing rates on a variety of field measurement values, measured on a Kentucky bluegrass/perennial ryegrass stand after 46 football games simulated at Hancock Turfgrass Research Center, Michigan State University, East Lansing, Michigan, on November 10, 1994.

Measurements: Impact absorption in Gmax; shear resistance in Nm; soil moisture in percent; surface temperature in degrees Fahrenheit.

Tt, Tp and rr% values are important as they 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 that surface is and the more likely the surface will resist compaction. Crumb rubber particle size was not significant in regard to these hardness characteristics.

Nor was particle size significant in shear tests, although levels of crumb rubber did matter. In 1993, shear values decreased significantly (got worse) as crumb rubber levels increased. In 1994, as crumb rubber levels increased, shear values increased significantly (got better) and stabilized.

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, so when the shear vane apparatus was applied to take a measurement, the teeth could not grip the surface as well. One correlation to this is when players dig their cleats into the surface and they slip out from underneath. In 1994, shear values increased significantly as crumb rubber levels increased because the crumb rubber had settled to the soil surface and stabilized.

The lesson learned is that turf managers should try to incorporate the rubber as far in advance as possible and expect better results as the treated area matures.

This settling process, in part, also explains the lack of significant differences in impact absorption values in 1994, unlike 1993.

Temperature

In 1993, surface temperatures were significantly higher as crumb rubber levels increased. The data collected on November 10, however, showed no significant differences in surface temperature. This occurred because on November 10 surface temperatures had dropped below 50 degrees Fahrenheit and the growth and recovery of the turfgrass had slowed.

Ultimately, however, the effect of crumb rubber on surface temperature was significant. On April 7 (data not shown here), there was a 7.5 degree Fahrenheit difference between the check treatment and the highest crumb rubber treatment. The exposure of crumb rubber at the surface heats the turf surface and revitalizes dormant turfgrass. This translates to

continued on page 31

Applicator's Log *continued from page 28*

possibly a quicker spring green-up, an important factor for any turf used in early spring.

One concern we had was the effect of crumb rubber on turfgrass during the summer. 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, an effect measured and confirmed during 1993 and 1994.

Integrated Tool

Although crumb rubber is an excellent tool, it is not a "cure-all." It cannot be an exclusive means for maintaining turf in any high-traffic area and must be used as a tool integrated into the management program.

We recommend: *turf managers have a 100 percent turfgrass stand, or as close to this as possible, before making any crumb rubber applications.* Crumb rubber should be topdressed between 0.375 and 0.50 inch (not more than 0.25 inch at any given application) in high-traffic areas.

TABLE 2. EFFECTS OF CRUMB RUBBER ON COLOR & DENSITY*

Crumb Rubber Particle Size	Color 27 Oct	Color 4 Dec	Density 27 Oct	Density 4 Dec
1/4"	5.9	4.6	5.7	0.216
10/20 mesh	5.9	4.4	5.8	0.236
Significance	NS	NS	NS	NS
Topdressing Depth				
0.00"	5.7	4.7	53.6	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

*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.

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.

While the research to date has been extremely promising, we have not covered every scenario in the turfgrass industry:

1. Crumb rubber topdressed at 0.50 to 0.75 inch levels (1,200 to 1,800 pounds/1,000 sq.ft.) will increase turfgrass wear tolerance and prevent soil compaction in turfgrass maintained above 0.63 inch. We have also done some testing at lower cutting heights with similar results — such as 3/8-inch bentgrass topdressed with 3/8-inch crumb rubber — but obviously there will be some limits.

2. Except for early in 1993, we have seen little difference in response from different crumb rubber sizes in our studies. However, we have noted the smaller size was easier to deal with in terms of working it into the turf area. It comes as no surprise that this is a more expensive product, and we caution against using a too finely granulated product as this could cause a detrimental effect in the soil profile relationship.

3. There is a question of crumb rubber particles contaminating soil and water quality. We have had crumb rubber tilled in the ground at MSU since 1990 and monitor soil samples annually. The major components of rubber are iron, sulfur and zinc. While iron and zinc levels have increased in our tests, none have approached levels of concern, nor do these elements pose concerns to water quality. At no time have we seen any toxicity to the turfgrass plant during our studies.

We are confident we have found another use for a difficult-to-reuse product that poses environmental hazards and takes up landfill space. When topdressed, crumb rubber can extend turfgrass wear tolerance and reduce soil compaction in high-traffic areas. The more this product is researched and tested, the more uses will likely be found.

Dr. J.N. Rogers III is with the Department of Crop and Soil Sciences at Michigan State University, and J.T. Vanini is head hockey coach for Cortland State University in New York. *MSU has received a patent on this use of crumb rubber and has sold its rights to JaiTire Industries (800-795-TIRE), Denver. Royalties paid to MSU go toward turfgrass research. So far, crumb rubber has been installed at more than 1,000 locations across the country.*

Materials and Methods

The Trial Plot

July 29, 1993: A trial plot consisting of perennial ryegrass (*Lolium perenne* var. Dandy, Target and Delray) and Kentucky bluegrass (*Poa pratensis* var. Argyle, Rugby and Midnight) was established on an 80-percent-sand/20-percent-peat mix at the Hancock Turfgrass Research Center (HTRC) at MSU to determine optimal crumb-rubber particle sizes and topdressing application rates.

July 29, September 11 and October 5, 1993: Crumb rubber was topdressed in two sizes (10/20 mesh and 1/4-inch size); five treatment amounts (0.0, 0.05, 0.10, 0.125 and 0.25 inch) added to the surface in equal applications; and reached final levels at 0.0, 0.15, 0.30, 0.38 and 0.75 inch. Since treatment areas were small (10 by 12 feet), the crumb rubber was topdressed with a rotary spreader. It was then dragged in for even distribution. Crumb rubber was not applied in 1994.

August 26 through November 14, 1993: Wear treatments were applied by the Brinkman Traffic Simulator (BTS) to simulate 48 football games. Two passes by the BTS are equivalent to the traffic experienced in one football game between the hash marks between the 40-yard lines.

May 16, 1994, trafficked lanes were slit-seeded with *Lolium perenne* var. Dandy at 1.1 pounds/1,000 sq.ft.

September 6 through November 15, 1994: Wear treatments were applied by the BTS to simulate 48 football games.

Measurements

In 1994, impact absorption was collected by the Clegg Impact Soil Tester (2.25 kg hammer). Impact absorption values were recorded with the Bruel and Kjaer 2515 Vibration Analyzer, replacing the read-out box. This analyzer allowed for further evaluation of surface hardness characteristics. The values recorded were an average of four measurements.

Shear resistance was measured with the Eiijkelkamp Shearvane. 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. Three soil samples (7.6 cm) per treatment were used for this method.

Density and color ratings were observed on October 27 and December 4. ❑