Effect of Crumb Rubber Topdressing on Golf Course Traffic Areas

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Executive Summary

During the summer of 1999, a crumb rubber topdressing experiment was established on two golf courses: one in Calgary and one in Edmonton. This experiment was continued in 2000. The goal of this study was to determine the impact of the crumb rubber topdressing on turfgrass quality in high traffic areas. Potential benefits of the crumb rubber topdressing are: improved wear tolerance, turf resiliency, and water infiltration. However, it is important that there be no negative impact on turf quality. In particular, zinc levels in soil and tissue were monitored to ensure these levels are not a problem for plant growth.

The experiment was established on high traffic areas at two golf courses: McCall Lake Golf Course in Calgary and Victoria Golf Course in Edmonton. The experiment was set up in a split plot design with four replications. Main plot treatments included four different crumb rubber mesh sizes: less than 20, 10-20, 7-10 and 6-16. Subplot treatments included four depths of crumb rubber topdressing: 0, 6, 12 and 18 mm.

The following observations were made:

- crumb rubber topdressing improved turf resiliency, but the different mesh sizes had no significant impact
- in the second year of the study, increased crumb rubber depth was associated with improved water infiltration, while the mesh size had no effect
- the crumb rubber mesh size had no effect on turf quality while the crumb rubber depth had a statistically significant, but very minimal effect
- the crumb rubber mesh size had no significant impact on the soil zinc levels, but higher tissue zinc levels were associated with the smaller mesh size
- both soil zinc levels and tissue levels were associated with increased crumb rubber depth
- as crumb rubber depth increased there was a related decrease in grass clipping dry weight and overall turf quality.

Therefore, the use of crumb rubber improved turf resiliency and water infiltration, had some impact on turf quality, and did release zinc that was taken up by the plants and reduced plant growth. Since there was higher tissue zinc associated with mesh size, there is a strong possibility that zinc release is related to surface area and a combination of using a larger mesh size, together with a washing treatment could eliminate the problem.

Introduction

A preliminary study was established in 1996 on two athletic fields in Edmonton to determine the impact of crumb rubber topdressing on the turf. These sites were set up with a one-time application of crumb rubber. The crumb rubber improved both turf resiliency and wear tolerance. For example, the first spring following application, there was a significant improvement in area cover in areas with the crumb rubber topdressing. However, by the second spring, all of the turf with and without crumb rubber topdressing was dead from over use. This had been a very mild winter and the two fields had been in constant use throughout the winter.

Based on this preliminary study, it was felt that the crumb rubber topdressing might have a beneficial impact on golf course high traffic areas. Over time, the crumb rubber may improve wear tolerance by cushioning the growing point of the plants from damage. Also, the crumb rubber should improve turf resiliency and water infiltration. However, it is important to demonstrate that there is no negative impact on turf quality. Since the crumb rubber contains high levels of zinc, soil and tissue zinc levels were monitored to determine if there were any toxic effects.

Materials and Methods

This experiment was established on two golf courses: McCall Lake Golf Course in Calgary and Victoria Golf Course in Edmonton. Plots were established in high traffic areas near the teeing areas.

The experiment was established in a split plot design with four replications. Main plot treatments included four different crumb rubber mesh sizes: less than 20, 10-20, 7-10 and 6-16. Subplot treatments included four depths of crumb rubber topdressing: 0, 6, 12 and 18 mm. Replications included two different holes on each golf course. On each hole, a rep was located in the rough and one was located in the fairway. The crumb rubber was applied in July, 1999. The crumb rubber was applied incrementally in three weekly applications with 6 mm applied each week.

Turf colour, density, area cover and quality (average of colour, density and area cover) were monitored using a 1-9 scale. Turf resiliency, water infiltration, grass clipping dry weight, zinc tissue content and soil zinc content were also measured.

Results

Turf Resiliency

The use of crumb rubber improved turf resiliency (Table 1). Improved turf resiliency is indicated by a reduction in the Clegg Impact Unit. Therefore, turf resiliency increased with increased depth of crumb rubber, but the mesh size had no impact. Also, improved resiliency was associated with the McCall site. A significant site by depth interaction resulted from the fact that there was a greater response to crumb rubber at the McCall site.

Table 1. Treatment effects on turf resiliency (CIU).

	Turf Resiliency (Clegg Impact Units)		
Source of Variation	Sept /99[1]	June /00	Sept /00
Site			
McCall	5.2b	6.1b	6.6b
Victoria	7.8a	7.5a	11.5a
Mesh Size			
<20	6.5a	6.6a	8.8a
10-20	6.5a	6.9a	9.3a
7-10	6.5a	6.8a	8.9a
6-16	6.6a	6.9a	9.1a
Depth			
0 mm	7.1a	7.2a	9.7a
6 mm	6.6b	6.8b	9.3b
12 mm	6.4c	6.7b	8.8c
18 mm	5.9d	6.4c	8.3d
Site x Depth			
McCall – 0 mm			6.8e
McCall – 6 mm			6.5e
McCall – 12 mm			6.6e
McCall – 18 mm			6.5e
Victoria – 0 mm			12.7a
Victoria – 6 mm			12.1b
Victoria – 12 mm			11.0c
Victoria – 18 mm			10.1d

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

Water Infiltration and Soil Bulk Density

In the second year of the study, water infiltration was significantly improved by increasing crumb rubber depth (Table 2). Mesh size, however, had no influence on water infiltration. There was increased water infiltration at the Victoria site.

Either mesh size or crumb rubber depth (data not shown) did not influence soil bulk density.

Table 2. Treatment effects on water infiltration.

	Infiltration (in/hr)[1]	
Source of Variation	Sept /99	Sept /00
Site		
McCall	8.9a	5.9b
Victoria	16.0b	10.4a
Mesh Size		
<20	9.2a	7.8a
10-20	11.1a	7.2a
7-10	13.9a	7.9a
6-16	15.6a	9.9a
Depth		
0 mm	9.1a	5.8b
6 mm	10.7a	8.0ab
12 mm	14.9a	9.6a
18 mm	15.1a	9.2a

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

Turf Quality (Area Cover, Density, Colour and Quality)

For the most part, turf area cover (Table 3), density (Table 4), and were not significantly influenced by either crumb rubber mesh size or crumb rubber depth. Turf colour (Table 5) and turf quality (Table 6) were typically not influenced by mesh size, but in the second year, were reduced with increased crumb rubber depth.

Table 3. Treatment effects on turf area cover.

	Area Cover Rating (1-9 Scale)[1]					
Source of Variation	July /99	Sept /99	Oct /99	June /00	Aug /00	Sept /00
Site						
McCall	8.7a	7.9a	7.9a	7.1a	7.6a	7.3a
Victoria	6.3b	7.6b	7.7b	6.6b	7.4a	7.3a
Mesh Size						
<20	7.6a	7.8a	7.8a	6.8a	7.4a	7.3a
10-20	7.6a	7.8a	7.8a	6.7a	7.7a	7.3a
7-10	7.5a	7.6b	7.8a	7.0a	7.6a	7.2a
6-16	7.5a	7.9a	7.9a	6.9a	7.5a	7.4a
Depth						
0 mm	7.5a	7.8a	7.8a	7.0a	7.6a	7.4a
6 mm	7.7a	7.8a	7.8a	7.0a	7.7a	7.3a
12 mm	7.5a	7.8a	7.8a	6.8a	7.5a	7.4a
18 mm	7.4a	7.7a	7.9a	6.6a	7.3b	7.2a

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

Table 4. Treatment effects on turf density.

	Density Rating (1-9 Scale)[1]					
Source of Variation	July /99	Sept /99	Oct /99	June /00	Aug /00	Sept /00
Site						
McCall	7.3a	6.7a	6.5a	6.2a	6.4a	6.3a
Victoria	5.1b	6.5a	6.3a	5.6b	6.3a	6.3a
Mesh Size						
<20	6.0a	6.8a	6.5a	5.7a	6.2a	6.2a
10-20	6.3a	6.7a	6.4a	5.9a	6.3a	6.2a
7-10	6.3a	6.5a	6.5a	6.0a	6.5a	6.3a
6-16	6.2a	6.6a	6.3a	5.9a	6.3a	6.5a
Depth						
0 mm	6.3a	6.6a	6.4a	6.0a	6.5a	6.4a
6 mm	6.3a	6.7a	6.3a	6.0a	6.4a	6.3a
12 mm	6.0a	6.7a	6.6a	5.8a	6.3a	6.3a
18 mm	6.2a	6.5a	6.5a	5.7a	6.2a	6.1a

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

Table 5. Treatment effects on turf colour

	Colour Rating (1-9 Scale)[1]					
Source of Variation	July /99	Sept /99	Oct /99	June /00	Aug /00	Sept /00
Site						
McCall	6.6a	6.5a	5.7a	6.6a	6.6a	5.8a
Victoria	5.3b	6.5a	5.1b	6.2a	5.8b	5.8a
Mesh Size						
<20	5.8a	6.4a	5.8a	6.6a	5.8a	5.8a
10-20	5.9a	6.6a	5.1d	6.1a	6.3a	5.5a
7-10	5.9a	6.3a	5.3c	6.6a	6.3a	5.7a
6-16	6.1a	6.5a	5.5b	6.3a	6.4a	5.9a
Depth						
0 mm	5.9a	6.5a	5.5a	6.8a	6.6a	5.9a
6 mm	6.0a	6.5a	5.3a	6.5ab	6.3ab	5.8a
12 mm	6.0a	6.5a	5.6a	6.2b	6.1b	5.8a
18 mm	5.8a	6.3a	5.3a	6.1b	6.0b	5.4b

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

Table 6. Treatment effects on turf quality.

	Quality Rating (1-9 Scale)[1]					
Source of Variation	July /99	Sept /99	Oct /99	June /00	Aug /00	Sept /00
Site						
McCall	7.5a	7.0a	6.7a	6.6a	6.9a	6.5a
Victoria	5.6b	6.9b	6.4b	6.1b	6.5b	6.4a
Mesh Size						
<20	6.5a	7.0a	6.7a	6.4a	6.5a	6.4a
10-20	6.6a	7.0a	6.4a	6.2a	6.8a	6.3a
7-10	6.6a	6.8a	6.5a	6.6a	6.8a	6.4a
6-16	6.6a	7.0a	6.5a	6.4a	6.7a	6.6a
Depth						
0 mm	6.6a	7.0a	6.6a	6.6a	6.9a	6.6a
6 mm	6.7a	7.0a	6.5a	6.5a	6.8ab	6.5a
12 mm	6.5a	7.0a	6.6a	6.3b	6.6bc	6.5a
18 mm	6.5a	6.8a	6.5a	6.1b	6.5c	6.2b

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

When significant differences in any of the turf quality ratings were present between sites, the McCall site had higher ratings.

Grass Clipping Dry Weight

In June and August of 2000, grass clipping dry weights were reduced as crumb rubber depth increased (Table 7). Mesh size, however, had no significant impact on the dry weight.

Table 7. Treatment effects on grass clipping dry weight.

	Dry Weight (g/plot)[1]			
Source of Variation	Sept/99	June/00	Aug /00	Sept/00
Site				
McCall		40a	43a	28b
Victoria		34a	30b	39a
Mesh Size				
<20	41a	32a	31a	32a
10-20	50a	39a	35a	36a
7-10	46a	41a	38a	32a
6-16	52a	36a	39a	35a
Depth				
0 mm	54a	41a	41a	35a
6 mm	49a	39ab	37ab	37a
12 mm	37a	33b	34b	31a
18 mm	49a	33b	33b	32a

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

Soil Zinc and Tissue Zinc Concentrations

Higher concentrations of soil zinc were present in the October rating periods in both 1999 and 2000 (Table 8). However, in the June 2000 rating, there was no effect of crumb rubber depth on the soil zinc concentration.

Mesh size had no influence on soil zinc concentration, while higher concentrations of soil zinc were often present at the Victoria site.

Table 8. Treatment effects on soil zinc concentration.

	Soil Zinc (ppm)[1]				
Source of Variation	Aug /99	Sept/99	Oct /99	June/00	Oct /00
Site					
McCall	-	3.2a	3.9a	1.05a	3.4b
Victoria	5.5	8.9b	9.2b	1.06a	10.3a
Mesh Size					
<20		6.3a	6.8a	1.05a	7.4a
10-20		5.6a	6.1a	1.05a	6.6a
7-10		6.2a	6.8a	1.07a	6.9a
6-16		5.9a	6.2a	1.05a	6.6a
Depth					
0 mm	5.5	5.8a	5.8d	1.06a	5.8c
6 mm	5.4	5.8a	6.1c	1.06a	6.7b
12 mm	5.6	6.0a	6.7b	1.05a	7.3ab
18 mm	5.6	6.5a	7.4a	1.04a	7.6a

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

The tissue zinc concentration was influenced by site, mesh size and depth (Table 9). As for the soil zinc concentration, higher zinc concentrations were present at the Victoria site. Consistently, higher zinc tissue concentrations were associated with the smaller mesh size and increasing crumb rubber depth.

Table 9. Treatment effects on tissue zinc concentration.

	Tissue Zinc (ppm)[1]				
Source of Variation	Aug /99	Sept/99	Oct /99	June/00	Oct /00
Site					
McCall	-	33a	32a	34b	46b
Victoria	36.9	50b	42b	46a	57a
Mesh Size					
<20		49a	42a	48a	56a
10-20		38b	36c	37b	48b
7-10		39b	39b	38b	55a
6-16		40b	33d	36b	47b
Depth					
0 mm	34.9	34a	30d	34c	40c
6 mm	36.3	40b	34c	39bc	49b
12 mm	39.7	44c	41b	42ab	58a
18 mm	36.6	49d	44a	45a	58a

[1]Within a column, for each source of variation, numbers followed by the same letter are not significantly different at p=0.05.

Discussion

The use of crumb rubber as a topdressing improved both turf resiliency and water infiltration. The improvement in turf resiliency improves the turf as a walking surface, while the improvement in water infiltration may help alleviate problems associated with compaction.

The lack of improvement in area cover associated with the crumb rubber topdressing differs from the results from the athletic field study. One explanation for the differences between the two studies is that the crumb rubber is most effective at reducing wear tolerance during the winter months when the turf is dormant.

The increase in zinc concentration is a concern and is probably responsible for the reduction in grass clipping dry weight and also for the slight decrease in turf colour and overall quality. However, there are some positive results in this as well. Since the smaller mesh size produced much higher zinc concentrations in the plant tissue, it is likely that the release of zinc is related to surface area. Therefore, it may be possible to reduce problems with zinc by using crumb rubber of a larger mesh size. Washing this crumb rubber prior to use to remove any fine sized particles may further reduce the problem.

One final caution. In this study, the turf took up much of the zinc that was released from the crumb rubber. In the absence of turf, this zinc would be mobile within the soil. For some non-turf crumb rubber applications this may be a concern.

Summary
The use of crumb rubber as a topdressing improved turf resiliency and water infiltration. There was no impact on area cover or density. However there were higher concentrations of both soil and tissue zinc associated with crumb rubber depth and higher tissue concentrations associated with smaller mesh size. The elevated zinc levels probably explain the reduction in grass clipping dry weight and slight reduction in turf colour and overall quality associated with increased crumb rubber depth. Since there was a relationship between tissue concentration and mesh size, the release of zinc is partially related to mesh size. If this is the case, it should be possible to greatly reduce the impact of zinc by using a larger mesh size and by washing the crumb rubber prior to application to eliminate fine particle sizes.

This trial was supported by the Tire Recycling Management Association of Alberta.