

Effect of Crumb Rubber Topdressing on Athletic Fields

D.K. Tompkins, J.B. Ross and D. L. Moroz

Executive Summary

During the summer of 1999, a crumb rubber topdressing experiment was established on two athletic fields in Edmonton. This experiment was continued in 2000. The goal of this experiment was to determine if the use of crumb rubber topdressing could improve various turfgrass quality ratings. Elevated zinc levels in the soil and plant tissue were expected to be associated with the use of crumb rubber, so it was important to determine if this had a negative impact on turf quality.

The experiment was set up in a split plot design with four replications. Main plot treatments included crumb rubber applications at the following intervals: one time, annual, and biennial. Therefore, results from 1999 included only the first application. In 2000, a second application (annual treatment) of crumb rubber was made to the appropriate plots. Subplot treatments included: 0, 6, 12 and 18 mm crumb rubber depth. The sites included the athletic fields at Tiger Goldstick and Confederation Park in Edmonton.

Results from this study can be summarized as follows. The use of crumb rubber:

- improved resiliency, especially on the site that experiences heavier traffic
- improved water infiltration, particularly at the site that experiences heavier traffic
- improved area cover on the site that experiences heavier traffic in the fall
- produced no effect on turf density or overall turf quality
- slightly reduced turf colour
- reduced grass clipping yields with a greater effect from the annual application
- increased the tissue zinc concentrations

The second treatment in 2000 did not improve resiliency, or water infiltration, but further reduced grass clipping yields and increased the soil zinc concentration.

If it is possible to reduce the release of zinc from the crumb rubber through the use of larger crumb size and using a washing treatment to remove the fine particles, the use of crumb rubber on athletic fields may be very promising.

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 did not have a negative impact on turf quality, and 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, the second spring, all of the turf with and without crumb rubber topdressing was dead from over use. That winter had been mild and the two fields had been in constant use.

In establishing these new sites, it was desirable to choose sites where access could be at least partly controlled during the winter months, to determine the impact of the crumb rubber on wear tolerance. Also, it was desirable to determine how long the crumb rubber remained effective and whether more frequent applications could produce further improvements in resiliency and wear tolerance without negatively impacting the overall turf quality.

Materials and Methods

This experiment was established on two different athletic fields in Edmonton: Tiger Goldstick and Confederation Park. Fields were chosen that will experience heavy use in the late fall and early winter, but where access is somewhat controlled so there won't be continual use during the winter months. Access to Tiger Goldstick is controlled more than Confederation Park, so it is not as heavily used in the fall and winter months.

The experiment was established in mid-July, 1999, in a split plot design with four replications. Main plot treatments include three frequency of application treatments: one time, biennial, and annual applications. Subplot treatments include four crumb rubber depths: 0 mm, 6 mm, 12 mm and 18mm. The replications were established in each of the four quadrants within a field. They were located ten meters off of the center lines running both down and across the field. This was to avoid heavy traffic areas that would have an unequal impact on plots running across those areas. For the annual application treatment, crumb rubber was applied to the appropriate plots in June, 2000.

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, soil bulk density, grass clipping dry weight, tissue zinc and soil zinc concentrations were also measured. Since there is a high concentration of zinc in the crumb rubber, it is important to determine if there is an impact on the turf.

Increased water infiltration and increased resiliency are associated with reduced soil compaction. Improved wear tolerance (measured by area cover) provides an indication of ability to withstand traffic.

Results and Discussion

For the first two years of the study, the main plot treatments include only the one time application (1999) and the annual applications (1999 and 2000).

Turf Resiliency

Improved turf resiliency (measured in Clegg Impact Units) was associated with the use of crumb rubber (Table 1). There was a positive relationship between crumb rubber depth and turf resiliency. Resiliency improved as crumb rubber depth increased (improved resiliency is indicated by a smaller number). Also, the effect was more pronounced on the Confederation Park site where resiliency was more of a problem. There was no improvement with the second application in year two.

Table 1: Effect of crumb rubber depth on turf resiliency (CIU).

Source of Variation	Turf Resiliency (Clegg Impact Units)	
	Aug /99 ¹	Aug /00
<u>Site</u>		
Confederation Park	6.3a	9.2a
Tiger Goldstick	5.8a	8.4a
<u>Applications</u>		
One time		9.0a
Annual		8.6a
<u>Depth</u>		
0 mm	7.2a	10.6a
6 mm	6.4b	9.1b
12 mm	5.4c	7.9c
18 mm	5.0d	7.6c
<u>Site x Depth</u>		
Confed – 0 mm		11.6a
Confed – 6 mm		9.5b
Confed – 12 mm		7.9cd
Confed – 18 mm		7.6d
Tiger – 0 mm		9.5b
Tiger – 6 mm		8.7bc
Tiger – 12 mm		7.9cd
Tiger – 18 mm		7.7d

¹Within 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)

In June of 2000, there was an improvement in area cover at the Confederation Park site indicating better wear tolerance to use in the fall and winter (Table 2). This site experienced heavier usage over the course of the previous fall and winter as evidenced by the lower area cover ratings compared to the Tiger Goldstick site. By October, 2000,

there was an overall improvement in area cover associated with increased crumb rubber depth.

In 2000, turf density was better at the Tiger Goldstick site on the June and October rating periods (Table 3). However, the crumb rubber depth had no impact on turf density in either 1999 or 2000.

Turf colour ratings were slightly reduced with the 12 mm and 18 mm crumb rubber applications at the October 2000, but there was no effect at any other time (Table 4). Overall turf quality was also unaffected by site, applications and crumb rubber depth (Table 5).

Table 2: Effect of crumb rubber depth on area cover.

Source of Variation	Area Cover Rating (1-9 Scale)					
	July/99 ¹	Aug /99	Oct /99	June/00	Aug /00	Oct /00
<u>Site</u>						
Confederation Park	7.9a	8.0a	6.6a	6.0b	8.2a	6.6a
Tiger Goldstick	7.8a	7.6a	5.9a	7.4a	8.0a	6.8a
<u>Applications</u>						
Once				6.6a	8.0a	6.7a
Annual				6.8a	8.2a	6.7a
<u>Depth</u>						
0 mm	7.8a	7.8a	5.6a	6.4a	8.1a	6.4b
6 mm	7.8a	7.8a	6.3a	6.8a	8.0a	6.7ab
12 mm	7.9a	7.9a	6.8a	6.8a	8.2a	6.7ab
18 mm	8.0a	7.8a	6.4a	6.8a	8.0a	6.9a
<u>Site x Depth</u>						
Confed – 0 mm				5.5c		
Confed – 6 mm				6.1b		
Confed – 12 mm				6.0b		
Confed – 18 mm				6.3b		
Tiger – 0 mm				7.4a		
Tiger - 6 mm				7.4a		
Tiger – 12 mm				7.5a		
Tiger – 18 mm				7.3a		

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

Table 3: Effect of crumb rubber depth on turf density.

Source of Variation	Density Rating (1-9 Scale)					
	July /99 ¹	Aug /99	Oct /99	June /00	Aug /00	Oct /00
<u>Site</u>						
Confederation Park	6.9a	6.9a	6.3a	5.6b	7.3a	6.6b
Tiger Goldstick	6.4a	5.8b	6.6a	6.9a	7.0a	7.6a
<u>Applications</u>						
Once				6.1a	6.9b	7.3a
Annual				6.3a	7.4a	6.9b
<u>Depth</u>						
0 mm	6.8a	6.1a	6.3a	6.0a	7.0a	7.3a
6 mm	6.6a	6.4a	6.6a	6.2a	7.0a	7.0a
12 mm	6.6a	6.4a	6.8a	6.5a	7.2a	7.3a
18 mm	6.5a	6.5a	6.3a	6.3a	7.3a	6.9a

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

Table 4: Effect of crumb rubber depth on turf colour.

Source of Variation	Colour Rating (1-9 Scale)					
	July /99 ¹	Aug /99	Oct /99	June/00	Aug /00	Oct /00
<u>Site</u>						
Confederation Park	7.6a	7.0a	5.2a	6.5a	7.3a	6.5a
Tiger Goldstick	8.0b	7.5b	5.5a	7.1a	7.3a	6.0a
<u>Applications</u>						
Once				6.6a	7.3a	6.5a
Annual				7.0a	7.3a	5.9a
<u>Depth</u>						
0 mm	7.9a	7.3a	5.0a	6.8a	7.5a	6.4a
6 mm	8.0a	7.0a	5.5a	6.8a	7.4a	6.4a
12 mm	7.8a	7.3a	5.8a	6.8a	7.3a	6.0b
18 mm	7.6a	7.4a	5.1a	6.8a	7.1a	6.1b

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

Table 5: Effect of crumb rubber depth on turf quality.

Source of Variation	Quality Rating (1-9 Scale)					
	July /99 ¹	Aug /99	Oct /99	June /00	Aug /00	Oct /00
<u>Site</u>						
Confederation Park	7.5a	7.3a	6.0a	6.0b	7.6a	6.6a
Tiger Goldstick	7.4a	7.0a	6.0a	7.1a	7.4a	6.8a
<u>Applications</u>						
Once				6.4a	7.4a	6.8a
Annual				6.7a	7.6a	6.5a
<u>Depth</u>						
0 mm	7.5a	7.0a	5.6a	6.4a	7.6a	6.7a
6 mm	7.5a	7.1a	6.1a	6.6a	7.5a	6.7a
12 mm	7.4a	7.2a	6.4a	6.7a	7.6a	6.6a
18 mm	7.4a	7.2a	5.9a	6.6a	7.5a	6.6a

¹Within 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

Water infiltration was better at the Confederation Park site and increased with crumb rubber depth (Table 6).

Table 6: Effect of crumb rubber depth on water infiltration (in/hr).

Source of Variation	Water Infiltration (in/hr)	
	Aug /99 ¹	Aug /00
<u>Site</u>		
Confederation Park	0.8a	8.5a
Tiger Goldstick	1.0a	2.3b
<u>Applications</u>		
Once		5.5a
Annual		5.3a
<u>Depth</u>		
0 mm	0.8a	3.5b
6 mm	0.8a	7.0ab
12 mm	1.0a	3.7ab
18 mm	1.0a	7.4a

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

Site, application frequency or depth (data not shown) did not affect soil bulk density.

Grass Clipping Dry Weight

The use of crumb rubber had a negative impact on grass clipping dry weight (Table 7). The impact increased as crumb rubber depth increased and during the August rating period was more pronounced for the annual application treatment.

Table 7: Effect of crumb rubber depth on grass clipping dry weight (g/plot).

Source of Variation	Grass Clipping Dry Weight (g/plot)			
	Aug /99 ¹	June /00	Aug /00	Oct /00
<u>Site</u>				
Confederation Park	146a	24b	21a	38b
Tiger Goldstick	160a	42a	20a	87a
<u>Applications</u>				
Once		35a	22a	63a
Annual		32a	19b	62a
<u>Depth</u>				
0 mm	176a	33a	23a	73a
6 mm	169b	36a	22ab	74a
12 mm	147c	34a	20bc	57b
18 mm	117d	30a	17c	46c

¹Within 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

Crumb rubber depth had no impact on the soil zinc concentration although in September 2000 there was a higher soil zinc level associated with the annual treatment (Table 8). In August, 1999 and September and October, 2000, the soil zinc levels were higher at the Confederation Park site.

Tissue zinc concentrations increased as crumb rubber depth increased in October 1999, and in June and September, 2000 (Table 9). The site effects were variable. Surprisingly, the number of applications had no influence.

Table 8: Effect of crumb rubber depth on soil zinc (ppm)

Source of Variation	Soil Zinc (ppm)					
	July/99 ¹	Aug /99	Oct /99	June/00	Sept/00	Oct /00
<u>Site</u>						
Confederation Park	5.6	5.6a	6.7a	1.01b	6.9a	7.2a
Tiger Goldstick	5.3	4.2b	5.2a	1.14a	4.7b	4.8b
<u>Applications</u>						
Once				1.05b	5.6b	5.9a
Annual				1.10a	6.0a	6.1a
<u>Depth</u>						
0 mm	5.5	4.8a	5.1a	1.10a	5.4a	5.6a
6 mm	5.3	5.0a	5.9a	1.05a	5.4a	5.8a
12 mm	5.8	5.0a	6.6a	1.05a	6.2a	6.4a
18 mm	5.4	4.8a	6.2a	1.09a	6.2a	6.1a

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

Table 9: Effect of crumb rubber depth on tissue zinc (ppm).

Source of Variation	Tissue Zinc (ppm)			
	Aug/99 ¹	Oct /99	June /00	Sept /00
<u>Site</u>				
Confederation Park	38a	37a	55a	50b
Tiger Goldstick	32b	30b	49a	59a
<u>Applications</u>				
Once			58a	53a
Annual			46a	56a
<u>Depth</u>				
0 mm	34a	27d	37a	43d
6 mm	35a	31c	64a	53c
12 mm	36a	34b	47a	59b
18 mm	35a	42a	59a	64a

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

Discussion

Crumb rubber applications improved turf resiliency and water infiltration with the effects pronounced on the Confederation Park site. However, the crumb rubber in the second year did not further improve resiliency. Also, wear tolerance over the fall and winter was improved at Confederation Park. Although there was no impact of the crumb rubber on wear tolerance at the Tiger Goldstick site, this may have been due to the fact there was not enough traffic on the site to create a problem. For example, area cover ratings were favourable even on the plots that did not have crumb rubber applied. Therefore, it may be concluded that a certain level of wear is necessary in order for an effect to be evident.

A concern is the increased level of zinc in the tissue. This may be related to the reduction in grass clipping yield. Assuming that there is a relationship between zinc release and crumb rubber surface area, it may be possible to greatly reduce this effect by using a larger size of crumb rubber and washing the crumb rubber to remove small fine particles.

Summary

The use of crumb rubber improved turf resiliency, water infiltration and wear tolerance. However, there was a reduction in grass clipping yield and an increase in the tissue zinc concentration associated with the use of crumb rubber.

The annual application did not appreciably improve any of the above factors. This is encouraging, the fact that the crumb rubber doesn't need to be applied every year reduces the zinc concerns. In the coming year, the effect of a biennial application will also be monitored.

Current work is underway to examine the impact of washing the crumb rubber prior to application to reduce the number of fine particles and hopefully reduce the release of zinc.

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