Influence of Application Methods on Phytotoxicity of Mustard (*Brassica juncea* L. Czern.) Seed Meal on Creeping Bentgrass (*Agrostis stolonifera* L.) Turf

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Introduction

Mustard [(*Brassica juncea* L. Czern.)] seed meal (MSM) is a byproduct of oil extraction from seeds. MSM contains a secondary compound, glucosinolate, which when wet is converted into a group of biocidal compounds including isothiocyanates (1). Previous research found that applications of MSM suppress a wide range of turfgrass pests, such as weeds (2) and fungi (3). However, its usage on turf has been limited due to potential phytotoxicity to turfgrass plants (2).

Objectives

The objective of this study was to investigate the influence of MSM application method and rate on phytotoxicity to foliar and root tissues of creeping bentgrass (*Agrostis stolonifera* L.).

Materials and Methods

Field study

- MSM was mixed with USGA sand and was applied as either topdressing only or topdressing following aeration. N treatment was applied by both delivery methods at N rate equivalent to MSM at 1000 kg•ha^{-1} (Table 1).
- As a topdressing, MSM was applied to a depth of 1.6 mm. For topdressing following aeration method, soil was aerated to a depth of 2.5 cm with hollow tines (1.3 cm diameter), spaced 7.6 cm × 7.6 cm apart. Cores were removed, and holes were filled with MSM.
- Plots were established on a "Penn-A4" creeping bentgrass maintained as putting green. Treatments were arranged in randomized complete block design with four replicate plots, each measuring 1.2 × 1.5 m.
- Phytotoxicity (1-9), turf quality (1-9) and percent turf coverage (0-100) were visually assessed weekly for 8 weeks after treatment (WAT). Root total length, average diameter, surface area and number of tips were analyzed by image analysis software WinRhizo, and root biomass at 15 cm depth was determined.

Greenhouse study

- Soil cores of creeping bentgrass "Penn-A4" were taken from the field and transplanted to tubes (6.4 cm diameter, 35.6 cm length) containing USGA sand.
- Treatments were the same as for the field study, except no nitrogen treatment was included. Measurements were made as in the field for a period of 3 months.

Table 1. MSM rates and application as top dressing or topdressing following aeration in greenhouse and field studies. N rate was equal to the amount of N contained in MSM at 1000 kg•ha^{-1}.

Treatment	Application method	MSM rate (kg•ha^{-1})	N rate (kg•ha^{-1})
T0	Topdressing	0	0
T1	Topdressing	1000	0
T3	Topdressing	3000	0
Tn	Topdressing	0	34[1]
A0	Topdressing following aeration	0	0
A1	Topdressing following aeration	1000	0
A3	Topdressing following aeration	3000	0
An	Topdressing following aeration	0	34

[1]UFLEXX (46-0-0) was used as nitrogen source.

Results

Field study

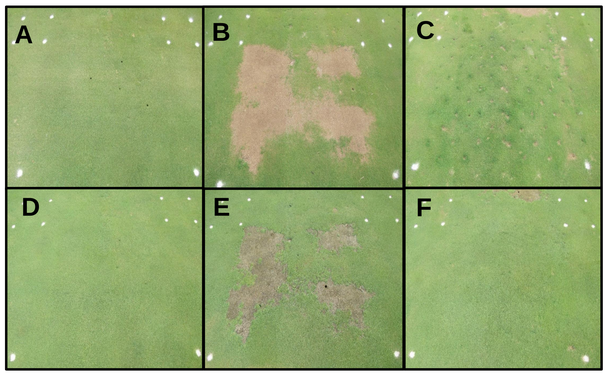

Figure 1. Representative response of creeping bentgrass to 3000 kg•ha^{-1} MSM by different delivery methods. First row: Control, T0 (A), Topdressing (B), and Topdressing following aeration (C) at 3 weeks after treatment (WAT). Second row: Control, T0 (D), Topdressing (E), and Topdressing following aeration (F) at 8 WAT.

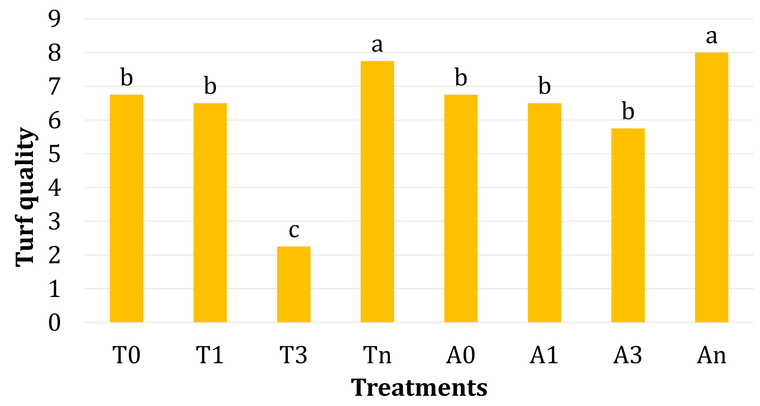

Figure 2. Turf quality of creeping bentgrass at 2 weeks after treatment (WAT). Bars with same letter do not differ significantly using Fisher's protected LSD (*P*=0.05).

- MSM at 3000 kg•ha^{-1} delivered by topdressing showed greater phytotoxicity to creeping bentgrass foliar tissue compared to topdressing following aeration.
- MSM at 1000 kg•ha^{-1} did not affect turf quality compared to control, regardless of delivery methods.

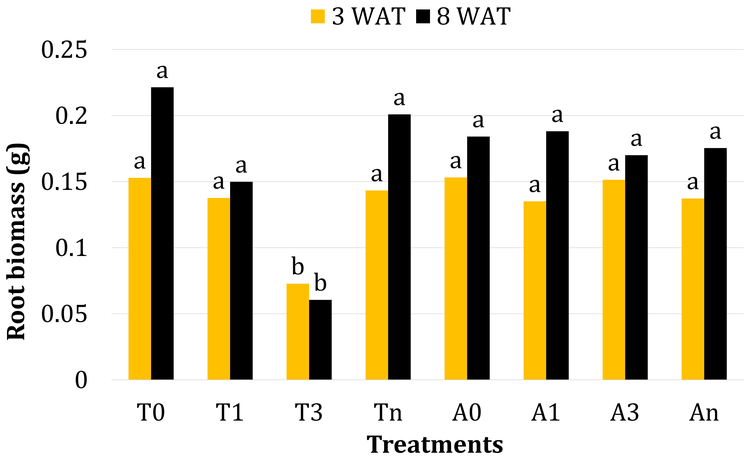

Figure 3. Root biomass of creeping bentgrass at 15 cm depth at 3 and 8 weeks after treatment (WAT). Bars with same letter do not differ significantly using Fisher's protected LSD (*P*=0.05).

Greenhouse study

Figure 4. Representative response of creeping bentgrass to MSM at 3 weeks after treatment (WAT). From left to right, MSM topdressing only at 0, 1000 and 3000 kg•ha^{-1} MSM; and MSM topdressing following aeration at 0, 1000 and 3000 kg•ha^{-1} MSM.

Table 2. Root total length, average diameter, surface area and number of tips at 3 week after treatment (3 WAT).

Treatment	Length (cm)	Average diam (mm)	Surface area (cm²)	Number of tips
T0	1020 a[1]	0.3 a	81 a	5123 ab
T1	699 ab	0.3 a	56 abc	4093 ab
T3	95 c	0.1 b	6 d	795 c
A0	917 ab	0.2 a	66 ab	6603 a
A1	855 ab	0.2 a	68 a	6111 ab
A3	410 bc	0.2 a	29 bcd	3300 bc
Contrast	**Results of orthogonal contrasts (*P* > *F*)**			
MSM 1000 vs. 3000	**[2]	**	***	**
Topdressing vs. Topdressing + aeration	NS	*	NS	*

[1]Means followed by the same letter are not significantly different using Fisher's protected LSD (*P*=0.05).
[2]Significance of results: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.005$, NS = no significant difference.

- Orthogonal test indicated that there were significant differences between 1000 and 3000 kg•ha^{-1} MSM for each parameter. There were significant differences between two delivery methods for root average diameter and number of tips.
- MSM at 3000 kg•ha^{-1} damaged roots more than MSM at 1000 kg•ha^{-1}, regardless of delivery methods.
- MSM topdressing alone resulted in significantly smaller root average diameter and number of tips compared to MSM topdressing following aeration.

Conclusions

- MSM applied at 1000 kg•ha^{-1} did not injure roots or foliar tissues of creeping bentgrass, regardless of delivery methods.
- MSM applied at 3000 kg•ha^{-1} as topdressing following aeration produced significantly less injury to foliar and root tissues of creeping bentgrass turf compared to MSM applied as topdressing alone.

References

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