Physiological Responses of Kentucky Bluegrass to Simulated Athletic Field Traffic

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Introduction

Present-day sports turf managers are pushing turf stands to perform at higher standards, and for longer periods, than previously thought possible, due to turf genetic improvements, advancements in turf culture technology, and pressure from end-users for "better" conditions. Because of these parameters, turf stress research has increased over the past two decades. Most of the research has focused on turf responses to heat, drought, or salinity stress, because mitigation of such stresses can be achieved through altered or improved cultural practices.

This is not the case with traffic or wear stress. Often there are minimal changes a turf manager can implement to alter the type, volume, or pattern of traffic stress, aside from a complete ban of traffic for a period of time. For this reason, traffic or wear stress must be tolerated by the turf and planned for by the turf manager. From the current knowledge base, improving traffic tolerance mostly is a function of turf species and cultivar selection, often only addressed during a sports field or golf course renovation. If renovation is not an option, improving traffic tolerance mostly is a function of regulating traffic frequency or severity, assuming all cultural practices are ideal.

The objective of this trial is to measure changes in activities of antioxidant enzymes when turf is subjected to simulated athletic field traffic. Enzyme assays will be performed on ascorbate peroxidase, catalase, and superoxide dismutase to determine the amount of change for each enzyme, plus when it changes in relation to simulated athletic field traffic. From this knowledge, baselines can be developed for future trials involving product application to mitigate negative enzyme concentration changes, or enhance positive enzyme concentration changes.

Materials and Methods

This trial was conducted at the Iowa State University Horticulture Research Station, Ames, Iowa, on a native soil Kentucky bluegrass (*Poa pratensis*) athletic field. Turf was cut at a 2-in. height two days/week using a riding rotary mower, with clippings returned. Irrigation was applied as necessary to facilitate optimal growing conditions. Fertility rate was 0.75 lb N/1,000 ft^2 per month (May-October) using 28-0-3, a granular slow release fertilizer. Experimental design was split-plot randomized complete block with four replications. Main plots were traffic treatment of 0 or 2 games/week, applied using a modified Baldree traffic simulator. Sub plots were timing of turf sampling: 0, 2, 4, 8, 12, and 24 hr after traffic application. Simulated traffic was applied and turf was sampled on seven dates between August 1 and October 1. This timeframe was chosen to best mimic the Iowa high school football season.

Individual turf blades were cut from each sub plot at the appropriate timing using a straight razor blade. One gram of turf blades was collected in a small paper envelope and then immediately submerged in liquid nitrogen, where these were stored until moved to a -80°C freezer at the end of the sampling day. Frozen samples were processed in a cold room

workspace (3-4°C). Samples were ground under liquid nitrogen, weighed into centrifuge tubes, and an extraction buffer was added. Tubes were centrifuged at 14,000g for 20 minutes at 4°C. Supernatant then was collected and allocated into various micro-centrifuge tubes for later enzyme assay analysis.

Results and Discussion

Ascorbate peroxidase (APX). Main effects of traffic treatment, sampling date, and sampling timing were significant in year one but were superseded by traffic treatment x sampling timing and sampling timing x sampling date interactions (Table 1). Ascorbate peroxidase activity in trafficked plots was lower than non-trafficked plots at 2, 4, 8, and 24 hr after traffic treatment. APX activity was similar for both traffic treatments at 0 and 12 hr (Figure 1). The APX activity by sampling timing generally decreased from 0 hr to 8 hr after traffic application, then recovering to or surpassing 0 hr activity level by 12 or 24 hr after traffic application (data not shown). Much of the variation is due to sampling date, meaning weather conditions were likely a large factor in determining overall ambient levels of APX activity. Additional research is needed to determine how weather conditions changed APX activity in this study.

Catalase (CAT). Main effects of traffic treatment, sampling date, and sampling timing were significant in year one but were superseded by traffic treatment x sampling date, traffic treatment x sampling timing, and sampling timing x sampling date interactions (Table 1). Catalase activity differed by traffic treatment on 3 of 7 dates. Non-trafficked plots had lower CAT activity than trafficked plots (data not shown). CAT activity differed by traffic treatment at 8, 12, and 24 hr after treatment. Trafficked plots at these timings had greater CAT activity than non-trafficked plots (Figure 2). CAT activity within sampling date by sampling timing was highly variable (data not shown). CAT activity usually increased as time progressed after simulated traffic treatment, often peaking at 8 hr. As with APX activity, ambient/background CAT activity within sampling date could be influenced by environmental conditions. Additional research is needed to determine how weather conditions changed CAT activity in this study.

Superoxide dismutase (SOD). Main effects of traffic treatment, sampling date, and sampling timing were significant in year one, but were superseded by traffic treatment x sampling date and sampling timing x sampling date interactions (Table 1). Superoxide dismutase activity was significant by traffic treatment on 5 of 7 dates. Trafficked plots had lower SOD activity than non-trafficked plots (Figure 3). Within most sampling dates, 4 of 7 dates, SOD activity decreased as time passed after traffic treatment application (data not shown). There also is a general downward trend in SOD activity from the second traffic application date to the fifth traffic application date.

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Table 1. Abbreviated ANOVA table for antioxidant activity response of Kentucky bluegrass to simulated athletic traffic, ISU Horticulture Research Station, Ames, IA.

Factor	Ascorbate peroxidase	Catalase	Superoxide dismutase
Replication	ns	ns	ns
Traffic treatment (TT)	.0266	.033	.004
Sampling date (SD)	.0003	<.0001	<.0001
TT x SD	ns	.027	.0009
Sampling timing (ST)	<.0001	<.0001	<.0001
TT x ST	.0018	.002	ns
ST x SD	<.0001	<.0001	<.0001
TT x ST x SD	ns[1]	ns	ns

[1]ns = not significant at P ≤ 0.05 level.

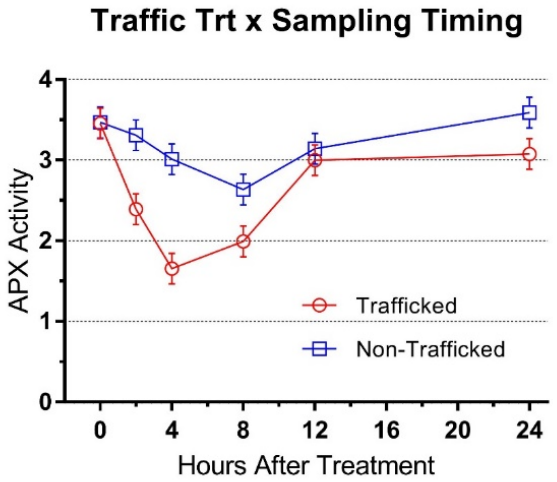

Figure 1. Ascorbate peroxidase activity: traffic treatment by sampling timing interaction. One unit of APX activity was defined as the conversion of 1 uM AsA into monodehydroascorbate in one min at 290 nm.

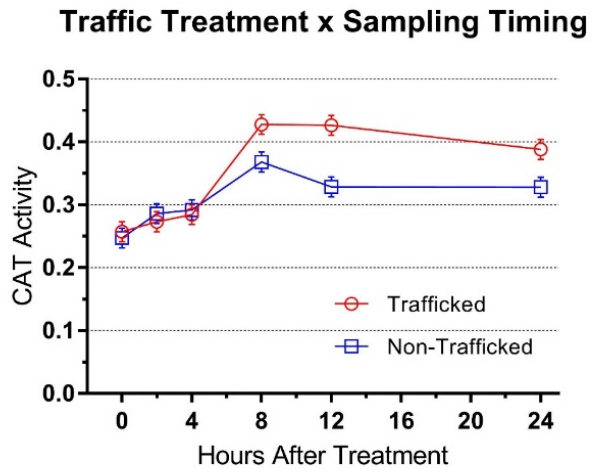

Figure 2. Catalase activity: traffic treatment by sampling timing interaction. One unit of CAT activity was defined as the degradation of 1 uM H_2O_2 in one minute at 240 nm.

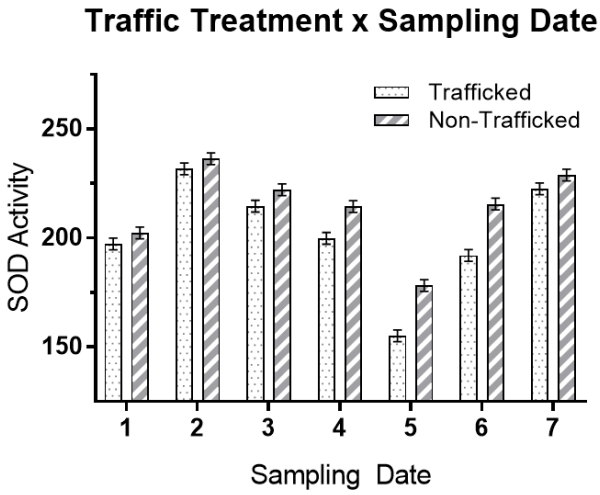

Figure 3. Superoxide dismutase activity: traffic treatment by sampling date interaction. One unit of SOD activity was defined as the enzyme causing 50% inhibition of formazan formation.