



Penn State's

**Center for
Sports Surface Research**

Synthetic Turf Heat Evaluation – Progress Report

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Executive Summary

Laboratory and outdoor tests were conducted to compare surface temperatures of infilled synthetic turfs composed of various fiber and infill colors/materials. In the laboratory study, the following surface temperature tests were performed: 1) synthetic turf system (infill installed into fibers), 2) fiber, and 3) infill. Surface temperature was evaluated by placing each sample under a 250 W infrared heat lamp. A total of 11 fiber/infill combinations were tested in the synthetic turf system trial. While temperature differences of up to 20 degrees were found among synthetic turf components (fibers and infills) when tested independently, when combined into synthetic turf systems, differences were 12 degrees or less. With temperatures of all tested treatments exceeding 150° F when evaluated as synthetic turf systems, no product in this study produced a substantial reduction in surface temperature compared to a standard green fiber/black rubber system. Outdoor testing was also conducted in the summer of 2011. The surface temperatures of many of the same treatments included in the laboratory test were also evaluated outdoors during warm, clear conditions. Outdoor testing only included synthetic turf systems and did not include individual component tests. Results from the outdoor testing were similar to the laboratory tests.

Introduction

The issue of high surface temperature on infilled synthetic turf continues to be a significant concern. Because surface temperatures can reach up to 200° F (Williams and Pulley, 2002), usage of synthetic turf fields may be limited during the peak heating hours of the day in the interest of athlete safety. Numerous methods have been attempted to mitigate high surface temperature (Serensits, et al., 2011). For example, the use of irrigation water has been shown to rapidly drop surface temperatures immediately after watering; however, temperatures quickly rebound to near pre-irrigation levels (McNitt et al., 2008). Other research has examined the effect of painting black crumb rubber infill white in an attempt to lower surface temperature (Devitt et al., 2007). Once installed in the carpet fibers, the white infill reduced surface temperature by only a few degrees.

Because some have questioned the safety of crumb rubber infill, alternatives to standard infill have become increasingly available to consumers. Many of these products claim advantages over traditional crumb rubber infill including reduced surface temperature. While marketing materials may claim lower surface temperatures, no scientific reports exist that substantiate such claims. The influence of fibers on surface temperature has also been recognized. One manufacturer claims to produce a fiber that significantly reduces surface temperature; however, again, there is no publicly available scientific evidence to support the claim.

The goal of this study was to evaluate the effects of fibers (color and type) and infills (color and type) on surface temperature.

Testing Procedure

Laboratory Setup

All samples were placed under a 250-watt infrared heat lamp suspended 17 inches above the sample surface (Figure 1). This testing setup has been correlated to outdoor sunny conditions. In the synthetic turf system study, samples were placed under the heat lamp for 3 hours. A temperature sensor was placed on the surface of each sample at the same location under the heat lamp. The temperature sensor was connected to a Watchdog data logger (Spectrum Technologies, Plainfield, IL.). Temperature data was collected every 1 minute. An infrared thermometer (Kintrex IRT0421) was used on a routine basis throughout the testing period to ensure the accuracy of the temperature sensor. Typically, temperatures were within 1 to 2 degrees when comparing temperature measuring methods. In the fiber and infill tests, each sample was placed under the heat lamp for 1 hour. Temperature measurements were made using an infrared thermometer (Kintrex IRT0421) after 15, 30, and 60 minutes under the lamp.

Synthetic Turf System Test

The following 11 synthetic turf systems were evaluated (all infills were installed into FieldTurf Duraspine Pro fibers unless otherwise noted; all infill was black cryogenic rubber unless otherwise noted):

1. White fibers with black rubber
2. Gold fibers with black rubber
3. Silver fibers with black rubber
4. Black fibers with black rubber
5. Green fibers (Duraspine) with black rubber
6. Green fibers (Revolution) with black rubber
7. Green fibers-AstroFlect (with ambient SBR)
8. Green fibers with green rubber
9. Green fibers with tan rubber
10. Green fibers with EcoFill (green)
11. Green fibers with TPE (green)

Fiber Test

The following 7 fiber colors/types were evaluated (all fibers were FieldTurf Duraspine Pro unless otherwise noted, Figure 2):

1. White
2. Gold
3. Silver
4. Black
5. Green
6. Green (FieldTurf Revolution)
7. Green (AstroTurf AstroFlect)

Infill Test

The following 5 infill colors/types were evaluated (all rubber was cryogenic, Figure 3):

1. Black rubber
2. Green rubber
3. Tan rubber
4. EcoFill (green)
5. TPE (green)

Statistical Analysis

In all tests, each treatment was replicated three times. ANOVA testing was performed for each trial. Tukey's Honestly Significantly Different (HSD) test was used to separate treatment means when the F ratio was significant at the 0.05 level.

Outdoor Testing Setup

Test specimens were installed onto a crushed stone base at the Joseph Valentine Turfgrass Research Center, located in University Park, PA. Surface temperatures were recorded using an infrared thermometer (Kintrex IRT0421). All fibers tested were FieldTurf Duraspine Pro with the exception of AstroTurf Astroflect fibers. The following surfaces were evaluated:

<u>Fiber</u>	<u>Infill</u>
White	Black
Green	Ecofill
Green	TPE (green)
Gold	Black
Black	Black
Silver	Black
Green	Green
Green	Tan
Astroflect	Black
Green	Black
Green	Gray*

*July 21 test only

The outdoor test was not replicated in space, but independent data was collected on three days during the summer of 2011. As a result, no statistical testing was performed on the outdoor data.

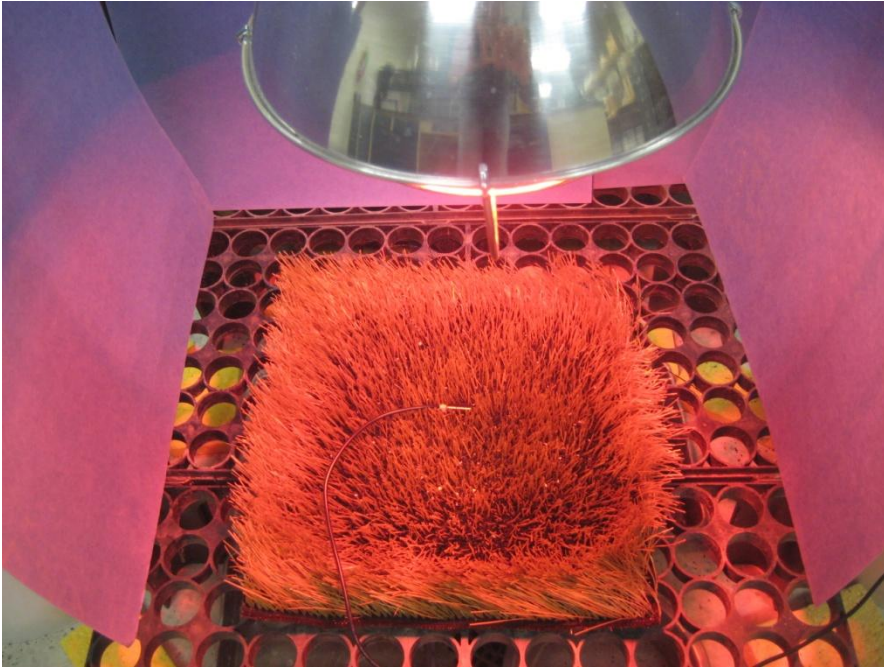


Figure 1. Laboratory testing setup



Figure 2. Various colors and types of fibers were tested



Figure 3. Various infills were tested including colored crumb rubber (left), EcoFill (bottom right), and TPE (middle right)

Results – Synthetic Turf System Test

Table 1. Surface temperatures of various fiber-infill combinations after 3 hours under heat lamp.

Fiber Color	Infill	Surface Temperature (F)
Gold	Black Rubber	171.1 a [†]
White	Black Rubber	170.4 ab
Silver	Black Rubber	169.2 ab
Black	Black Rubber	169.2 ab
Green	Ecofill	167.3 abc
Green (FieldTurf Revolution)	Black Rubber	165.6 abcd
Green	Black Rubber	165.5 abcd
Green	Green Rubber	163.8 bcde
Green	Tan Rubber	161.1 cde
Green	TPE	160.5 de
Green (AstroTurf AstroFlect)	Black Rubber	158.9 e

All fibers were FieldTurf Duraspine Pro unless otherwise noted

[†]Temperatures that do not share the same letter are significantly (statistically) different

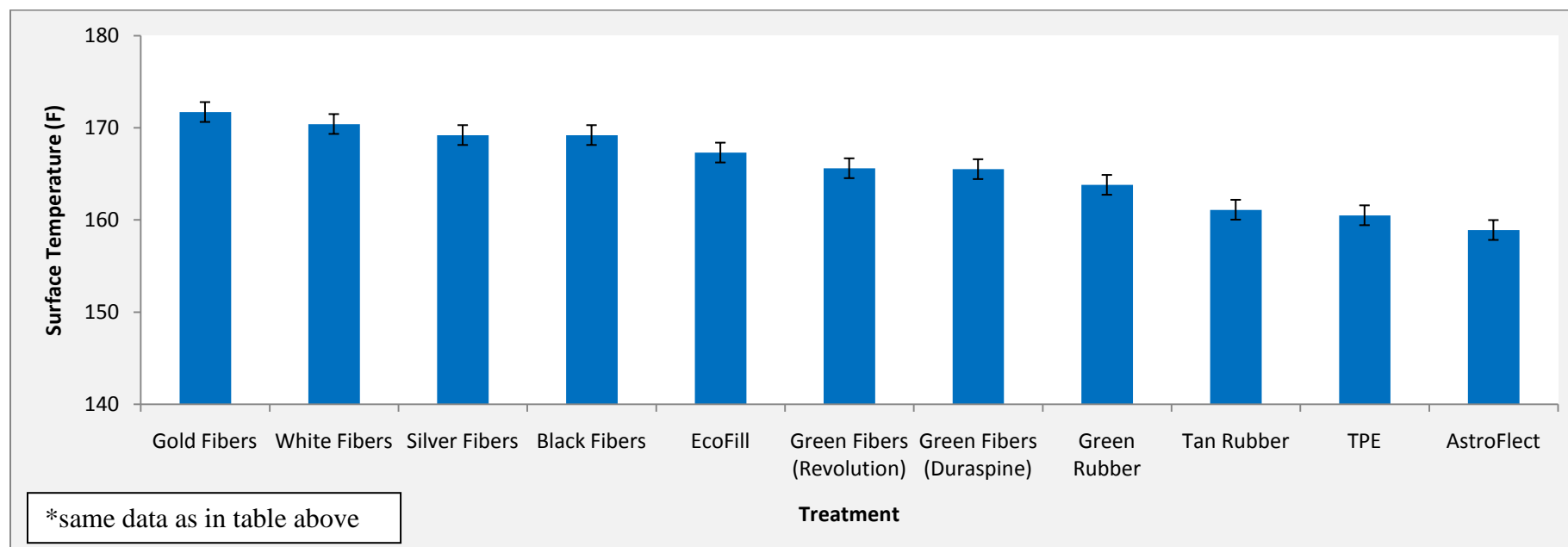


Figure 4. Surface temperature of various fiber-infill combinations after 3 hours under heat lamp

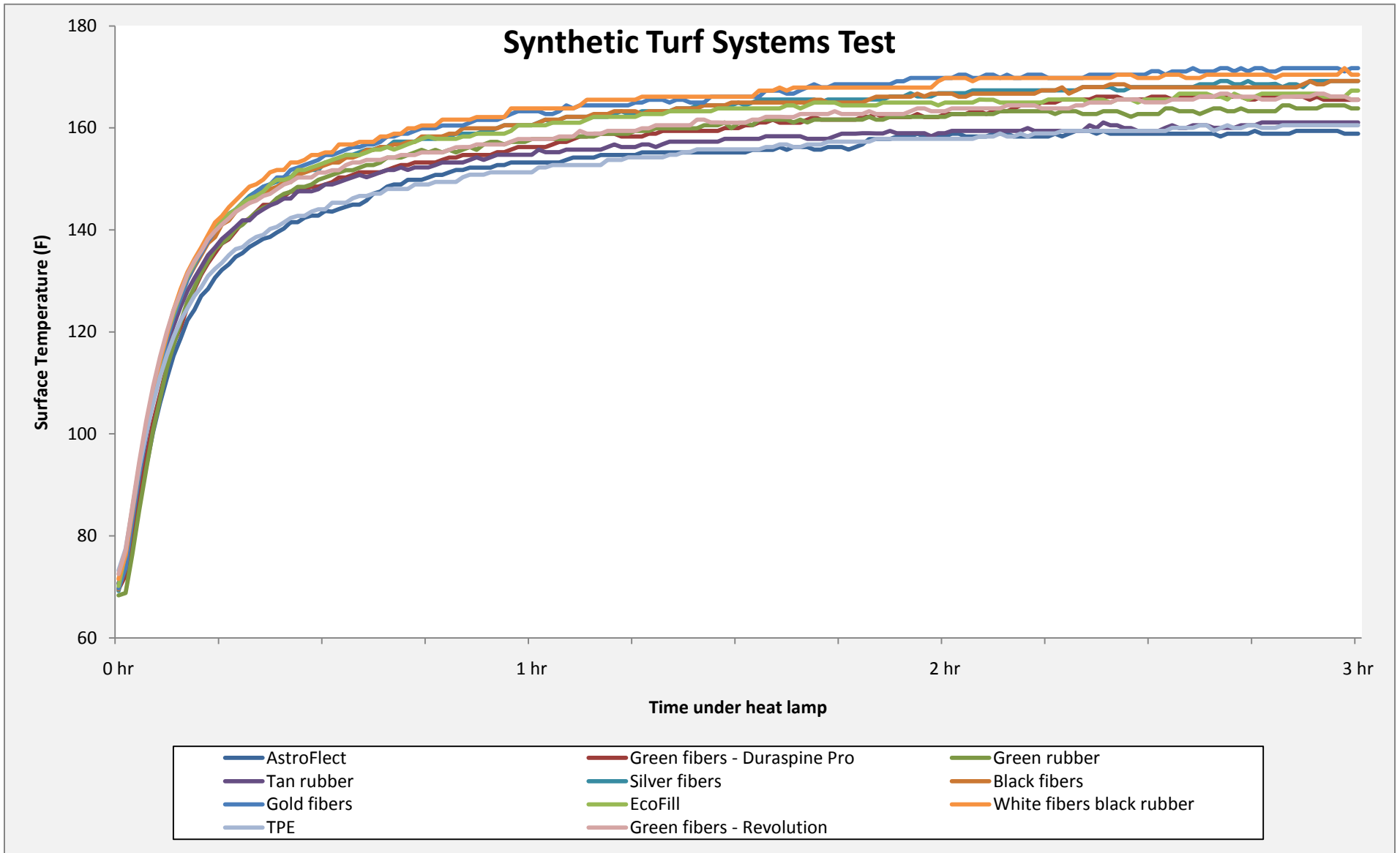


Figure 5. Temperature data collected every one minute by temperature probe placed on turf's surface

Results - Fiber Test

Table 2. Surface temperatures of various fibers after 1 hour under heat lamp

Fiber Color	Surface Temperature (F)
Silver	149.4 a [†]
Black	144.3 b
Green	140.5 bc
Gold	139.8 bc
Green (FieldTurf Revolution)	138.6 c
Green (AstroTurf AstroFlect)	137.9 c
White	128.7 d

All fibers were FieldTurf Duraspine Pro unless otherwise noted
[†]Temperatures that do not share the same letter are significantly (statistically) different

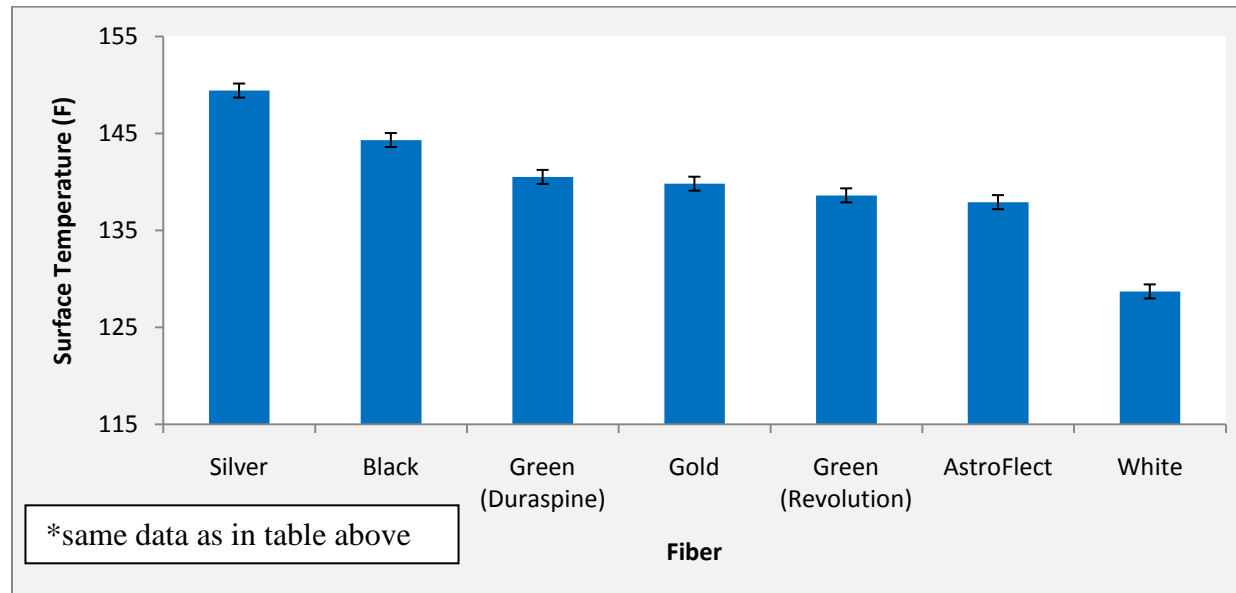


Figure 6. Surface temperature of various fibers after 1 hour under heat lamp

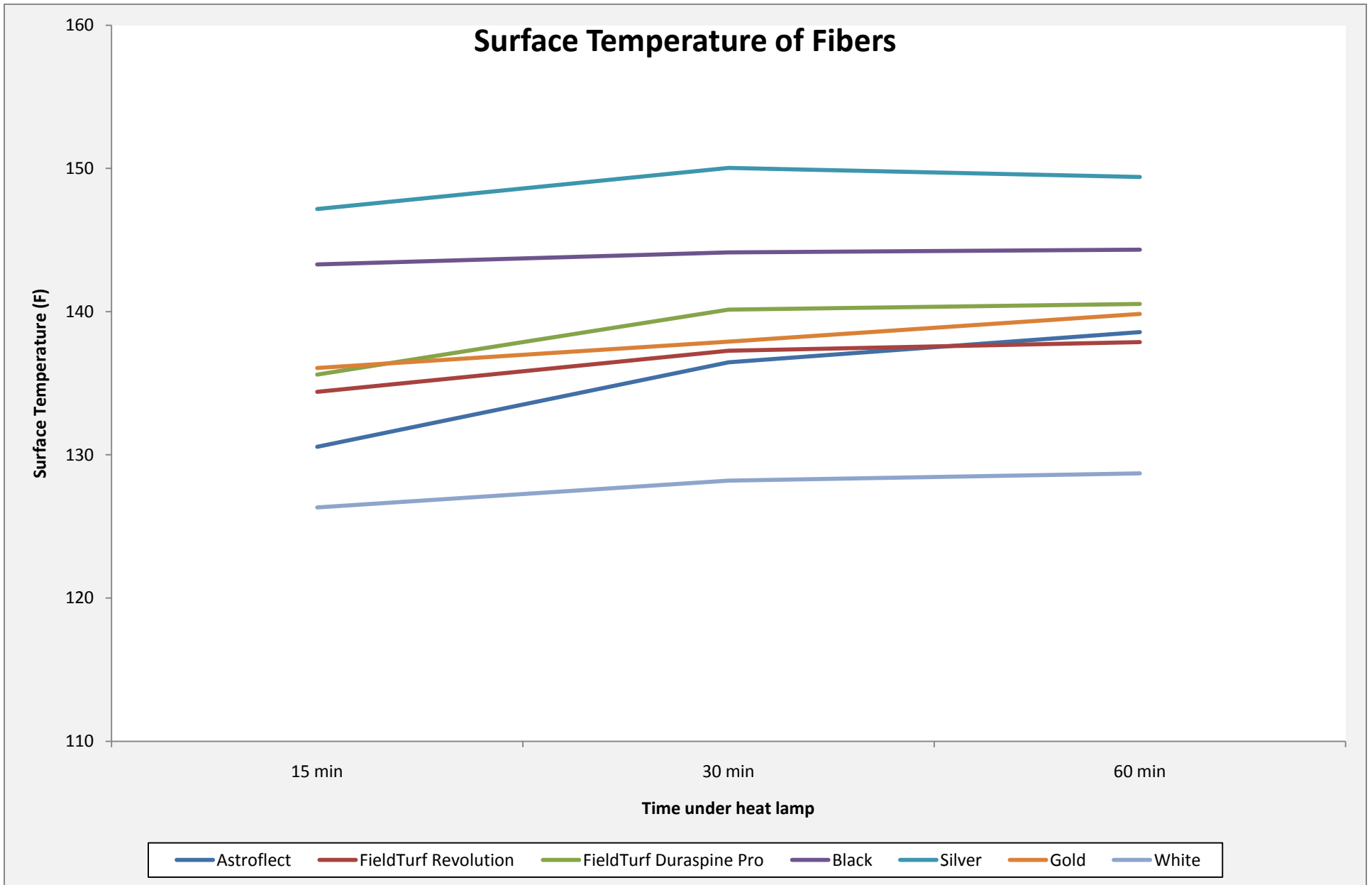


Figure 7. Surface temperatures of various fibers without infill installed at 15, 30, and 60 minutes under heat lamp.

Results - Infill Only Test

Table 3. Surface temperatures of various infills after 1 hour under heat lamp

Infill	Surface Temperature (F)
Black Rubber	156.0 a [†]
Tan Rubber	153.4 a
Green Rubber	147.9 b
Ecofill	141.6 c
TPE	136.4 d

[†]Temperatures that do not share the same letter are significantly (statistically) different

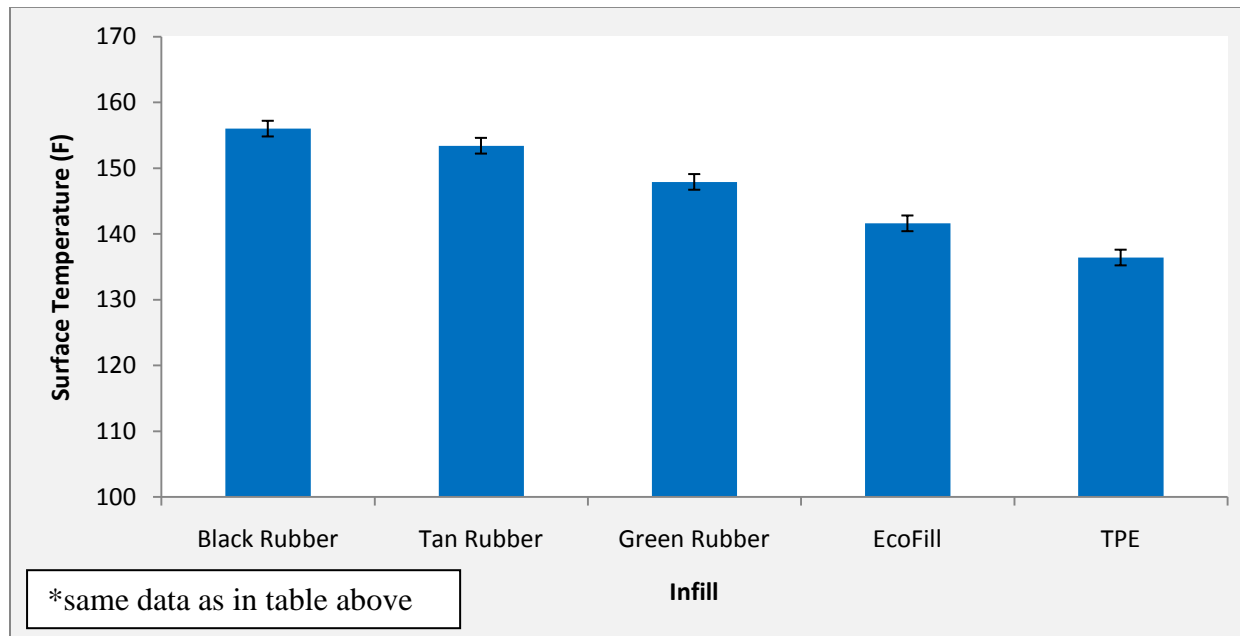


Figure 8. Surface temperature of various infills after 1 hour under heat lamp

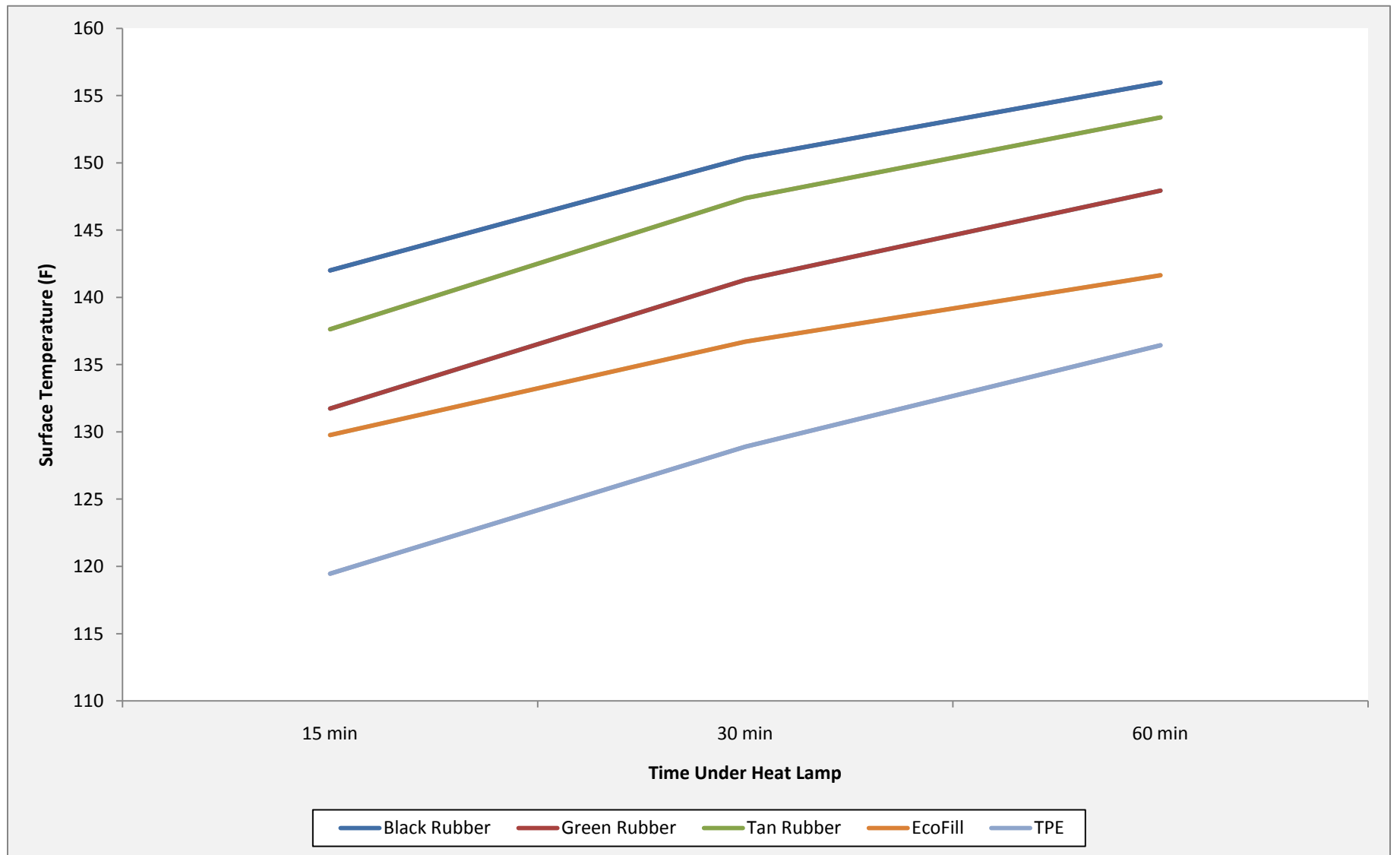


Figure 9. Surface temperatures of various infills not installed into fibers at 15, 30, and 60 minutes under heat lamp.

Outdoor Testing

Table 4. Surface temperature measurements recorded on June 6, 2011 during clear, sunny conditions at the Joseph Valentine Turfgrass Research Center in University Park, PA. All infills are crumb rubber with the exception of Ecofill and TPE. All fibers are FieldTurf Duraspine Pro with the exception of AstroTurf Astroflect.

Fiber	Infill	12:00 PM	1:00 PM	2:00 PM	3:00 PM	AVERAGE
-----Maximum Temperature (F)-----						
White	Black	149.3	154.7	162.0	155.4	155.3
Green	Ecofill	148.3	162.8	153.6	158.4	155.8
Green	TPE (green)	152.4	155.5	154.9	153.3	154.0
Gold	Black	168.6	177.0	175.5	172.4	173.4
Black	Black	161.8	170.1	172.6	164.8	167.3
Silver	Black	161.6	175.5	171.1	168.1	169.1
Green	Green	158.2	165.9	169.7	163.8	164.4
Green	Tan	156.3	160.3	166.3	162.5	161.4
Astroflect	Black	151.0	155.4	157.1	154.9	154.6
Green	Black	156.9	161.3	169.0	164.2	162.9
AIR TEMP		73	75	77	79	76

Table 5. Surface temperature measurements recorded on June 30, 2011 during clear, sunny conditions at the Joseph Valentine Turfgrass Research Center in University Park, PA. All infills are crumb rubber with the exception of Ecofill and TPE. All fibers are FieldTurf Duraspine Pro with the exception of AstroTurf Astroflect.

Fiber	Infill	1:00 PM	2:00 PM (breezy)	3:00 PM (breezy)	AVERAGE
-----Maximum Temperature-----					
White	Black	161.3	145.7	146.3	151.1
Green	Ecofill	157.8	139.5	142.0	146.4
Green	TPE (green)	151.7	130.6	138.3	140.2
Gold	Black	171.8	152.7	153.3	159.3
Black	Black	172.1	147.9	148.3	156.1
Silver	Black	164.9	136.7	144.5	148.7
Green	Green	163.9	143.1	141.1	149.4
Green	Tan	155.8	138.5	141.1	145.1
Astroflect	Black	152.6	131.0	137.6	140.4
Green	Black	158.3	144.0	144.1	148.8
AIR TEMP		75	77	79	77

Table 6. Surface temperature measurements recorded on July 21, 2011 during hazy, breezy, hot conditions at the Joseph Valentine Turfgrass Research Center in University Park, PA. All infills are crumb rubber with the exception of Ecofill and TPE. All fibers are FieldTurf Duraspine Pro with the exception of AstroTurf Astroflect.

Fiber	Infill	11:00 AM	1:00 PM (breezy)	3:00 PM (breezy)	AVERAGE
-----Maximum Temperature-----					
White	Black	136.8	155.4	155.3	149.2
Green	Ecofill	134.9	144.8	148.8	142.8
Green	TPE (green)	128.4	145.1	146.1	139.9
Gold	Black	135.4	161.0	160.3	152.2
Black	Black	137.2	155.9	155.5	149.5
Silver	Black	134.4	147.8	150.1	144.1
Green	Green	135.7	159.0	155.6	150.1
Green	Tan	131.6	154.8	151.4	145.9
Astroflect	Black	126.6	148.4	146.1	140.4
Green	Black	129.6	150.8	144.3	141.6
Green	Gray	130.5	147.9	149.8	142.7
AIR TEMP		88	92	99	93

Summary

No product in this test substantially reduced surface temperature compared to the traditional system of green fibers filled with black rubber in both the indoor and outdoor test. Reductions of five or even ten degrees offer little advantage when temperatures still exceed 150° F. Until temperatures can be reduced by at least twenty or thirty degrees for an extended period of time, surface temperature will remain a major issue on synthetic turf fields.

References

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