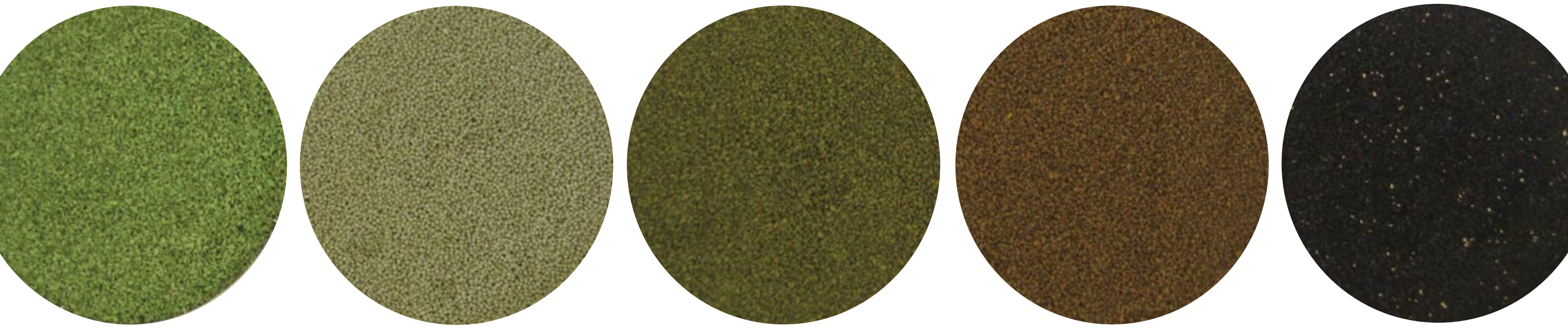

Is there any way to cool synthetic turf?

>> **Figure 1. INFILLS TESTED** included (left to right) Ecofill, TPE, green crumb rubber, tan crumb rubber, and black crumb rubber.

WHEN WALKING ACROSS A SYNTHETIC TURF FIELD on a sunny summer day, it does not take long to notice the heat emanating from the surface. While synthetic turf has undergone design changes that have improved overall field conditions, the issue of high surface temperature remains. Should I irrigate my field to cool it off? Do alternatives to black crumb rubber infill really lower surface temperature as they claim? At Penn State's Center for Sports Surface Research, our studies are beginning to answer these questions.

Before we get into the results of our testing, it is useful to have an understanding of when and why these surfaces get hot. Surface temperatures reach their peak during bright, clear sunny days with little humidity and haze. The temperature of a field on an 82° F clear, sunny day will be higher than on a hazy, humid day with an air temperature in the 90's.

How hot can synthetic turf really get? The highest recorded temperature was 200° F during a summer day on the campus of Brigham Young University in Provo, UT. While this may be an extreme case, it is not uncommon for temperatures to surpass 150° F. In fact, during Penn State's Turfgrass Field Days this past summer, we recorded temperatures as high as 175° F on our research plots. For a comparison, natural turf rarely reaches 100° F, even on the hottest, clearest days.

Irrigation is the most common method used to try to reduce the surface temperature of synthetic fields. Pumping water onto synthetic turf may garner some odd looks, but the application of water can rapidly cool the surface of the field. The problem is that cooling effect is short-lived. Our research shows temperatures quickly rebound 20 minutes after irrigation stops and the irrigated surface is only slightly cooler than a non-irrigated surface three hours after watering (less than 10 degree difference). Another issue with irrigation is the potential for increased humidity directly above the turf's surface. Rising temperatures coupled with high humidity may expose athletes to even more heat stress.

The reason we have not been successful in significantly reducing the temperature of these surfaces through irrigation is that these systems have been designed to rapidly drain water. They simply do not hold onto much water and thus the evaporative cooling is short-lived. We have attempted to increase water holding capacity of the systems and thus increase the duration of the cooling effect by adding water-holding particles to the crumb rubber infill.

In our testing, we mixed a substantial amount of calcined clay with crumb rubber (1 to 1 on a volume basis). While successful in prolonging the duration of cooling initially, the calcined clay particles were reduced to dust when subjected to simulated field use. Not surprisingly, the cooling effect was lost as the particles broke down. Additionally, such a high amount of calcined clay may affect the playability of the field and the dust could impact drainage, although this was not measured in our study.

Although it is common to blame the sunlight's interaction with the black crumb rubber for the hot surface, the fibers also significantly contribute to a field's temperature. Anyone who has spent time working with traditional (non-infilled) Astroturf-type surfaces can tell you that those fields also got extremely hot and they do not contain any crumb rubber. In fact, results from our research plots show that the surface temperature of traditional Astroturf is higher than infilled synthetic turf when no irrigation is applied.

Surface temperature reduction has been attempted through modifications to both the infill material and changes in the fiber. Marketers of crumb rubber infill alternatives claim their products reduce surface temperature. Some have proposed chang-

>> **Figure 2. EXPERIMENTAL SETUP** to evaluate surface temperature of synthetic turf.

ing the color of traditional crumb rubber particles as a cooling technique. Certain turf fibers are even claimed to contain technology that significantly reduces surface temperature. Unfortunately, independent research supporting the claims of these products has been lacking and unavailable to consumers.

At the Center for Sports Surface Research, we conducted a series of experiments to evaluate the effects of varying these components on surface temperature. Surface temperatures of infill materials and fibers were tested independently and as a system (infill installed into carpet). A variety of infill materials including various colors of crumb rubber, Ecofill (polyolefin granules), and TPE were evaluated (Fig 1). For the fibers, we recorded the temperature of white, gold, silver, black, and green (FieldTurf Duraspine, FieldTurf Revolution, and AstroTurf AstroFlect) fibers. The combined turf system test included a total of 11 fiber-infill combinations. We conducted our tests indoors using a 250-watt infrared heat lamp (Fig 2) that has been correlated to sunny outdoor conditions at Penn State.

Our study indicates that none of the fiber-infill combinations tested measured substantially lower in surface temperate than the standard green fibers and black crumb rubber infill systems (Table 1). We did find certain combinations of infill type and fiber can lower the surface temperature slightly. In the fiber test, it's not surprising

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 (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

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 (FieldTurf Duraspine Pro)	140.5 bc
Gold	139.8 bc
Green (FieldTurf Revolution)	138.6 c
Green (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

Table 3.
Surface temperatures of various infill 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

that the darkest colors produced the hottest surfaces (Table 2). White fibers were the coolest, resulting in a surface temperature approximately 10 degrees cooler than green fibers. When comparing the three green fibers, both FieldTurf fibers (Duraspine Pro and Revolution) and AstroTurf's AstroFlect did not statistically differ from one another.

In the infill material comparison, the color of crumb rubber proved to have little or no effect on surface temperature (Table 3). Green rubber was marginally cooler (less than 10 degrees) than both black and tan rubber, but was still nearly 150° F. Both Ecofill (141.6° F) and TPE (136.4°) were cooler than all crumb rubber colors (black: 156.0° F, tan: 153.4° F, green: 147.9° F).

While it is valuable to examine the influence of synthetic turf components on surface temperature individually, what really matters is the effects of these components after they are combined in turf systems. In our study, any effect of fiber color was essentially negated with the addition of black crumb rubber infill (Table 1). It did not matter whether the fibers were white or black—surface temperature was essentially the same for any fiber color tested. AstroTurf's AstroFlect was not statistically different from FieldTurf Duraspine Pro fibers (green) that contained either TPE, green rubber, or tan rubber, even though it trended about four degrees cooler.

Reductions of five or even ten degrees offer little comfort when temperatures can still exceed 150° F.

NO MAGIC BULLET

What do these results tell us? As of right now, it is obvious that there is no "magic bullet" available to dramatically lower the surface temperature of synthetic turf. Reductions of five or even ten degrees offer little comfort when temperatures can still exceed 150° F. Until temperatures can be reduced by at least 20-30 degrees for an extended period of time, surface temperature will remain a major issue on synthetic turf fields.

We will continue to investigate methods to cool these systems. You can follow our work on our website (http://ssrc.psu.edu), "Liking" us on Facebook (Penn State's Center for Sports Surface Research), following us on twitter (@PSUsportsturf) and on www.stma.org. We have also introduced a free video series on our website called the "Sportsturf Scoop." Topics related to both natural grass and synthetic turf (including a video on surface temperature of synthetic turf) are available and new topics are added regularly. ■

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