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A new look at turf growth, overseeding and transition issues

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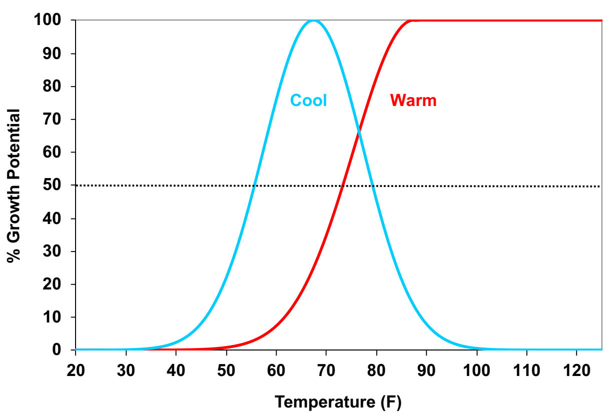
Bottom line: The proper choice of turf types, overseeding strategies and transition practices can have huge impacts on turf quality and on the turf manager's ability to achieve their goals. It is therefore important to be able to communicate and clearly demonstrate the agronomic advantages and disadvantages of the decisions that you make on these issues. To assist in this important task, we have developed a turf growth model that illustrates the critical role of site-specific weather in the performance of different turf types in different locations. The model is useful for helping to explain the biological reasons behind the ups and downs that you experience with optimizing turf growth at your own golf course, and for providing a scientific basis for decisions about turf types, overseeding and transition practices.

In this issue of *PACE Insights* we will show you the dramatic and overwhelming effect that weather has on the growth of warm-season and cool-season turf, and therefore on the success (or failure) of different turf types, overseeding programs and transition practices. To illustrate this, we have improved upon a tool that we originally developed in 2000, the "PACE Turfgrass Growth Model", and have found new applications for it. This model can be used to help educate golfers and managers, to provide a scientific basis for decisions, and to predict the performance of different turf types when exposed to different climates, and different overseeding and transition practices.

Figure 1. Percent growth of cool-season turf (blue curve) vs. warm-season turf (red curve) at different average air temperatures. Note that the best turf growth (100% growth potential) occurs at 68F for cool-season turf and 88F for warm-season turf. Increasingly vigorous growth occurs at 50% growth potential (horizontal dotted line) and higher, while turf growth becomes slower and slower as the growth potential decreases below 50%.



Warm vs. cool-season turf: Vive la différence!

One of the most important differences between cool and warm-season turf varieties (see Table 1) is that cool-season turf grows best between average air temperatures of 60° and 75°F (with optimum growth at about 68F), while warm-season turf grows best at average air temperatures between 80° and 95°F (with optimum growth at about 88F). These are the differences that are exploited in overseeding programs. Depending on your climate, you will be more or less successful in exploiting these differences, as we will show below.

The contrasting temperature requirements for cool- vs. warm-season turf are illustrated in Figure 1. Note that for cool-season turf, growth reaches 100% of the plant's growth potential (GP) when average air temperatures are 68F. When it is cooler than 68F, the GP decreases. Similarly, when it is warmer than 68F, the GP decreases as well. Warm-season turf growth has a similar shaped curve, up to 88 F. When average temperature is above 88 F, warm season grasses continue to grow well.

Putting the turf growth model to work

Take a look at Figure 3, which shows the GP graphs for 8 locations around the U.S. The temperatures used to generate these graphs are the average monthly air temperatures for each location, averaged over the last 30 years. To get the hang of using the Turf Growth Model, we're going to start by looking at two relatively extreme environments — Worcester, Massachusetts, where cool-season turf is the dominant turf type and Guam, where warm-season turf dominates.

Brrrr!!: Take a look at the first graph in Figure 3, for Worcester, MA. It shows that temperatures are warm enough for good growth of cool-season turf (greater than 50% GP) from about mid-April through October. Before and after this time period, temperatures are very cool, making it more difficult for cool-season turf to grow. But as long as the GP is above zero, cool-season turf will continue to grow — just more and more slowly as temperatures cool down and GP approaches zero. At average air temperatures below 38F, cool-season turf growth basically stops (Table 3). Warm-season turf, on the other hand, barely reaches 20% GP, even in the warmest month (July). Does this mean that warm-season turf won't grow at all in Worcester? No, not at all. In fact, looking at this graph, we would expect to see some warm-season turf growth from June through August in most years. But it would be growing very slowly, and without the heat it needs for vigorous growth. As a result, the turf would be more susceptible to disease, insect attack, traffic damage, weed invasion, and most of all, competition from cool-season turf. Common sense already probably told you that bermudagrass is a poor choice for a Massachusetts location — now, these GP graphs and the Turf Growth Model back it up.

Too darn hot!: The reverse situation is seen in the next graph in Figure 3 for Guam, where it is too hot year-round for vigorous (greater than 50% GP) growth of cool-season turf. Instead, in this tropical location, where the warm temperatures do not fluctuate very much from month to month, warm-season turf dominates the entire year. Can cool-season turf be grown in this location? Most definitely. But compared to the vigorous growth of warm-season turf, it will be somewhat stressed by high temperatures throughout the year.

Table 1. Growth requirements for cool and warm-season turf varieties. Temperatures listed are average air temperatures.

Cool-season turf	Warm-season turf
Bluegrass, fescue, bentgrass, ryegrass	**Bermuda, paspalum, buffalo, zoysia, St. Augustine, centipede, bahiagrass***
Grows best 60°-75°F	**Grows best 80°-95°F**
Growth decreased >80°F and <50°F	**Growth decreased (dormancy) <55°F**
Solar radiation optimum: 242-485 langleys/day (116-233 watts/m^2/day)	**Solar radiation optimum: 812-969 langleys/day (390-465 watts/m^2/day)**
Sensitive to heat, drought and salts	**Tolerant to heat, drought and salts**
C3 carbon fixing cycle in photosynthesis	**C4 carbon fixing: helps plant deal w/ high temperature and high solar radiation**

*Kikuyugrass, which is classified as a warm-season variety shares many features with cool-season turf. As a result, it straddles these two categories, with values that are intermediate for salinity tolerance, solar radiation requirements, and heat requirements.

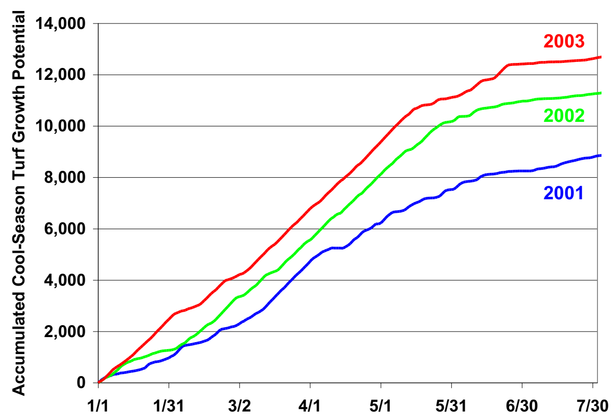
The ideal overseeding environment: does it exist?

If there is an ideal overseeding environment in the U.S., it can be found in the desert southwest — Palm Springs, CA or Phoenix, AZ, for example. Look at the GP chart for Phoenix in Figure 3 — what makes this such a good environment for overseeding?

- There are more than four months each year in which warm-season turf clearly dominates cool-season turf (May – October). During these months, it is way too hot for cool-season turf growth, and it usually dies or slows down its growth significantly.
- There are about 6 months each year when cool-season turf clearly dominates (November – April). During these months, it is too cool for warm-season turf (it goes dormant), but it is perfect weather for growth of rye, poa, bent and other cool-season overseeded varieties.
- The large differences between cool- and warm-season turf in this location are reflected in the almost 100% spread between these two turf types at the most strategically important times of the year (i.e. summer and winter). These differences indicate that when warm-season turf growth is at 100%, cool-season turf growth is very close to zero — and vice versa. In other words, there is limited competition bewteen these two turf types — at least for most of the year.

But even in this "perfect" environment, there can be problems with overseeding. To understand why, you need to look at Figure 3 and note the times of year when the cool-season GP line crosses the warm-season line — roughly in mid-April and again in late September/early October. What is happening at these times of year? The answer is that **both** turf types can grow vigorously during these critical periods, which are otherwise known as the spring and fall transitions. When the GP is simultaneously high for both cool-and warm-season turf, then there is heavy competition between the two turf types, and it is difficult to manage the system to favor one over the other.

Figure 2. Year-to-year variation in cool-season turf growth during the spring transition. Cathedral City, CA. GP units are accumulated, starting with January 1 of each year to show the differences that can occur from one year to the next.



This can vary a great deal from year to year. For example, if the mid-April time period is warmer than normal one year, as it was in Cathedral City (near Palm Springs, CA) in 2003 (Figure 2), then cool-season turf will die rapidly and warm-season turf will roar into the vacuum that is left by the dying overseeded turf — it will be a good spring transition. But if it is a cooler than normal April, as it was in Cathedral City in 2001 (Figure 2), then cool-season turf will hang on, and warm-season turf will grow weakly. As a result, splotchy, polystands of both warm- and cool-season turf will result, and the spring transition will be judged a failure. In years like 2001, chemical transition aids, such as Kerb or the new sulfonylurea herbicides (Monument, Revolver, TranXit) would be very useful.

And then, there's the rest of us

Most locations, fall somewhere in between the three scenarios described above. Let's take a look at the GP graphs for Lexington, KY and Richmond, VA (Figure 3). In both of these locations, there are some golf courses that cultivate only cool-season turf, while others cultivate both warm and cool-season turf. There are also some courses that overseed, and others that do not. Based on the GP graphs in Figure 3 (and assuming that you could run a golf course based solely on agronomic principles), which turf types and overseeding strategies would make the most sense in these environments? To help answer this question, note the following trends illustrated in Figure 3:

- Cool-season turf dominates warm-season turf for the entire year, and its GP is over 50% for practically the whole year. However,it is heavily stressed by hot temperatures during the summer, as illustrated by the decline in GP that takes place during the summer months.
- Warm-season turf barely makes it over 50% GP, and when it does, it is only for one or two months.

A choice to grow only cool-season turf appears to make the most agronomic sense. However, the summer months will be tough, because during this time, it gets hot enough to cause a big drop in cool-season GP. This can lead to thinning and stressed turf and all of the problems it engenders. Cool-season turf is also more susceptible to damage by white grubs and by diseases such as gray leaf spot. A greater investment in pesticides and water is required to maintain high quality cool-season turf in these locations. But if the budget and commitment are there, this strategy will deliver the highest quality turf on a year-round basis.

The second most desirable choice would be to cultivate non-overseeded warm-season fairways and/or roughs. Howevever, while the turf will perform adequately during the summer months, it will be dormant (with all of the problems that dormancy engenders) for the majority of the year.

The least desirable choice would be to overseed the warm-season turf. However, because of the transition style climate, it will be difficult to accomplish successful spring or fall transitions, and both the cool- and war-season turf will struggle as they compete with each other. Mixtures of weakened stands of both turf types are frequently the end result of overseeding in environment such as these.

In these two locations, therefore, there is no ideal strategy. This is where the non-agronomic considerations come into play — what time of year are the most rounds played in? Is it a resort or a private or a public course? What are the expectations of the membership? What are the inlufences of water and soil quality (if poor, warm-season turf would be favored) and shade and/or overcast conditions (if prevalent, cool-season turf would be favored).

In other words, if you don't fall into one of three extremes (cool-season dominance, warm-season dominance, or "ideal" overseeding climate), you are in that gray, borderline area where overseeding may or may not be beneficial. In these cases, non-agronomic factors come into greater play in making transition-related decisions.

A look at the other graphs in Figure 3 for Gainesville, Dallas and Miami show locations with increasingly good conditions for overseeding — though none of these areas approach the good overseeding conditions experienced in the desert southwest. Given the fact that we have already demonstrated that even the so-called "ideal" overseeding conditions of the desert southwest are problematic on a fairly frequent basis, it should be clear that locations with more competition between cool- and warm- season turf (i.e., locations that have less than a 100% difference in GP between warm- and cool-season turf) will have even more problems with successful transitions.

Where does your location fit in?

Do any of the scenarios painted above describe your situation? Or do you fall somewhere in between? To get a better idea of what goes on nationwide, as well as at individual locations, we have used the Turf Growth Model to estimate the growth of warm- and cool-season turf at different U.S. locations that were selected based on proximity to PACE members (Table 2).

Uses for the Turf Growth Model

Educate golfers and management: Use the information in Figure 3 and Tables 2 and 3 to help educate yourself, golfers and management about the biology behind the performance of the turf varieties at your location, and how the turf will behave in an average year. This historical data can help to communicate:

- Why cool- and/or warm-season turf perform the way that they do at your location
- How unexpected weather patterns can influence turf growth and quality
- Why it is a good idea (or not a good idea) to overseed at your location

Decision support: The information in Figure 3 and Tables 2 and 3 can help you to determine:

Variety selection: If new plantings are being considered, whether warm- or cool-season turf varieties are optimal.

Overseed date: When the best overseeding date would typically be at your location. This occurs when cool-season GP is significantly higher than warm-season GP. There should also be several weeks of high cool-season turf GP **after** the overseeding date so that the overseed has time to establish before the ocold weather sets in.

Timing of chemical transition product application: If chemical transition aids (Kerb or sulfonylurea herbicides) are going to be used in the springtime, when the optimal time for use would be. There are two guidelines that are useful in this respect. **When warm-season turf GP is above 50% and warm-season turf cover is 80% or higher,** chemical transition aids can be safely applied without the risk of producing significant numbers of bare spots (the bare spots appear because of lack of sufficient warm-season turf cover at the time of application). A second guideline, proposed by Dr. Fred

Yelverton of North Carolina State University, takes a different approach. He has proposed that **bermudagrass needs at least 100 days** to grow without interference from overseeded cool-season turf. This means that the date of application of chemical transition aids should be at least 100 days earlier than your planned date for fall overseeding. For example, if you plan to overseed on October 1, then your chemical transition aid should be applied no later than June 22. Combining these two approaches can give you a well-rounded and well reasoned basis for making application timing decisions.

Interpret current turf performance: Figure 3 and Table 2 use historical weather data to provide guidelines for predicting turf performance, but you can also evaluate current conditions to get an idea of whether the temperatures at your location are going to favor or inhibit growth of the turf varieties you have selected over the next several days. To do this:

- Click on “Weather Update” on the Member’s Page of the PACE website.
- Look at the five day forecast for % cool-season GP and % warm-season GP.
- If GP for either turf type is greater than 50%, then good growth should be expected.
- If the GP appears to be declining over the next few days, be prepared for some degree of turf stress — even if the overall GP remains above 50%. On the other hand, if GP is increasing over the next five days, you are in good shape for the near future.
- If you are maintaining overseeded turf, compare the GP values for warm- and cool-season turf varieties to predict how they are going to compete (or not compete) with one another over the next several days.

If you are interested in comparing the GP data at your location to others, use the data in Table 3 to do so.

Table 3. Percent growth potential (GP) of cool-season and warm-season turf at different average air temperatures

Air Temp (F)	%Warm GP	%Cool GP	Air Temp (F)	%Warm GP	%Cool GP	Air Temp (F)	%Warm GP	%Cool GP
38	0	1	60	7	75	82	90	35
39	0	2	61	9	81	83	93	30
40	0	2	62	10	86	84	96	26
41	0	3	63	12	90	85	98	22
42	0	4	64	15	94	86	99	18
43	0	5	65	17	97	87	100	15
44	0	6	66	20	99	88	100	12
45	0	8	67	23	100	89	100	10
46	0	10	68	27	100	90	100	8
47	0	12	69	30	99	91	100	6
48	0	15	70	35	97	92	100	5
49	1	18	71	39	94	93	100	4
50	1	22	72	43	90	94	100	3
51	1	26	73	48	86	95	100	2
52	1	30	74	53	81	96	100	2
53	2	35	75	58	75	97	100	1
54	2	40	76	63	70	98	100	1
55	3	46	77	68	64	99	100	1
56	3	52	78	73	58	100	100	1
57	4	58	79	78	52	101	100	0
58	5	64	80	82	46	102	100	0
59	6	70	81	86	40	103	100	0

GROWTH POTENTIAL MODEL EQUATION

GP = growth potential
obsT = observed temperature (F)
optT = optimum turf growth temperature (F)
sd = standard deviation of the distribution
(sd warm = 12; sd cool = 10)
e = natural logarithm base **2.718282…**

$$GP := 100 \cdot \left[\frac{1}{e^{\left[\frac{1}{2} \cdot \left[\frac{(obsT - optT)}{sd} \right]^2 \right]}} \right]$$