Poa annua invasion of bentgrass greens: The role of bentgrass quality

By: Larry J. Stowell[1], Ph.D., Roger Yenny[2], CGCS, Ali Harivandi, Ph.D.[3]
[1]PACE Turfgrass Research Institute, [2]Mesa Verde Country Club, [3]University of California

Poa annua (annual bluegrass) invasion of newly seeded bentgrass greens is a universal problem shared by golf course superintendents around the world. For that beautiful 12 month period right after the green has been seeded, everyone is always optimistic that a pure bentgrass stand can be maintained -- this time. But soon, small colonies of Poa begin to appear without warning, and three to five years later, significant Poa invasion has occurred. By then, the all too familiar never-ending battle is underway.

Let's be honest up front. There are currently no products available that can completely prevent Poa from invading newly seeded bentgrass greens. In many areas, the only way that superintendents have found to maintain pure bentgrass greens for longer than four years is to implement an aggressive and labor intensive daily hand weeding program. Preemergent herbicides may assist in preventing invasion, but without hand weeding, occasional escape Poa plants will eventually lead to Poa invasion. Cultural practices, such as fertility programs, turf stress management and bentgrass overseeding programs may also help slow down the rate of Poa invasion, but cannot completely prevent it.

In this article, we will describe how selection of the bentgrass varieties that perform best in your region can play a major role in reducing Poa invasion. But we will remind you again at the end of the article that no current method, or combination of methods can completely and permanently stop Poa invasion on bentgrass greens. That may have to wait until genetically engineered, herbicide resistant varieties of bentgrass are introduced -- a technology we will review here as well.

Summary

Common sense and experience tell us that the higher the turfgrass quality, the harder it will be for Poa to invade. But until recently, there was very little scientific data available to back up this intuition. Fortunately, we have been able to review data collected from four, multi-year bentgrass variety trials and have confirmed what we expected -- that the speed of Poa invasion is directly related to the quality, or performance of the bentgrass. In other words, generally, the best looking turf had the slowest Poa invasion rates, and the worst looking turf had the fastest Poa invasion rates.

When researchers make turfgrass quality ratings, they are taking a visual measurement that takes into account the color, fineness of the leaf blades, uniformity, and density of the turf. Usually, turf is rated on a scale of 1 to 9, with a 9 representing the best turfgrass quality possible. Although this rating system may appear flawed because it is subjective, it has turned out to be an effective method for selecting improved turfgrass cultivars and also for a range of other applications (Skogley and Sawyer, 1992).

Materials and Methods

Bentgrass variety trials

Our conclusions in this article are based on the results from bentgrass variety trials in four locations. Trials in Urbana, Illinois and Blacksburg, Virginia were reported by the National Turfgrass Evaluation Program (USDA, 1996 and USDA, 1997). The remaining two trials were located in northern California (Sunnyvale, CA) (Harivandi and Hagan, 1995) and in Southern California (Costa Mesa, CA) (Stowell and Yenny, 1997). The data from each of these four locations was also compared against the average quality data from NTEP (National Turfgrass Evaluation Program) trials in 1993 (16 locations), 1994 (26 locations) and 1996 (24 locations).

Poa invasion

Poa invasion is the result of a very complex interaction between the bentgrass variety, cultural practices, Poa varieties at the sites evaluated, and the environmental conditions. When researchers make Poa invasion ratings, they visually estimate the amount, or percent of Poa within each plot. A second method for rating Poa invasion is used by NTEP, which uses a scale of 1 - 9 to rate Poa invasion, with 1 representing heavy Poa invasion and 9 representing no Poa invasion. Data based on both of these rating systems are presented in this summary. Poa invasion ratings were taken the following number of years after bentgrass seeding: Urbana (1 year), Blacksburg (2 years), Sunnyvale (3 years), Costa Mesa (4 years).

Analyzing the data

When analyzing the turf quality and Poa invasion data from each trial, we asked these two questions:

1. Do the bentgrass varieties perform the same in all locations?

2. Can we predict the extent of Poa invasion by looking at bentgrass variety quality ratings?

To answer these questions, we used a method known as **regression analysis**, which allows us to look at two factors (such as turf quality and Poa invasion) and determine if one factor has an effect on the other. If we find that turfgrass quality has an effect on Poa invasion, then we say that there is a **correlation** between the two factors. And the correlation becomes a **significant correlation** if the probability that the results are due to chance does not exceed 5% (denoted as $p<0.05$ in Tables 2 and 3) or 1% (denoted as $p<0.01$ in Tables 2 and 3). All statistical analyses were carried out using Systat 7.0.1 for Windows (SPSS Inc.).

A summary of all of the data we used in these analyses is presented in Table 1. Table 2 shows the correlation between turfgrass quality and Poa invasion and Table 3 shows the correlation between turfgrass quality ratings at different locations.

Results and Discussion

Regionality of turfgrass quality: Location, location, location

The golf turf industry has benefited greatly from the NTEP national turfgrass quality trials that are conducted using standardized testing and reporting techniques. One of the most important features of these tests is that they are conducted in a wide variety of locations across the United States, so that results will be relevant to turf managers in all regions of the country.

In order to answer question number 1, above "Do the bentgrass varieties perform the same in all locations?", we looked at turfgrass quality ratings from each of the four locations, and compared them against each other, and against NTEP national quality rating averages (Table 3). Looking at Table 3, note that the West Coast quality ratings (Sunnyvale and Costa Mesa, CA) do not correlate very frequently with the quality ratings from Illinois or Virginia. Is this is a surprise? Probably not, since the environmental conditions in coastal California (including lack of a real winter!) are very different from those in the Midwest or the Southeast. In other words, depending on the location, different bentgrass varieties may perform differently. The take home message is that data from your own region is likely to be the most useful and the most predictive when it comes time for you to select the best bentgrass variety for your course.

Relationship of turfgrass quality to Poa invasion

The easiest way to look at the answer to question number 2, "Can we predict the extent of Poa invasion by looking at bentgrass variety quality ratings?" is to graph the results (Figure 1) of turfgrass quality ratings vs. Poa invasion ratings. If the majority of points fall on or near the diagonal line on each graph, then the two factors -- turf quality and Poa invasion -- are correlated and have an influence on one another. The closer the points are to this line, the stronger the correlation. Looking at Figure 1, we can see that there was a strong correlation between turfgrass quality and Poa invasion in all four test locations, with perhaps the strongest correlations in Costa Mesa and Sunnyvale, CA. In all four locations, the probability that the correlation was due to chance was lower than one in one hundred ($P<0.01$), which is the kind of strong, consistent data we like to see.

Practical recommendations

There are a few important conclusions contained in all of these data. First, we now have strong data to support the idea that the best performing bentgrass varieties will also be the most resistant to Poa invasion. This means that when superintendents use quality ratings from NTEP or other bentgrass variety trials, they are not only picking the best looking turf, but also the turf most likely to resist Poa invasion. And if you like to perform some of your own testing, we encourage you to supplement national trial data by growing several varieties at your own location, to see how they perform under the specific conditions at your golf course. Your experience and training should enable you to do an excellent job of rating quality. Suggestions on plot design and rating procedures can be obtained from the authors of this article.

The strong correlation between turfgrass quality and Poa invasion also confirms that whichever variety of bentgrass you choose, Poa invasion will be significantly slowed if turf quality is maintained at high levels through proper irrigation, fertility, aeration, traffic management, pest management and other cultural practices.

Thirdly, this data confirms that different bentgrass varieties do not perform the same way in different climates and environments. For this reason, you should rely most strongly on turfgrass quality data that comes from an area most similar to your own. However, don't completely ignore data from other locations, since this data may help you make your final decisions.

And finally, no matter which bentgrass you choose, the best that can be hoped for is a decrease in the rate of Poa invasion. Currently, there is no way to completely stop it. As illustrated in Figure 1, even the highest quality bentgrass varieties had some Poa invasion by 1-4 years after bentgrass seeding.

The future

All is not bleak, however. Genetic engineering has provided some interesting plot twists in the Poa invasion story. Researchers are developing bentgrass varieties that are resistant to broad spectrum herbicides (Hartman et. al., 1994, Lee et. al., 1995 and 1996). In this case, Poa invasion is no longer an issue. If Poa invades, it can be blasted out of the bentgrass using effective herbicides without damage to the herbicide-resistant bentgrass. When these varieties enter the marketplace, the turfgrass industry may be transformed as never before. Poa greens will slowly disappear as old greens are resurfaced using new bentgrass varieties that can be maintained, Poa-free, by periodic application of herbicides. Fact or fiction? Only time will tell.

Larry Stowell, Ph.D. is Research Director, PACE Turfgrass Research Institute, San Diego, CA. Roger Yenny is a certified golf course superintendent at Mesa Verde Country Club, Costa Mesa, CA. Ali Harivandi, Ph.D. is an environmental horticulturist for the University of California Cooeprative Extension Service, Hayward, CA.

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Acknowledgments

The PACE Turfgrass Research Institute Advisory Board plays a critical role in providing research direction, generating financial support, offering and maintaining research sites, and participating in research experiments. The Board is composed of: Brian Archbold, El Niguel Country Club; Buzz Barker, Antelope Valley Country Club; Jeff Beardsley, Big Canyon Country Club; Mike Caranci, Candlewood Country Club; Sandy Clark, Rancho Bernardo Country Club; Candice Combs, City of San Diego; Gary Dalton, San Diego Country Club; Bruce Duenow, La Jolla Country Club, Jim Duffin, Los Amigos Golf Course; Bill Gallegos, Los Coyotes Country Club; Mike Greninger, Titleist/Cobra Test Facility, John Harkness, Oak Valley Golf Club; Mike Huck, USGA Green Section; Eric Lover, Dove Canyon Country Club; John Martinez, SCGA; David Michael, Friendly Hills Country Club; Wayne Mills, Valencia Country Club; Jim Neal, Rolling Hills Country Club; Ronald Nolf, Vista Valley Country Club; Robert O'Connell, Brentwood Country Club; Don Parsons, Old Ranch Country Club; Kurt Rahn, Leisure World, Laguna Hills; Mark

Schaer, San Luis Rey Downs; John Welter, Menifee Lakes Country Club; Bruce Williams, Los Angeles Country Club; Reed Yenny, Mesa Verde Country Club; David Zahrte, Santa Ana Country Club.

Table 1. Summary of data for bentgrass variety quality and Poa invasion from each of four test locations (Urbana, IL; Blacksburg, VA; Sunnyvale, CA; Costa Mesa, CA) and summary of average bentgrass variety quality data from NTEP trials from 1993, 1994 and 1996. Not all varieties were evaluated in each location.

Variety	1996 NTEP Average Quality	1994 NTEP Average Quality	1993 NTEP Average Quality	Urbana Quality 1994	Urbana Percent Poa 1994	Sunnyvale Quality 1993	Sunnyvale Percent Poa 1993	Costa Mesa Quality 1997	Costa Mesa Percent Poa 1997	Blacksburg Quality 1996	Blacksburg Poa Invasion 1996
18th Green	5.3	5.7	5.8	4.1	28.3	5.2	37.1			4.6	5.7
88.CBE			6.1			5.2	34.7				
Allure			4.7			4.2	48.6				
Backspin	5.9	5.9		4.5	18.3					5.1	7.7
Bar AS 492	4.4	4.6		3.1	50.0					4.8	5.3
Bar WS 42102	6.0	5.8		4.6	31.7					5.6	3.7
Bardot			4.9			4.3	42.1				
Carmen			5.7			5.4	22.8	6.7	16.7		
Cato	6.3	6.2		5.1	20.0			8.0	15.0	5.9	6.3
Century	6.1	6.0		5.1	18.3					5.4	7.0
C-N-C								8.0	9.0		
Cobra			6.0			6.3	11.8	6.3	16.7		
Crenshaw	5.8	6.2		5.5	16.7			8.1	11.6	5.2	6.0
DG-P	5.9	5.6		4.2	31.7					5.2	5.3
Egmont			4.9			5.1	26.8				
Emerald			5.2			5.4	20.8	5.1	36.7		
Imperial	6.1	6.0		5.1	20.0					5.5	6.7
ISI-AP-89150	5.8	5.7		4.8	16.7					5.1	5.0
Lofts L-93	6.6	6.4		5.3	18.3					6.3	6.7
Lopez	5.7	5.6	6.0	4.3	25.0	5.5	21.0			5.0	4.7
Mariner	5.4	5.4		4.8	11.7					5.0	5.0
MSCB-8			5.8			5.9	20.2				
MSUEB	5.7	5.7		4.7	15.0					5.2	5.3
National			5.4			4.9	42.8	6.1	15.7		
Penn A-1	6.5	6.3		5.3	23.3					6.0	7.0
Penn A-4	6.5	6.5		5.5	16.7					6.2	7.7
Penn G-2	6.3	6.1		4.9	35.0					6.4	6.3
Penn G-6	6.2	6.1		4.8	26.7					6.3	8.0
Penncross	5.4	5.5	5.9	4.7	11.7	5.7	14.9	6.1	25.1	4.9	5.3
Pennlinks	5.9	5.8	5.9	5.0	15.0	5.7	14.9	6.7	16.7	5.3	6.3
Pro/Cup	5.7	5.6	5.9	4.5	21.7	5.9	27.1			5.0	5.0
Providence	6.3	6.3		5.9	16.7					5.8	6.0
Putter			6.1			5.9	11.1	7.5	15.1		
Regent	5.8	5.8	6.3	4.7	13.3	5.9	15.7	6.2	30.1	5.0	4.3
Seaside	4.6	4.5		3.9	11.7					4.5	3.0
Southshore	6.1	6.1		4.9	13.3			8.2	8.0	5.3	5.0
SR 1020	5.9	5.9	6.2	4.8	18.3	6.1	10.7	7.8	11.7	5.4	4.7
TAMU 88-1			5.8			6.0	12.0				
Tendenz	4.3	4.8		3.3	36.7					3.9	4.0
Tracenta			4.9			4.4	46.2				
Trueline	5.7	5.5		4.3	16.7					5.2	6.0

Table 2. Correlation matrix for turfgrass quality ratings and Poa invasion comparing the NTEP national averages and individual locations. A plus (+) indicates that the correlation between turf quality and Poa invasion is significant using the F test, p•0.05 (there is a 5% chance that the correlation is due to chance). Two pluses (++) indicates that the correlation is highly significant using the F test, p•0.01 (there is a 1% chance that the correlation is due to chance).

	Poa Invasion Rating			
Turfgrass Quality	Urbana, IL	Sunnyvale, CA	Costa Mesa, CA	Blacksburg, VA
NTEP 1993 Average		++		+
NTEP 1994 Average				++
NTEP 1996 Average				++
Urbana	++			++
Sunnyvale		++		
Costa Mesa			++	
Blacksburg		+		++

Table 3. Correlation matrix for turfgrass quality ratings for national average and individual locations. A plus (+) indicates that the correlation between quality ratings is significant using the F test, p•0.05 (there is a 5% chance that the correlation is due to chance). Two pluses (++) indicates that the correlation is highly significant using the F test, p•0.01 (there is a 1% chance that the correlation is due to chance).

	Turfgrass Quality			
Turfgrass Quality	Urbana, IL	Sunnyvale, CA	Costa Mesa, CA	Blacksburg, VA
NTEP 1993 Average	+	++		+
NTEP 1994 Average	++		+	++
NTEP 1996 Average	++			++
Urbana				++
Sunnyvale				+
Costa Mesa				

Figure 1. Graphs evaluating the relationship between turfgrass quality and Poa invasion. Plots represent data presented in Table 1. In all cases the correlations are highly significant (F test, $p<0.01$) with high quality correlated with lower Poa invasion. Data from Urbana, IL; Costa Mesa, CA; and Sunnyvale, CA reported Poa invasion as percent Poa. The Blacksburg location reported Poa invasion on a 1 to 9 scale with 1 equal to severe Poa invasion and 9 representing no Poa invasion. Poa invasion ratings were taken the following number of years after bentgrass seeding: Urbana (1 year), Blacksburg (2 years), Sunnyvale (3 years), Costa Mesa (4 years).