



Fertilizer Responses in a Bentgrass Fairway

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INTRODUCTION

A researcher's retirement is fraught with tough decisions. Do I throw out old data files that, when re-visited, could hold gems of useful information or provide confirmation of what we already hold to be true? Of concern here is a file containing 1,728 measurements of creeping bentgrass color ratings and clipping N contents collected from a fairway treated for three years with four different fertilizers, each applied at three N rates. I decided it may be worthwhile to take one last look at the data.

FINDINGS

When N rate and source are the variables in a study, researchers typically measure turfgrass responses in one or more ways - turfgrass quality, clipping production, color ratings, or clipping N content. Because the rates of N applied to turfgrass are far below those required for maximum clipping production, there is always a strong, straight line relationship between clipping yield and N content. When taken by the same person, color and quality ratings also bear strong relationships to clipping N content and production, but these are generally not straight line relationships. This is illustrated in figure 1 for the clipping N contents and color ratings recorded in this study. The reason for this is the reluctance on the part of researchers to assign the maximum possible color and quality ratings of 9.0. This is why in this study the decision was made to use clipping N content as the primary measure of creeping bentgrass response to the fertilizers applied.

You've likely read or heard about the seasonal bimodal pattern of turfgrass responses to fertilizer. It's generally attributed to the influences of air temperature on turfgrass growth. Near optimal temperatures allow for a surge in early season growth response to fertilizer, elevated summer temperatures suppress these responses, and declining autumn temperatures lead to another surge in growth. In more than 20 years I've never seen this seasonal response pattern and it was not evident in this study as well (Fig. 2). The seasonal pattern of bentgrass color and clipping N content shown in figure 2 was found for all fertilizers, all rates of application, and for all three years of the study. If ever there was a year where air temperatures would have notably suppressed bentgrass responses to fertilizer, it should have been 1988. Most of you may be too

Figure 1

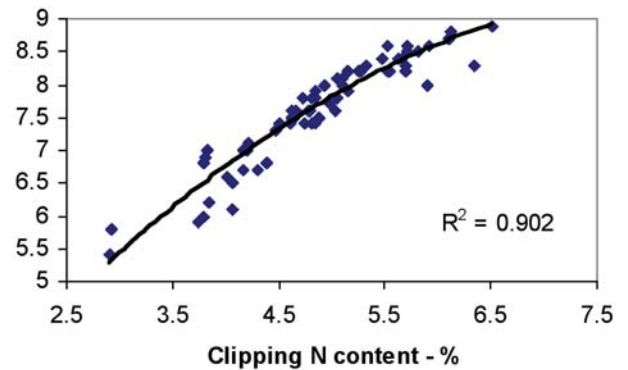
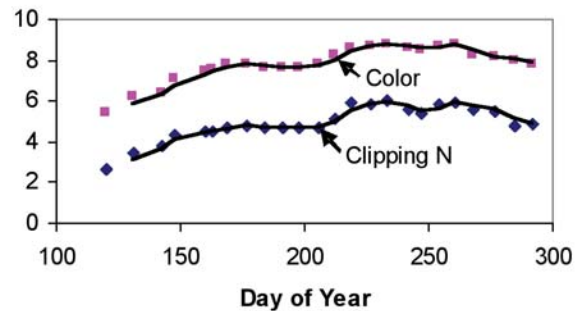


Figure 2



young to remember, but in that year we experienced nearly a full week of air temperatures above 100°F. Even under these conditions there was no evidence in this study of a bimodal seasonal response to the fertilizers. I've always suspected that the classical bimodal growth response of turfgrass is more the result of moisture than temperature stress. Researchers need to revisit this because so many fertilizer recommendations are based on the assumption that a seasonal bimodal growth response is the norm for turfgrass.

As indicated in figure 2, fertilizer response measured in terms of clipping N content peaked at about day 233, which is August 21. This was consistently true regardless of whether the fertilizer was Milorganite, urea or IBDU for all annual rates and frequencies of applica-

tion. This is vividly illustrated in figure 3 for IBDU applied four times during the season and urea applied biweekly. The IBDU gave a consistently better response, but the pattern of response was the same for urea. Note in figure 3 that there appeared to be a short duration suppression of fertilizer response from days 243 to 261 (August 31 to September 18), but by no means resulted in a seasonal bimodal response pattern.

Increasing the annual N rate of the fertilizers had the same effect on bentgrass seasonal patterns of response. The influence of annual N rate on the seasonal response patterns is illustrated in figure 4 for regular grade Milorganite. The general trend lines largely parallel one another except early and late in the season, where there was separation between responses to the lowest and intermediate N rates. The intermediate N rate elicited a disproportionately greater response than did the lowest rate. This was true for all the fertilizers applied. This suggests that late and early season N rates may need to be higher than during the summer months to sustain high turfgrass quality on bentgrass fairways late in the season and to stimulate early season growth and rapid recovery from winter injury.

A seemingly unending debate among turfgrass researchers is the best form of N to apply late season. In this study the last applications of fine grade Milorganite, regular grade Milorganite, urea, and IBDU were made in mid-October at various N rates. Their stimulatory effects on early season growth were judged based on bentgrass clipping N contents the following April. These were found to be almost exclusively related to the October N rate (Fig. 5). It was virtually impossible to single out natural organic Milorganite, the 100 % water soluble urea or the low solubility IBDU as the preferred late season N source. This was true whether based on color response or clipping N content. Early and late season responses to these three types of fertilizer N were almost identical (Table 1).

In studies such as this the question always arises as to which was the preferred fertilizer. This question was addressed in this study three different ways. The first was to plot graphs that allowed for identification of the annual rates of each fertilizer required to achieve the annual color ratings and clipping N contents indicative of a high quality bentgrass fairways. Depending on the criteria applied, these optimal annual N rates ranged from a low of 1.3 lb N/M applied as IBDU to 6.5 lb N/M in the form of fine grade Milorganite (Table 2). These N rates reflect the fact that throughout this study IBDU always elicited the most bentgrass response per pound of N applied and fine grade Milorganite the least. Responses to urea and regular grade Milorganite were intermediate between fine grade Milorganite and IBDU and were often indistinguishable from one another.

The ideal N fertilizer, yet to be created, is the one

Figure 3

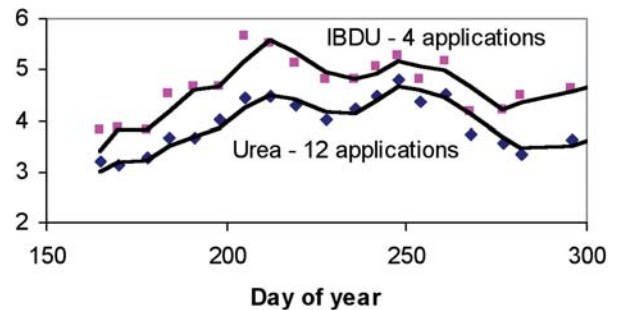


Figure 4

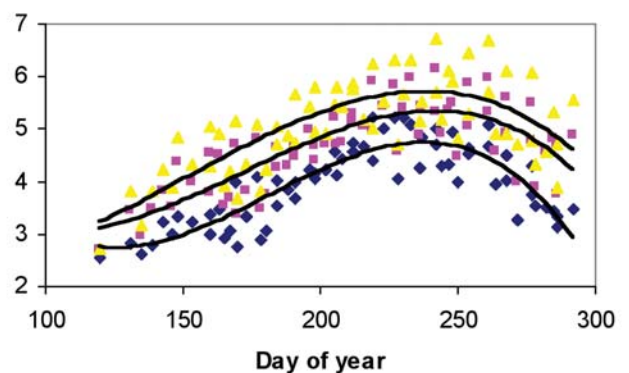
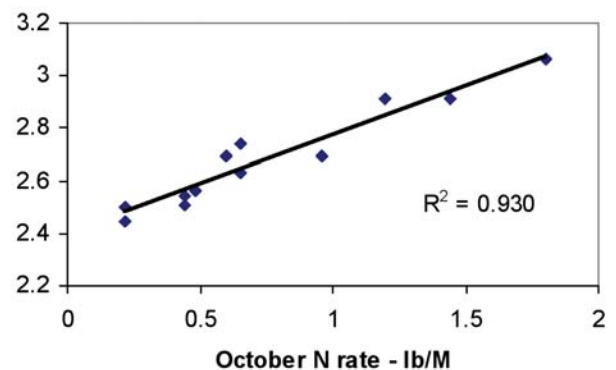


Figure 5



that provides near constant color ratings and clipping N contents over time. As seen in figure 2, responses to fertilizers always vary over time primarily due to changing growing conditions. One way to judge the amount of variability in turfgrass responses to a fertilizer is to calculate a statistic known as the standard deviation. The larger the standard deviation the greater the variability in what has been measured. Standard

Table 1. Early and late season bentgrass responses to fertilizers.

Fertilizer	Change April 30 to June 9		Change Sept 18 to Oct. 19	
	Color rating	Clipping N	Color rating	Clipping N
Milorganite	+2.0	+1.86 %	-1.0	-1.09 %
Urea	+2.0	+1.72 %	-0.9	-1.09 %
IBDU	+2.0	+1.91 %	-1.1	-1.06 %

Table 2. Optimum annual N rates based on bentgrass color and N content.

Fertilizer	Optimum annual N rate – lb/M	
	Based on color	Based on clipping N
Fine grade Milorganite	5.8	6.5
Regular grade Milorganite	3.3	3.6
Urea	4.1	4.8
IBDU	1.3	2.4

Figure 6

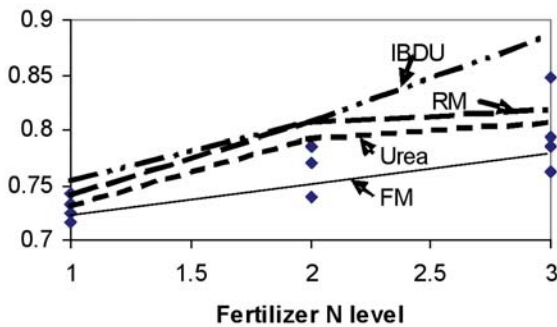
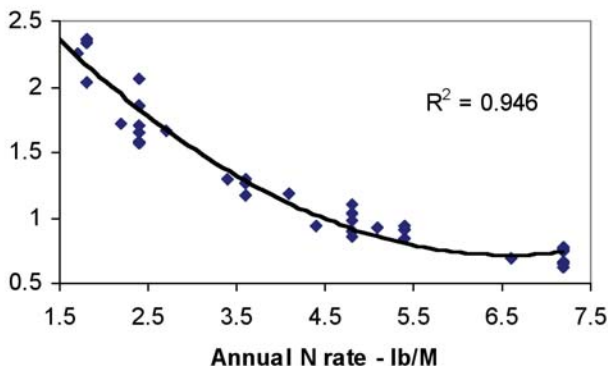


Figure 7



deviations for clipping N content for the four fertilizers tested in this study are shown in figure 6 for the three annual levels of N applied. The first thing to note is that the standard deviations increased with the amount of N applied. This is always true. It is also true that the standard deviation associated with a particular fertilizer is related to how well the turfgrass responds to the fertilizer. The greater the response, the greater is the standard deviation. The consequence is that among the four fertilizers IBDU generally had the highest standard deviations and fine grade Milorganite the lowest.

Because the optimum rate of annual N application differed for each fertilizer applied (Table 2), the standard deviations shown in figure 6 can be misleading. When applied at their optimum rates the clipping N standard deviation for fine grade Milorganite was 0.765, for regular grade Milorganite was 0.758, for urea was 0.740, and for IBDU was 0.715. Therefore, had the fertilizers all been applied at their optimum rates IBDU would have provided the most uniform bentgrass response during each seasons and for all three years. In view of the relatively low optimum rate of IBDU required and the resulting uniformity in bentgrass response, it's unfortunate that economics has led to the demise of this fertilizer.

Yet another way to evaluate N fertilizers is to calculate their nitrogen use efficiency (NUE). The NUE of a fertilizer is the amount of response per pound of N applied. In this study, NUE was calculated as clipping % N per pound of N applied. The efficiency with which turfgrass utilizes fertilizer N always decreases with the amount of N applied. This was clearly evident in this study, where NUE declined from around 2.3 % clipping N/lb fertilizer N when the rate was 1.6 lb/M to 0.7 % clipping N/lb fertilizer N when the annual N rate exceeded 6.5 lb/M (Fig. 7). Examination of the NUE values for the individual fertilizers showed that notable differences arose only when the annual N rates were < 4.5 lb/M. Under this circumstance, regular grade Milorganite and IBDU had the highest and similar NUE values. Fine grade Milorganite and urea had lower and similar NUE values.

SUMMARY COMMENTS

This and many other studies designed to evaluate turfgrass response to different fertilizers have shown that color and quality ratings, clipping production and N content are all highly related to each other. Any one of them provides a valid means for assessing fertilizer performance. The more intense the color development the higher the turf quality, clipping yield and tissue N content. Any superintendent wishing to conduct their own tests with different fertilizers can do so merely by noting color responses to side-by-side applications of the fertilizers. Color is and always has been a reliable


guide for determining the frequency and at what rate N should be applied. Use of color as your guide rather than a fixed application rate and schedule compensates for inevitable changes in weather patterns that influence color response to fertilizer. The end result of using color as your guide is custom tailoring of your fertilization program to your golf course.

There is a well ingrained notion in the turfgrass world that during summer months high air temperatures suppress turfgrass growth and its capacity to respond to fertilizer. This often leads to the recommendation that N rates should be reduced at that time of year or fertilizer application actually be suspended until air temperatures decline. In this and many other studies I've conducted, there has never been a pronounced summer

decline in bentgrass growth rates as long as the turf was irrigated to prevented moisture stress. With this requirement being met in the present study, turfgrass color and clipping N contents consistently peaked in late August rather than earlier in the year when air temperatures were likely more favorable for bentgrass growth. This contradicts the idea that N rates should be reduced on bentgrass fairways during the summer months.

The results of this study also refute the idea that one form of fertilizer N is preferred over another when it comes to late season fertilization. At issue is the influence of late season N on growth resumption the following spring and rate of recovery from any type of winter injury. When April tissue N contents were the criteria for judging the effectiveness of late season applica-

tions of N, rate of application proved far more important than the form of N applied. The differences among Milorganite, urea and IBDU were miniscule and of no real consequence.

The four fertilizers tested in this study varied significantly in their nitrogen use efficiencies. This resulted in substantial differences in the annual rates required to achieve a common level of bentgrass color development or clipping N content. Indications were that the optimum annual N rate ranged from 1.3 lb/M for IBDU to 5.8 lb/M for fine grade Milorganite. Such large rate differentials have obvious implications regarding annual fertilizer expenditures. Not so obvious is the gain in uniformity in bentgrass response over time that results from application of lower annual N rates. 

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