Long-term study confirms clippings sustain fertility

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Leaving clippings on a lawn recycles plant nutrients and enhances turfgrass quality.

A recent study conducted at Rutgers concluded that when clippings are returned, an equivalent or better turf color can be achieved by using only two pounds of nitrogen per 1000 square feet per year instead of the usual rate of four pounds of nitrogen per 1000 square feet per year (Table 1). Leaving clippings was also found to reduce the population of weeds in turf.

In 1994, the first year the plots with the two different mowing practices were established, turf color improved throughout the growing season where clippings were returned when compared to where they were removed. A darker green, more luxuriant appearance was apparent within four months of initiating the practice of returning clippings.

This difference in turf color continued during the following fall, winter, and spring months. In subsequent years of returning or removing clippings, a better turf color was consistently maintained when clippings were returned. These results suggest that the improved turf color was a result of nutrients being recycled within the turfgrass system.

After six years of comparing mowing practices, soil test results confirm that higher levels of soil fertility are maintained when clippings are recycled.

When clippings are removed about 300 pounds of fresh clippings (58 pounds of dry

TABLE 1.

Turfgrass color responses to nitrogen application rate and mowing practice.

Nitrogen Rate	**Season Average Turf Color Rating**	
Pounds N per 1000 square feet per year	Clippings Returned	Clippings Removed
	------------------Color Rating[1]------------------	
0	5.2	3.2
2	6.9	5.5
4	7.7	6.4

1=A 1-10 COLOR SCALE WAS USED WITH 1 REPRESENTING BROWN TURF AND 10 REPRESENTING DARK GREEN COLOR.

TABLE 2.

Influence of six years of mowing practice (clippings returned vs. clippings removed) on soil fertility (Mehlich-3 soil test method) of a Kentucky bluegrass turf at the Rutgers Hort Farm II. Soil sampling was performed on May 10, 2000 from the 0 to 2 inch depth.

Soil Test Item	Clippings Returned	Clippings Removed	Statistics†
Soil pH	6.3	6.3	NS
Exchange Capacity (meq/100g)	8.8	8.5	**
Soil Organic Matter %	3.3	3.0	**
Nitrate, NO_3-N (ppm)	2.3	1.7	*
Ammonium, NH_4-N (ppm)	8.7	5.3	**
Soluble Sulfur (ppm)	21	21	NS
Phosphorus (ppm)	245	244	NS
Potassium (ppm)	168	125	***
Calcium (ppm)	992	978	NS
Magnesium (ppm)	244	221	***

†,*,**,*** SIGNIFICANT AT THE 0.05, 0.01, AND 0.001 LEVELS, RESPECTIVELY.
NS = NOT SIGNIFICANT.

matter) are collected per 1000 square feet of lawn in one year. Leaving these clippings on the turf would instead recycle an estimated (pounds per 1000 square feet per year) two pounds of nitrogen, 0.18 pounds of phosphorus (0.4 pounds P_2O_5) and 1.2 pounds of potassium (1.4 pounds K_2O). Thus, the recycling of clippings after a period of years may be expected to maintain soil fertility levels better than when clippings are removed.

After six years of comparing mowing practices soil test results confirm as predicted that higher levels of soil fertility are maintained when clippings are recycled

Soil nutrient supplies to turfgrass were significantly greater for nitrogen, potassium, and magnesium where clippings were returned. The soil organic matter content was also increased by the return of clippings. These findings support the recommendation that fertilizer rates should be reduced when clippings are being recycled.

Based on the findings of the current study and previous research (Heckman et al., 2000) Rutgers Cooperative Extension recommendations for turf management when leaving clippings are as follows:

Use a slow release fertilizer to reduce surge growth and amount of clipping residue.

Apply less fertilizer. The nitrogen application rate should generally not exceed 2 pounds of nitrogen per 1000 square feet per year. Phosphorus and potassium application rates may also be reduced but the amounts to apply should be based on the results of regular soil sampling and testing.

Increase the frequency of mowing during periods of rapid growth.

REFERENCE:

Heckman, J.R., H. Liu, W.J. Hill, M. DeMillia, and W.L. Anastasia, 2000. Kentucky Bluegrass Responses To Mowing Practice and Nitrogen Fertility Management. Journal of Sustainable Agriculture. 15:25-35.

Just What Constitutes True Foliar Feeding?

The "real thing" should lower nutrient inputs, boost stress tolerance

By William D. Middleton

In the past 25 years I've visited more than 4,000 golf courses throughout North America, in every state except Alaska and every Canadian province except Newfoundland and Prince Edward Island. Over that time, maintenance standards have ratcheted steadily upward to keep pace with escalating player demands for "tournament type" playing conditions. At the same time, pressures from environmental advocates, legislators and regulators to implement lower input turfgrass management practices have also increased.

This article is intended to help today's professional turf manager better understand the current state-of-the-art in the rapidly evolving technologies that meet these demands and to discuss how they can overcome some of the shortcomings associated with conventional soil nutrition and root feeding.

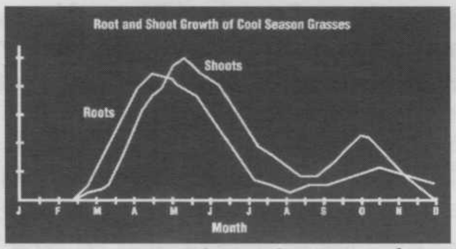

Figure 1. Seasonal growth patterns for root and shoot development in cool season turfgrass.

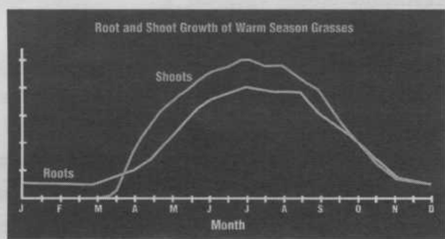

Figure 2. Seasonal growth patterns for root and shoot development in warm season turfgrass.

Better turf, less inputs

In my conversations with golf course superintendents, I frequently ask these two questions:

1. Do you think golf course conditioning demands will continue to rise for the foreseeable future or will they level off or perhaps even decline?

2. Do you think pressures from regulators, legislators and activists for lower input turfgrass management will increase, decrease, or stay about the same?

Many are concerned that they will have to produce ever better turf but with fewer chemical and nutrient inputs. In other words, they will be asked to do more with less.

In fact, their concerns are well-founded. Until recently, most of the efforts to lower inputs focused on lowering pesticide inputs.

Now, however, the attention of legislators and regulators is broadening to include lowering nutrient inputs. Both nitrogen and phosphorus are coming under much more intense environmental scrutiny because of their detrimental effects on water quality.

In Missouri, for example, HB-914 recently introduced in the Missouri House of Representatives would limit the use of fertilizers containing more than three percent phosphorus on managed turf. The bill does not discriminate between homeowners and professional applicators. It would require commercial fertilizer applicators to be certified by the state.

Similar bills are being introduced throughout the U.S., including Florida, New York and Michigan. A bill in St. Johns County, Florida, for example, would impose a ban on quick-release fertilizers for lawn care. Clearly, the pressures on golf course superintendents and other professional turf managers to target their environmental stewardship efforts on lowering nutrient inputs are going to increase dramatically.

As Professor Nick Christians, Ph.D., of Iowa State puts it: "Turf Managers must be just as careful with fertilizers as with pesticides." (Golf Course Management, February 1996.)

At the same time, the pressures to produce top quality turf under conditions of lower mowing heights and higher stress conditions will also continue to mount. So, the prospect of having to do more with less will become a high priority issue with turf professionals. That is why there is so much more interest in true foliar fertilization.

True foliar fertilization offers the realistic potential to produce higher quality, more stress resistant turf with lower nutrient inputs.

True foliar fertilization

Most modern day golf course superintendents have three main components in their fertility programs:

■ A synthetic fertilizer component, including granular and liquid controlled release materials applied for root uptake

■ An organic fertilizer component targeted at stimulating soil microbial activity as a well as providing plant nutrients for root uptake and

■ A sprayable fertilizer component designed to supplement the first two and intended for foliar absorption rather than root uptake.

In addition, many superintendents include "inorganic" components, some of which are natural, such as muriate of potash.

In general, most turf professionals and, in fact, most turf researchers are far better informed about the first two components. In recent years significant advances have been made in fluid nutrition and foliar formulation chemistry that help overcome the shortcomings associated with conventional soil nutrition and root feeding.

To be sure, impressive advances have been made in soil nutrition and root feeding technologies over the past several years with products like IBDU, Polyon, Agrotain and others. However, when you look closely at the root systems of intensively maintained turfgrasses and the negative impacts that higher maintenance standards and lower mowing heights have on them, it becomes abundantly clear that more and better nutritional strategies are essential.

Consider, for instance, how fundamentally different the seasonal growth patterns are for root and shoot development in cool season and warm season turfgrasses as shown in figures 1 and 2.

With cool season turfgrasses, both root and shoot development peak in late spring and then decline abruptly. Both hit bottom in summer—just in time for the dog days. This pattern represents the single biggest shortcoming of conventional soil nutrition and root feeding with respect to cool season turfgrasses.

At the very time of the year when the turfgrass plant needs nutrition most critically for stress tolerance and survival, the plant's root system is least able to provide it. This pattern is the driving force behind the development of true foliar nutritional alternatives to conventional soil fertilizers and micronutrients.

It's as simple as this: a conventional root uptake turf fertilization program can be no better than the root system itself. Its effectiveness is limited by the root uptake capacity. Root uptake capacity is limited by seasonal growth patterns and further reduced by both high temperature and low mowing heights. So while significant improvements in conventional root uptake fertilization technology have been made, they cannot overcome the seasonal limitations inherent in the root systems of intensively-maintained turfgrasses; nor can they ameliorate the effects of environmental and cultural stresses.

Perhaps it would be helpful to clarify a couple of things at this point. First of all, let's define what we mean by a true foliar nutritional alternative. A true foliar is designed to overcome the numerous obstacles to foliar uptake of traditional plant nutrients, thus allowing for efficient utilization of all its beneficial components. Secondly, all true foliars are liquids...but not all liquids are true foliars.

To qualify as a true foliar, all of the beneficial components of the product must have the potential to penetrate the leaf surface and translocate within the plant; overcoming molecular size exclusion and electrochemical gradient barriers, as well as other obstacles.

Historically, the entryway into the foliage was through the stomates. However, as we will see, there are inherent limitations with stomatal openings.

In recent years, advances in formulation chemistry have made it possible to maximize the use of transcuticular pores as the points of foliar entry. These submicroscopic spaces are several orders of magnitude smaller and vastly more numerous than stomatal openings.

If you picture a piece of turfgrass about the size of your thumbnail (1 sq. cm.), it would have about 20,000 stomates. In that same space there would be 10 billion transcuticular pores.

Looked at in the other extreme, you could imagine a gargantuan blade of turfgrass about 200 miles long and 20 miles wide. Each of the stomates in that space would be the size of three football fields joined end-to-end. Each of the transcuticular pores would be about the size of a golf ball.

Size exclusion, then, is the first barrier a true foliar must overcome.

The transcuticular pore spaces on the surface of the leaf blade are the openings through which true foliar nutrient molecules must pass to penetrate into the turfgrass plant. Unlike stomatal openings, which are closed more often than they are open the transcuticular pore spaces are open all the time. These pore spaces are much more numerous but also much smaller than stomatal openings.

So, the first step in designing true foliar fertilizers, micronutrients and trace elements is to make sure the molecular structures are small enough to pass through the transcuticular pores.

Another obstacle to be overcome is the electrochemical gradient within the turfgrass plant itself. Two primary forces regulate the movement of nutrient ions in solution; one is chemical and the other is electrical. Ions move down the chemical gradient from a higher to a lower concentration in order to reach equilibrium. Ions also tend to be transported most easily against an electrical gradient when their electronegative potential is low.

The cell walls of living plants carry a negative charge. Since opposite charges attract and like charges repel, for a negatively charged ion such as nitrate (NO_3) to cross the cell wall and move into plant cells where nitrate concentrations are higher, additional energy must be expended by the plant to overcome the electrochemical gradient. It is as if the nitrate ion is swimming against the current and so the plant must expend more energy. This is referred to as active transport.

Positively charged species such as Ammonium ions (NH_4^+) are generally taken up by passive transport which requires no additional energy expenditure by the plant. [There are some notable exceptions to the active/passive transport rules. Potassium (K+), for example, is taken up by active transport at low K+ concentrations and only transported passively at high K+ concentrations.]

The best designed true foliars sidestep the obstacles of chemical and electrical gradients by packing a powerful nutrient punch into a formulation made up of neutral or only partially charged species. These special nutrient forms are then secured in a non-traditional matrix that protects the nutrient species, minimizes the potential for leaching and volatilization, and enhances uptake and utilization of the beneficial components of the formula.

Two basic questions

There are two fundamental questions that professional turf managers ask and want answered about true foliar nutrition. Compared to conventional soil nutrition and root feeding, can fluid nutrition and foliar feeding:

1. produce comparable or superior results with more control and less risk of diseases associated with higher fertility levels?

2. produce comparable or superior results with greater efficiency and lower nutrient inputs?

To address those questions, lets look as some recent efficacy data and nutrient input data.

In the year 2000 at the University of Nebraska, Dr. Roch Gaussoin conducted a study that where conventional treatments were designed by a panel of experienced Nebraska golf course superintendents. The study showed the effects of two fluid nutrition and foliar feeding programs on the establishment and maturity of USGA type Providence creeping bentgrass putting greens compared to two conventional programs. The details of Dr. Gaussoin's research on "Grow-In Protocol 2000" are available through the author of this article.

The major conclusions are these:

■ In terms of efficacy, the fluid nutrition and foliar feeding programs were comparable in terms of overall quality (color and density) to the conventional programs.

■ With regard to lowering nutrient inputs thereby reducing the potential risks for negative environmental impacts, as well as certain diseases, the fluid nutrition and foliar feeding programs were far superior; producing comparable results with 25 to 80% less Nitrogen, 5 to 90% less Phosphorus, 55 to 85% less Potassium.

One of the goals of the research was to demonstrate the theoretical potential efficiency of foliar feeding of turf as an exclusive source of post-plant nutrition. Toward that end, it was necessary to conduct the trial on new, never fertilized plots, to be certain there was no residual fertility in the root zone that could skew the results.

During the subsequent weeks throughout the summer, the plots fertilized solely with the foliar products from Emerald Isle compared favorably with the conventionally fertilized plots in terms of quality.

In addition, in July though there was significant pythium in the high input conventionally fertilized plots, there was none in the foliar-treated plots. By July, the treated plots were also denser than the conventionally fertilized plots, and by September, they had statistically better color.

Until recently, efforts to lower inputs focused on lowering pesticides. Now legislators and regulators include lowering nutrient input.

It bears repeating that these benefits were achieved with significantly lower fertilizer inputs to the foliar plots than the conventional plots. The foliar plots received about 25 to 80 percent less Nitrogen, 75 to 90 percent less Phosphorus, and 55 to 85 percent less Potassium than the conventionally fertilized plots.

Interestingly, comparison of the microbial levels in the root zones yielded significantly higher levels of both bacteria and fungi in the foliar treated plots. It is theorized that the higher microbial levels and the lower N inputs may have been responsible for avoiding the pythium earlier in the season.

Perhaps most remarkably, at the end of the season, the foliar fed treatments yielded rootzone nutrient levels that in all comparisons, were equal to or higher than the levels found in the conventionally fertilized root zones. These data would suggest that during the course of the four-month growing/fertilizing season, significant N, P, and K supplied to the conventionally fertilized plots was neither utilized by the turf nor remained in the rootzone.

These data would further suggest that the foliar treated plots also lost fewer nutrients to leaching and/or volatilization than the conventionally fertilized plots. The foliar products included in this trial were Emerald Isle NutriRational nitrogen (19-1-6), Emerald Isle NutriRational phosphorus (6-12-6), and CPR (4-0-1 with 3% Iron).

Based on these results, we will continue this research in order to determine how much further we can reduce (and seasonally tailor) our application rates, and still grow superior turf with efficiency, control, and reduced likelihood of disease.

It is not an overstatement to say that true foliar fertilization offers the realistic potential to produce better quality, more stress tolerant turf with lower nutritional inputs. This is not to suggest that foliars can or should replace conventional granular, liquid or water-soluble controlled release fertilizers. However, it does suggest that new generation true foliars can be used strategically to get more of the genetic growth and survival potential out of intensively-maintained turfgrasses than can be achieved with conventional root uptake fertilizers alone.

Not your father's foliars

True foliars produce plant responses at surprisingly low dosages and those responses often last longer than those produced by traditional liquids and water solubles. The new generation foliars take some getting used to…not unlike getting familiar with a new set of golf clubs.

The best advice is to simply start using them based on soil and/or tissue testing results and your own experience with your own turf. The beauty of these materials is that the responses are typically rapid so the feedback is almost immediate.

After that, your experience and judgment will dictate how you can use true foliars most effectively to achieve your turf management goals.

William D. Middleton is founder and president of Emerald Isle Ltd. since its incorporation 24 years ago. He is also President and founder of Ocean Organics, Inc., and is a Director of the O.J. Noer Research Foundation. With a degree in International Business, Bill previously held numerous positions with AT&T, Johnson and Johnson and Warner Lambert.