The Park Grass Experiment and the Fight Against Dogma

Sometimes the value of a turfgrass management practice takes a long time to become apparent.

BY MICAH WOODS AND FRANK ROSSI

A close-up view of potassium (K) versus no potassium and dandelion growth. Copyright Rothamsted Research Ltd.

A spring view of dandelion growth in a plot receiving potassium (K), and no dandelions in the adjacent plot receiving no potassium. Copyright Rothamsted Research Ltd.

It seems we are inundated with new technology for golf turf management. Technology can be a vital aspect of turf management, yet it can also be distracting. When technology distracts us from the basic biological and ecological principles, we lose the value of resource efficiency.

Current research can inform our decisions about technology, but often it is short term and gives rise to dogma, i.e, stating an opinion as if it were fact. However, understanding fundamental principles often requires a longer period of study and, when properly assessed with variable technology, can lead to informed decision-making.

Few would argue the value of long-term ecological research, especially when it can continue to be relevant to modern management. We would argue that the most important experiment of this type has been underway outside of London since 1856 at the Rothamsted Experiment Station.

BACKGROUND

In 1856, 11 fertilizer treatments and two unfertilized control plots were laid out on a meadow at the Rothamsted estate in England. Rothamsted was owned by John Bennet Lawes, the holder of a patent on superphosphate and a fertilizer manufacturer. Lawes had great interest in agricultural experimentation, eventually selling his fertilizer business interests and establishing the Lawes Agricultural Trust.

Lawes engaged Joseph Henry Gilbert as a chemist in 1843, and together they would transform agricultural theory over the next 57 years. The experiment in the meadow, managed as pasture, at Rothamsted (the Park Grass experiment) is thought to have been Lawes's favorite.

This classical Park Grass experiment is ongoing more than 150 years after the first fertilizer treatments were applied. The results of this experiment and the conclusions we can draw have multiple applications to modern turfgrass management. Yet the Park Grass Experiment seems to go unnoticed by turfgrass scientists and managers.

The Park Grass experiment was initiated when there were 30 United States, before the Civil War, and before Darwin published *Origin of Species*. For 154 years the fertilizer treatments have been applied and plots harvested and analyzed. The seven-acre experiment was originally conceived to investigate agricultural questions such as hay yield and quality by removing herbage twice each year. It became apparent from the start that the fertilizer treatments affected not only the yield of the plots, but also the very plants and grasses that grew on them. From an ecological perspective, the effect of fertilizer treatment on the botanical composition of the plots would be most relevant to turfgrass science.

Fertilizer treatments include nitrogen, from different sources and at different

A view over the unmown plots showing the sharp distinction in plant species that grow based on the fertilizer applications.

rates, along with plots to which various minerals (P, K, Mg, Si, Na, S) are added or withheld. In addition, there are control plots that receive no fertilizer as well as others that receive organic fertilizer treatments. Each plot is divided into four sub-plots for liming treatments to maintain pH of 7, 6, 5, and an unlimed treatment. The same treatments, with thoughtful additions and modifications, have been applied to the same plots every year for the last 154 years.

In the initial scientific publication on this experiment, published in the Journal of the Royal Agricultural Society of England in 1860, Lawes and Gilbert[1] wrote that "the plots had each so distinctive a character in regard to the prevalence of different plants that the experimental ground looked almost as much as if it were devoted to trials with different seeds as with different manures [fertilizers]."

CONCLUSIONS

The botanical composition of the Park Grass plots changed dramatically in the first 50 years of the study, but since 1920 there has been relatively little change, indicating the populations have adapted and stabilized. This has been reported by the numerous publications from the research over the last 100 years.

The application of the Park Grass results to golf turf were recognized in 1912 in the classic *Book of the Links*. In fact, the chapter on fertilization of golf courses[2] was written by Sir Daniel Hall, former director of the Rothamsted Experiment Station. A dozen years later, in 1924, Charles Vancouver Piper, first chairman of the USGA Green Section, wrote on the results of Park Grass in the *Bulletin of the Green Section* of the USGA . His prefatory remarks on the Park Grass results remain relevant and lucid[3]:

"At the Rothamsted Experiment Station, near London, England, an extensive series of experiments in the fertilizing of grass-lands has been carried on continuously for nearly 70 years, that is, since 1856. Specifically, the tests are on a clay loam soil and the results are measured in hay yields. While the maintenance of grass-land for hay crops is not the same thing as its upkeep for producing turf, nevertheless the Rothamsted work is not without bearing on greenkeeping. It must be borne in mind that the results of parallel experiments in fertilizing differ with the soil and with the climate; also that the effect of fertilizers on such hay grasses as timothy and orchard grass does not directly concern golf courses. It is also to be remembered that there are many English plants that do not occur in America, and vice versa. Naturally, the behavior of such plants cannot be compared for the two countries. But with those limitations borne in mind, the Rothamsted results nevertheless carry lessons of high importance in the growing of golf turf. . . . The results correlate so closely with experiments in this country that they must be regarded as highly significant."

In the years since Piper penned these words, the absence of the Park Grass results in the turfgrass science literature is conspicuous. Specifically, the results indicate that nitrogen application reduces species diversity and favors the growth of grasses,[4] as evidenced by the grasses consistently accounting for 90% of clipping dry weight on plots receiving nitrogen. This is especially evident on plot 1d that receives a single spring application of ammonium sulfate at a rate of about 1 pound nitrogen per 1,000 square feet, applied annually since 1856. In 1856 there would have been about 40 species growing on this plot, but simply through regular addition of ammonium sulfate, this plot is almost entirely composed of colonial bentgrass (*Agrostis capillaris*) and sweet vernal grass (*Anthoxanthum odoratum*). Another striking ecological observation is that adding lime, phosphorus, or potassium will increase the abundance of non-grass species. For example, where K has been applied, dandelions (*Taraxacum officinale*) flourish, and where no K has been added, dandelions are conspicuously absent. Furthermore, dandelion populations are greater in plots with lime and K than with K alone. Results on the effect of K fertilizer on dandelion have been confirmed by research in Minnesota, where dandelion growth and soil K were analyzed under field and greenhouse conditions.[5]

We argue that results from the Park Grass Experiment are worthy of further attention if for no other reason than from a weed management perspective in an effort to reduce our reliance on chemical herbicides.

IMPLICATIONS

The Park Grass Experiment provides a glimpse into the ecological future of golf courses, as resources become limited. The value of this ecological research, i.e., the study of the interaction between organisms and among organisms and the environment, goes

Plot 1D in the background treated with ammonium sulfate and no lime, resulted in only grass. Plot 1C in foreground was treated with ammonium sulfate and limed to pH5. Dandelion and other weeds are now present in the plot.

Plot 6D in May – this plot received the same ammonium sulfate along with phosphorous (P), potassium (K), sodium (Na), and magnesium (Mg), resulting in many weeds.

Plot 1D in May, after receiving only ammonium sulfate, had no broadleaf weeds.

beyond the traditional problem-solving approach of current turfgrass research.

A dynamic framework observed over long periods of time is our only defense against dogma. Our current need for just-in-time answers to the latest problem, researched in a mere two to three years, leaves us to provide answers based on inadequate information.

Superintendents want to know what to expect when they intervene with a management practice. Short-term applied studies help us to understand the role of human intervention (management practice) in a defined period but neglects the role of environmental factors.

Ecological research often reports information about organisms in a flexible and dynamic way, looking more for broader concepts than causality. Traditional turfgrass research is more pragmatic, seeing information based only on its practical value. A blended approach would be best.

Clearly, many of our most pressing problems facing the turfgrass industry cannot wait 15 years for a solution. However, there are many cases where something we concluded after three years was contrary to what we would conclude after ten years.

A case in point is the recently published long-term nitrogen leaching study at Michigan State University.[6] Initial indication from the first few years of the study showed little to no nitrogen leaching. However, after fertilizing the turfgrass area for six years, and now after 12 years, the concentrations in the leachate are regularly above the advisory levels.

Other studies on the manipulation of pH for reducing annual bluegrass populations or reducing earthworm populations show little to no benefit in the first three years of a study, but after eight to ten years and longer demonstrate the value of a long-term commitment to a practice. Most courses that have low pH have little annual bluegrass and low earthworm populations.

The application of this theory is underway in Denmark, where pesticide use has been severely restricted. Several courses have been undergoing an ecological shift by creating an environment favorable to fine fescue that deters annual bluegrass. It has taken a decade in several cases, but many of the courses are well on their way to an ecological shift.

A quick glance at the work underway at Rothamsted for the past 150 years would provide the same conclusions.

REFERENCES

[1]Lawes, J. B., and J. H. Gilbert. 1860. Report of experiments with different manures on permanent meadow land. Part III. Description of plants developed by different manures. Journal of the Royal Agricultural Society. 20:246-272.

[2]Hall, A. D. 1912. The manuring of golf greens and courses. In *The Book of the Links*, M.H.F. Sutton, ed. W. H. Smith & Son, London.

[3]Piper, C. V. 1924. Grass experiments at Rothamsted, England. Bulletin of the Green Section of the USGA. April:101-104.

[4]Silvertown, J.; P. Poulton, E. Johnston, G. Edwards, M. Heard, and P. M. Biss, 2006. The park grass experiment 1856-2006: its contribution to ecology. Journal of Ecology. 94:801-814.

[5]Tilman, E. A., D. Tilman, M. J. Crawley, and A. E. Johnston, 1999. Biological weed control via nutrient competition: potassium limitation of dandelions. Ecological applications. 9(1):103-111.

[6]Frank, K. W., K. O'Reilly, J. Crum, and R. Calhoun. 2006. Nitrogen fate in a mature Kentucky bluegrass turf. [Online] USGA Turfgrass Environ. Res. Online. 5(2):p. [1-6].

DR. MICAH WOODS (micah@asianturfgrass.com) *is research director at the Asian Turfgrass Center.* DR. FRANK ROSSI (fsr3@cornell.edu) *is an associate professor in the Horticulture Department at Cornell University.*