Rutgers University conducted a fungicide experiment on the third green at Charleston Springs North Golf Course (New Jersey). Field testing in real world situations can be an effective research strategy.

This Product Is So Good, It Didn't Need Any Research!

When choosing what's best for your golf course, rely upon scientific research rather than black magic.

by JAMES H. BAIRD, Ph.D.

"Take any common-place remedy, give it a mysterious origin, advertise it with extravagant claims, and it will be purchased by the [gullible]. At present, the crop of grass-growing [snake oils] appears to be above normal!" – Dr. Charles V. Piper and Dr. Russell A. Oakley, *The Bulletin of the USGA Green Section*, 1922.

SOME THINGS never change. Thankfully, neither has the commitment from the USGA Green Section and the scientific community to provide information for improving golf turf that is based upon scientific observation and experimentation. While it is true that science oftentimes seems dull and monotonous, it is factual. On the other hand, how many products, technologies, or services are you currently using that are based solely upon slick pitches from salespeople? Or maybe you've been persuaded by testimonials from leaders of the golf turf management profession. If they use it, it must be good, right? Or could it be that these people employ sound agronomic practices and excel at managerial skills in spite of using products that do nothing to improve their already pristine turf? Perhaps you are from the school of thought that these products can't hurt anything, so why not use them?

Although using snake oils may not harm your turf, what effects do they have on the professionalism that both you and the golf turf management industry have worked so hard to build? And more to the point, how much of your club's money is being spent on these products, and would you exercise they same blind faith if it were your money?

The primary purpose of this article is to provide the reader with a better understanding of the importance of research and the scientific method in the evaluation of products and technologies. Along the way, this article describes key elements for obtaining the most useful and unbiased information from a testing program on your golf course.

The Scientific Method

Research can be defined as an organized investigation into a subject to discover new facts or principles. The general procedure for research is called the *scientific method* and consists of:

• Formulating an hypothesis.

• Planning an experiment to test the hypothesis.

• Carefully observing and collecting data.

• Interpreting the results of the experiments.

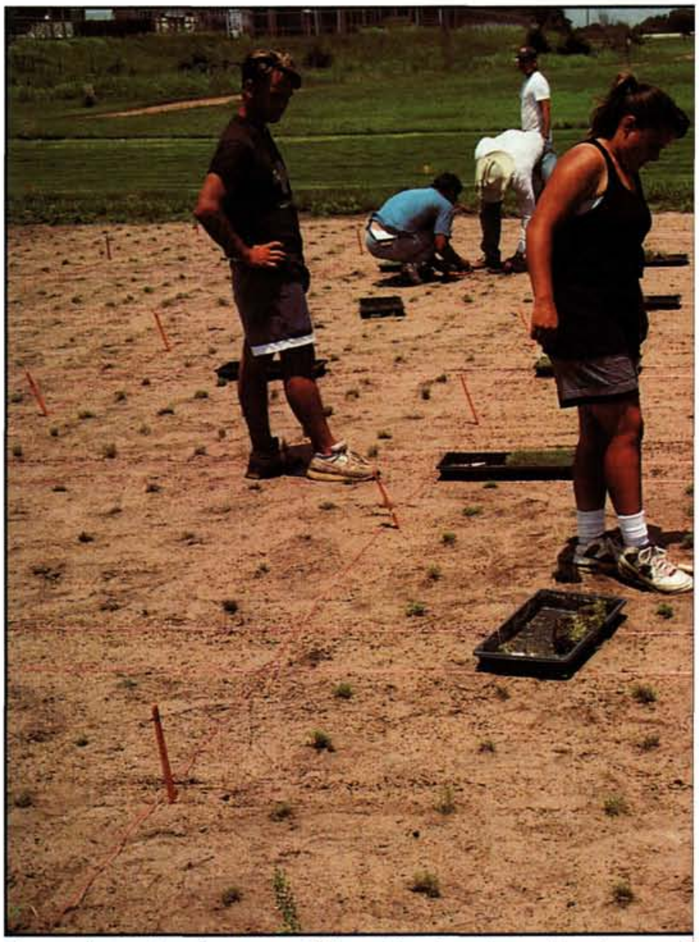
To better illustrate the scientific method, let's say that you have been approached by a salesperson who claims that his product, we'll call it Thatch Away, will reduce thatch accumulation in your turf, thus reducing the need to cultivate. Because your golfers are up in arms about the holes that you regularly punch in the greens, you decide that this product is worth further investigation. What should you do next? First, ask the salesperson a lot of probing questions. How exactly does this product work? If the product works according to the claims, why isn't everyone using it and discarding their aerators, verticutting machines, and topdressers? Most important, is there any documented university research available that supports the claims for this product? Specifically, was the research conducted only in the laboratory or also in the field? Now, I am hopeful that most superintendents already know the likely answers to these questions and would graciously say, "Thanks but no thanks. I'll keep my cultivation equipment for the time being." However, in the back of your mind you may still be haunted by golfer distaste for cultivation and decide this product is at least worth a try on your golf course. Where do you go from here?

The Hypothesis

A hypothesis is often referred to as an educated guess or speculation in regard to the possible cause of a phenomenon. Any experiment and the interpretation of its results are only as good or bad as the hypothesis(es) or the objective(s) for performing it. In formulating your hypothesis, be specific about what you expect the outcome of the experiment to be. If Thatch Away reduces thatch by the smallest measurable increment, would this reduction result in any real benefit to the turf or significant change in your cultivation practices? The likely answer is no. So, if the concern about the disruptive effects of cultivation has led you to try this product, then a plausible hypothesis might be that *Thatch Away reduces thatch accumulation equivalent to or exceeding that of standard cultivation practices.*

Planning an Experiment to Test the Hypothesis

The two primary components of an experiment are the treatment and the experimental unit. A treatment is a dosage of material or a method that is to be tested in the experiment. The experimental unit refers to the unit of experimental material to which a treatment is applied. In our experiment, the treatments represent the Thatch Away product and cultivation practices, while the experimental unit is the turf in question, let's say the putting greens.



Research can involve many different treatment combinations and especially when it involves evaluation of turfgrass germplasm.

A major challenge in experimentation is that variability exists throughout nature. Differences due to genetics, soil, or the environment are especially apparent throughout the golf course. Have you ever attended a university turfgrass research field day and wondered why the greens are flat and have no trees surrounding them, unlike the conditions you face on the golf course? Even though variability still exists at the research facility, the idea is to minimize it as much as possible and to set up experiments that test treatment effects independent of unaccounted variability related to the experimental unit or its surrounding environment. In statistical science, unaccounted variability is called experimental error, and if we can design the experiment to provide an estimate of experimental error, then a more precise measure of the treatment effects can be made.

Let's say we decide to test Thatch Away by treating one of the greens on the golf course. Evaluating a practice on a single experimental unit (in this case one putting green) and then comparing this unit to one that is similar but untreated provides no measurement of experimental error and therefore is a poor measurement of whether or not differences in thatch accumulation were due to the product.

Three important principles of experimental design are replication, randomization, and local control. Replication of treatments on more than one experimental unit provides an estimate of experimental error and therefore a more precise measure of treatment effects. The number of replications is dependent upon the degree of precision desired and also the variability of the data to be collected. Measurement of thatch accumulation or reduction is likely to be more variable than measurement of weed control or fertilizer response. However, treatments in most field experiments are typically replicated three times.

Randomization is the assignment of treatments to experimental units so that all units have an equal chance of receiving a treatment. This ensures an

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unbiased estimate of treatment means and experimental error. Randomization can be accomplished using a computer or random number table found in the appendix of most statistics textbooks. However, drawing numbers corresponding to treatments out of a hat is the simplest way of randomization in small experiments.

Local control is a restriction on randomization by grouping treatments in similar areas or blocks that are expected to perform differently. Let's say that you've decided to conduct a replicated experiment on one of your putting greens that is rather severely sloped from back to front and is lined with trees along the back side of the green. In order to account for the effects that slope and trees might have on thatch, all treatments would be randomized within each of three or however many blocks positioned from the back to the front of the green.

Hopefully, by now you have a better understanding of experimental design, but still we must select the treatments for our experiment. Here is where you refer back to the original hypothesis stating that *Thatch Away reduces thatch accumulation equivalent to or exceeding that of standard cultivation practices.* Therefore, one of the treatments would include Thatch Away applied without cultivation practices. Other treatments may include various rates or timing of application of this product, if deemed necessary. An important treatment to include in the experiment is the check or untreated control. In this scenario, the untreated control would include cultivation without Thatch Away. To carry this a step further, you could test whether or not your cultivation practices reduce thatch accumulation by including a treatment with no Thatch Away and no cultivation.

Careful Observation and Collection of Data

Measurement of thatch in the upper portion of the rootzone profile will be the main source of data collection in this experiment. The easiest way to do this without sending samples for laboratory analysis would be to measure thatch thickness from at least three subsamples of soil profiles taken from each plot throughout the experiment. Fortunately or unfortunately, thatch accumulation or reduction does not occur overnight, and an experiment like this may take several years to find measurable differences among treatments. Also, it would be a good idea to measure thatch thickness in the plots before application of treatments to serve as a baseline. In general, variability decreases as plot size increases, up to a point. This is advantageous on a golf course because equipment would not be available to treat small plot areas. However, by using large spray equipment you may need to treat individual putting greens as blocks, each containing one replication of all treatments in the experiment.

Interpretation of Results

Normally, data collected from an experiment is subjected to statistical analysis in order to provide evaluation of treatment differences according to tests of significance based on measuring uncontrolled variability. One test that most everyone should be familiar with from attending turf conferences, field days, or by reading experimental results such as the National Turfgrass Evaluation Program (NTEP) is the Least Significant Difference (LSD), usually at the 5% probability level. Thus, if the difference between two treatment means (e.g., 7.5 vs. 7.0, 7.5 – 7.0 = 0.5) is greater than the $\text{LSD}_{0.05}$ = 0.4, there is a 95% probability that the difference was due to treatment effects or a 5% probability that the difference was due to chance alone. Obviously, not many superintendents are going to subject their data to statistical analysis; however, it would be easy to calculate treatment means and to visually compare differences among treatment means. Conclusions should have as wide a range of validity as possible, meaning what works or does not work on your golf course should do the same at another golf course. The best way to ensure this is to conduct the experiment at more than one location and time. However, it is important to keep in mind that in any experiment there is always some degree of uncertainty as to the validity of the conclusions.

Conclusion

Research is a complex, time-consuming, and costly venture that is best left to the expertise of scientists. However, should the need or desire arise to test products on your golf course, remember that a well-planned experiment starts with a well-defined hypothesis or objective. And in order to distinguish real treatment effects from naturally occurring variability, treatments should be replicated, randomized, and grouped into blocks for local control, if necessary. Your state turfgrass extension specialist may be able to provide some assistance when planning a comparison of treatments at your golf course.

What's more important, let's hope this article sheds more light on the need for scientific research in your decision-making process when it comes to deciding what's best for your golf course. Don't underestimate your ability to grow good turf using sound agronomic practices that are firmly rooted in scientific research.

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