UNDERSTANDING RESEARCH…

SIFTING THROUGH THE DATA

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Without research from university turfgrass programs, turf managers of all kinds would be at a huge disadvantage. Fewer new cultivars with improved performance would be developed, and information essential to managing turfgrass pests, using plant growth regulators, selecting the proper rootzone material, optimizing fertilizer applications and other vital issues would be limited or unavailable. The bottom line is that the turfgrass industry as a whole benefits from ongoing research, and advancements would not be possible without it.

In an age of instant information shared via newsletters, blogs, Facebook and Twitter, however, we are often too impatient to wait for science to tell the full story, and instead we opt to hold faith in the word of others. Unfortunately, the purported success of a product is often attributed to the anecdotal findings of one or more people and not based on actual research results. That's not to say that "perceived" benefits aren't in fact true, but without sound scientific research, it's impossible to say.

Let's take a look a closer look at some of the ways research is conducted and reported. Reported results may come from anecdotal observations or sophisticated, controlled experiments. Regardless of what data you use to make your decision, it's important to understand the differences in research methods, and it's essential to understand how to critically review and interpret the results put in front of you.

Anecdotal

Although often used as a basis for a product's success, anecdotal information is simply a report or story from an individual or group. For example, a superintendent may attribute the success of the course's healthy greens in a given year to his or her use of a new product. Unfortunately, many other factors (Mother Nature being a primary one) may have contributed to the improved turfgrass quality. Without a comparison, it's impossible to determine the cause for the improved turf.

Testimonials based on anecdotal reports are often used in advertising or promotion of a product. Such claims, however, can be accepted as truth only with the support of stronger evidence, usually scientific in nature. This doesn't mean that the information isn't true; it just means that it has not been proven or subjected to rigorous scientific analysis. Unfortunately, many companies have significantly larger advertising and marketing budgets than the funds they set aside for research.

The board method

Although not considered a true scientific evaluation, using the board method can, at a minimum, help you see what would have happened had you not applied a specific product. This process simply involves spraying over a piece of plywood set on the ground. This untreated area can serve as a side-by-side comparison of the treated vs. untreated turfgrass.

A great example of where this may be useful is in pest control. Let's say that a superintendent switched to a new preventive fungicide for his anthracnose control this year and reported excellent control. My first question would immediately be,

Replication in a research trial is important in order to be able to determine true statistical differences among individual treatments based on experimental error.

"How severe was the disease pressure?" Without an area of turf left untreated, it's impossible to attribute the reduction in disease symptoms to the fungicide application, since it may have simply been due to a lack of disease pressure this year versus last. Many golf course superintendents utilize this method to evaluate the efficacy of their applications.

Scientific research trials

The true test of whether a product or method works is the conducting of one or many scientific experiments. A research program is generally a well-organized effort by a scientist and is designed to gain a better understanding about a specific subject. At Penn State, each faculty member has his or her own research program involving specific areas of emphasis (e.g., nutrition, soils, pathology, weed control, etc.). The research conducted involves numerous experiments (sometimes spanning an entire career) conducted by the faculty with the help of graduate students, technicians and others.

Experiments can be defined as "investigations that establish a particular set of circumstances under a specific protocol in order to observe and evaluate implications of the resulting observations" (Kuehl, 1994). A basic example of a comparative experiment would be the evaluation of various fungicides for the control of a specific disease. The individual fungicides included in the experiment serve as the treatments for comparison. An untreated control is also an essential component and serves as a standard to evaluate the efficacy of the fungicides evaluated.

So, that's it, right? We can just spray an area with a fungicide and call it science? Not really. The details are a little more complicated than that and involve a better understanding of experimental error, research design and statistical analysis. Although I won't go into too much detail regarding all of these factors, I do think that it's important to at least touch on a few important components.

Experimental error represents the "variation among identically and independently treated experimental units" (Kuehl, 1994). Using the comparison fungicide experiment example above, the experimental error would refer to differences in the percent anthracnose within individual plots (also known as a replication) treated with the same fungicide. These differences could be caused by a number of things, including:

- Natural variation within the study area
- Variability in measuring the response

- Inability to reproduce treatment conditions from one plot to the next
- Interaction of treatments and experimental units
- ANY other outside factor that influences the study

Using specific data from one of my disease trials last summer, I observed differences in dollar spot severity in my untreated plots, ranging from 151 to 221 infection centers (Figure 1, at right). Although the reported average on that rating date was 169, all data from the four replications of that treatment are needed in order to determine if significant differences exist among all treatments being evaluated.

Why is this important? This is the primary way for you as the decision-maker to determine whether one product is better than another.

To explain this point, let's use the following data from two disease studies at Penn State. Look at the level of dollar spot control shown in Figures 2 and 3, and decide which fungicide you think is providing the best control in each study. When you have decided, continue reading.

Now for the answer. First, the figures are exactly the same. The only difference is that I rearranged the treatment names so that the data is associated with different fungicides. Using Figure 2 for reference, the fungicides providing the greatest dollar spot suppression (based on statistical analysis) are Fungicides 1, 2 AND 3. Due to the natural variation of dollar spot within the study area (refer to the discussion above and Fig. 1), statistically there is no difference in disease control between Fungicide 1 (<1 infection center on average per plot) and Fungicide 3 (an average of 21 infection centers per plot). The differences in the number of infection centers can't be attributed to the fungicide treatment, but rather some other unknown factor.

So, how are you supposed to know this? Let's take a look at Figure 3. In this figure, we can see letters above the means for each fungicide. Any data you see in an advertisement or in a presentation should

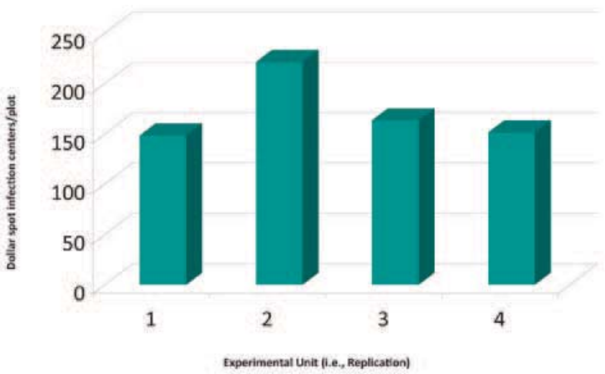

Figure 1. **Natural variation in the level of disease within the study area can be seen in the number of dollar spot infection centers within each of the four untreated plots. All plots were treated exactly the same way (no fungicides, same cultural practices, etc.), but dollar spot infection centers ranged from 151 to 221 spots per plot.**

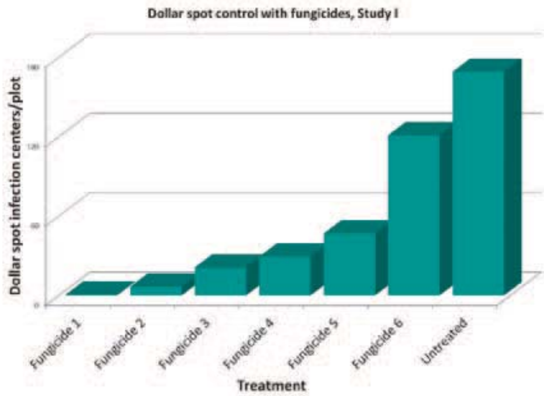

Figure 2. **Dollar spot severity in a fungicide trial conducted at Penn State in 2012 (Study I).**

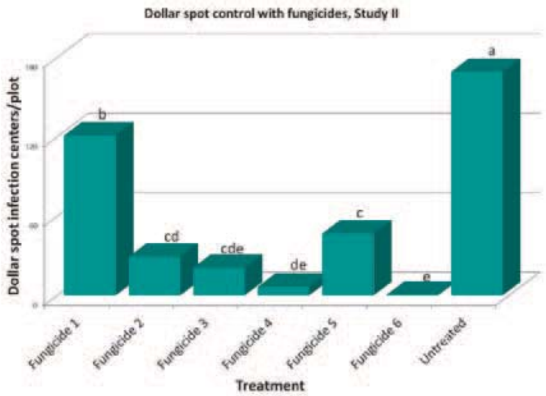

Figure 3. **Dollar spot severity in a fungicide trial conducted at Penn State in 2012 (Study II).**

Data collection for research projects can be a tedious task, but precise and repeatable assessment techniques help improve the validity of the results.

include some information that allows you to determine statistical differences among treatments. The letters that I used in the figure allow you to determine what those differences are. In this example, all fungicides labeled with the same letter are providing an equivalent level of dollar spot control.

In this trial, the untreated control had the greatest number of dollar spot infection centers (DSIC). Fungicide 1 had significantly fewer DSIC than the untreated but significantly more DSIC than all other fungicide treatments. Fungicides 2, 3, 4 and 5 have varying levels of DSIC. Fungicide 5 provided a similar level of suppression as Fungicide 2 and 3, but significantly less than Fungicides 4 and 6. Fungicides 2 to 4 provided equivalent levels of control, as did Fungicides 3, 4 and 6. Fungicide 2, however, did not provide as much dollar spot suppression as Fungicide 6.

Many would say that Fungicide 6 provided the best control of dollar spot, but this is incorrect. If you were looking for the "best" fungicides based on this data, you would select Fungicide 3, 4 or 6, which all provided a statistically similar level of disease suppression. These separations are based on the least significant difference (often referred to as the data's LSD). The LSD for this data was 28.09 — therefore, ANY fungicide treatment that had a mean number of infection centers within 28.09 of another treatment provided similar levels of dollar spot control.

Final thoughts

I hope this information will help you better understand some of the fine details of conducting research and the reporting of results. Proper interpretation of data from research experiments will help you select products and implement cultural practices that are best for your turf and also your budget. Although interpreting data can be confusing at times, it is important to keep this information in mind so that you can make informed decisions based on the available research.