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To ensure your fungicide program works its hardest for you, be sure to maximize the health of your turfgrass before making chemical applications. **Photos courtesy of Syngenta**

(pre-season prep)

Sharpening your axe

Proper agronomic planning and programs can set your golf course on the path for success, year after year.

By getting your thoughts down in a document, you'll be able to easily review them with your team.

Give me six hours to chop down a tree, and I will spend the first four sharpening the axe.

While every season in the turf management industry is different, preparation is nonetheless an essential part of effective turfgrass management. As the above saying suggests, appropriate preparation for a job can often take more time than the job itself.

Managing turf on a golf course is no different. The presence of various biotic and abiotic stresses is often inconsistent and unpredictable, so superintendents constantly have to find ways to treat their turf quickly and effectively. The damaging effects of disease, insects and abiotic stresses, such as heat and drought, can wreak havoc on your turf, but that doesn't mean they have to wreak havoc on your schedule, team and budget. By preparing and strengthening your turf quality in advance of the onslaught of seasonal stress, your turf can recover more swiftly, enhancing aesthetics and playability and also maximizing profitability.

Developing an agronomic program is a critical foundation for your pre-season work. There are many factors to consider while formulating a program of your own, and this guide offers a cornerstone for beginning your pre-season preparations.

Cultural practices

A successful agronomic program begins with good cultural practices such as mowing and nutrient management, which should be clearly planned to help your fungicide program work harder for you. The ultimate goal is to maximize the health of greens, tees and fairways prior to

any chemical applications so that the turf can better withstand stress and be more receptive to applications.

Management practices can have a profound effect on the development of disease. For example, mowing — a necessary physical stress on turfgrass — can have a significant impact on anthracnose. According to studies conducted at Rutgers University, a slight increase in height of cut resulted in a noticeable decrease in anthracnose on annual bluegrass. As you are coming up with an agronomic approach to managing your turf, experiment with various mowing heights to determine a cut that is least stressful to your turf.

Additionally, properly managing the nutrient intake of turfgrass can lead to better turf quality. Many diseases, including anthracnose and dollar spot, become more severe when nitrogen levels are below optimal levels, while others, such as brown patch, *Pythium* blight and gray leaf spot, become more severe when nitrogen levels are too high.

Mapping out a program

When developing an agronomic program, creating a decision tree on paper can help you make your choices. This will allow you to gather all necessary information — such as management practices, target pathogens and product selections — in one place and order it in a logical sequence. By getting your thoughts down in a document, you'll be able to easily review them with an agronomist you trust, as well as with your team.

After identifying target diseases on your course, make a list of all the fungicide classes and active ingredients for control of each disease, and be sure to include the FRAC number for each fungicide.

Areas of your course

Begin by segmenting the golf course into distinct areas that can be treated separately, such as greens, tees, fairways, roughs and clubhouse grounds. This is a vital step, because many fungicides have application limits that are site-specific. Chlorothalonil fungicides, for instance, have different seasonal limits on the label for greens, tees and fairways.

Turfgrass species and target pathogens

It is important to clearly identify the turfgrass species in each area of your course, and to develop an agronomic program for each desirable turfgrass species. You should also create a list of target diseases for each turfgrass species, as disease spectrum can differ based on turf type and height of cut. For example, four common diseases on annual bluegrass are basal rot anthracnose, brown ring patch, dollar spot and summer patch, while dollar spot, brown patch and take-all patch are more common on creeping bentgrass.

Fungicide selection

After you have identified the target diseases, you should make a list of all fungicide classes and active ingredients that are labeled to control each disease. The list should include the group number assigned to each product by the Fungicide Resistance Action Committee (FRAC). These numbers are typically listed on the fungicide label and can be found on the FRAC website (www.frac.info).

Selecting a fungicide also requires understanding how a fungicide moves on or into the plant (phytomobility), how it controls fungal pathogens (mode of action), how it should be applied, and whether there is a risk of disease resistance. Approximately 39 fungicide active ingredients in 20 chemical groups — plus sev-

5 Steps in an agronomic control program

- ☑ Identify areas of your golf course
- ☑ Identify turfgrass species, target pathogens
- ☑ Make fungicide selections
- ☑ Make PGR/plant activator selections
- ☑ Plan application timing

Resistance risk for common turfgrass diseases

High risk	Medium risk	Low risk
Anthracnose	Brown patch	Algae
Dollar spot	Copper spot	Fairy ring
Gray leaf spot	Drechslera leaf spot	Summer patch
Pythium blight	*Pythium* root rot	Take-all patch

eral combination products — are registered to control disease on turfgrass. With so many options, determining what or how to apply can easily get confusing.

A fungicide can move throughout a plant in several ways. Contact, or "protectant," fungicides remain on the plant surface and may be redistributed by irrigation, rain or dew. These fungicides protect the immediate area where they are applied. Most contact fungicides impact fungal development at multiple sites, while a few exhibit site-specific activity.

Local penetrant fungicides move into the waxy cuticle and mostly remain at the point of entry, with some having translaminar movement across the leaf tissue. Acropetal penetrant fungicides move upward in the xylem and have translaminar movement across the leaf tissue. Systemic fungicides move upward in the xylem and downward in the phloem, but also have translaminar movement across the leaf tissue.

When selecting a fungicide to control a specific disease, carefully reading product labels is imperative. Fungicide treatment options are numerous for some diseases and limited for others. Ten chemical groups are registered for the control of anthracnose, for instance, and only four chemical groups for summer patch. Even though two products may belong to the same FRAC group, it doesn't necessarily mean they will control the same diseases.

For example, the active ingredients boscalid, flutolanil and penthiopyrad all belong to FRAC group 7 (SDHI: succinate dehydrogenase inhibitors). However, boscalid is labeled to control dollar spot but not brown patch, summer patch or anthracnose. Flutolanil is labeled to control brown patch but not dollar spot, summer patch or anthracnose, while penthiopyrad is labeled to control all four diseases.

Resistance management should also be given heavy consideration when preparing a program so that a class of chemistry can remain effective on medium- and high-risk diseases. Four turf diseases are classified by FRAC as having a high-risk potential: anthracnose, dollar spot, gray leaf spot and *Pythium* blight. Other diseases are classified as either medium or low risk to developing resistance.

Fungicides that target a specific site within a pathogen present a higher risk of developing resistance, while multi-site fungicides are classified as having a low risk potential for resistance. If you choose to apply a high-risk fungicide to control a high-risk pathogen, you should rotate to a different chemical class after every application. Additionally, you should tank-mix with a low-risk fungicide for every application, making sure that both fungicides have activity against the field population of the target pathogen when used alone. If resistance is not an issue, tank mixtures also help improve disease control when there is more than one target pathogen.

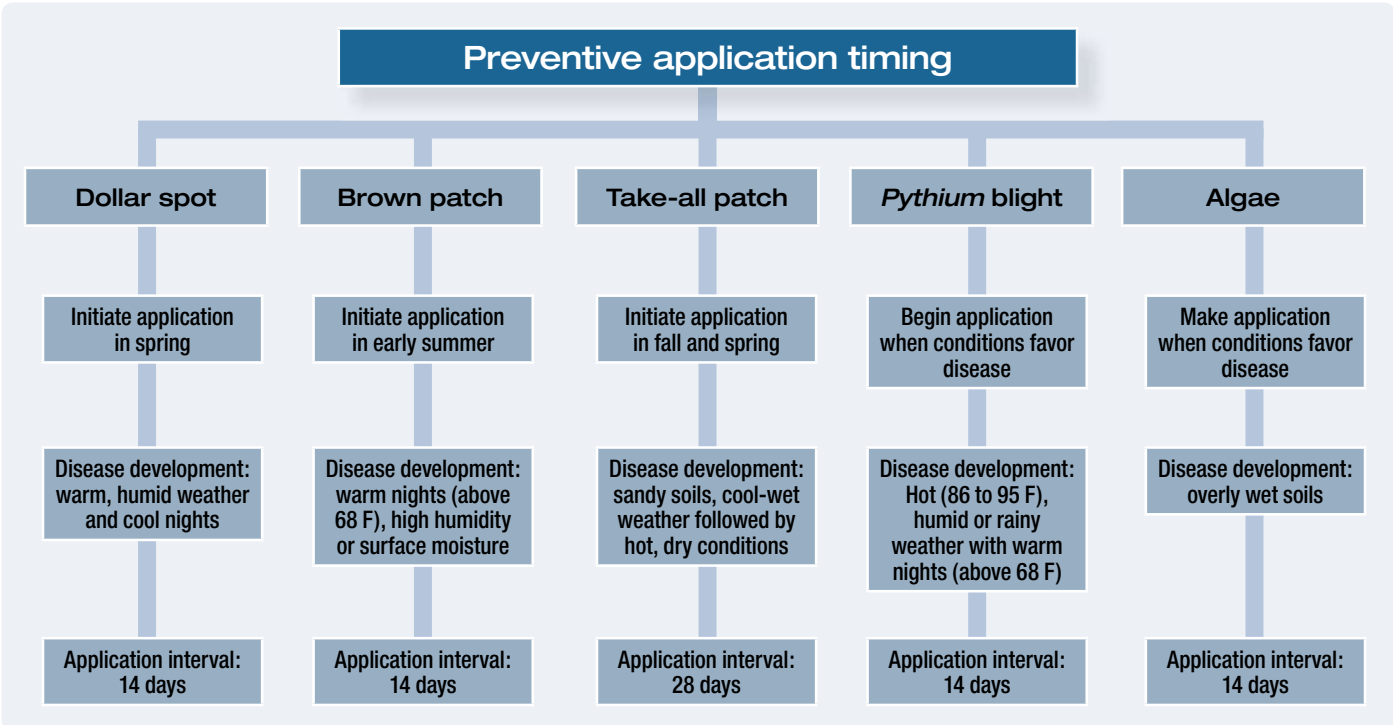
PGRs and plant activators

Aside from traditional fungicides, there are other products that have a critical role in agronomic programs for disease control. Plant growth regulator trinexapac-ethyl (TE) and the plant activator acibenzolar-S-methyl (ASM) play an important part in mitigating the adverse effects of biotic and abiotic stress. Extensive research with plants preconditioned with TE has demonstrated reduced levels of anthracnose and increased the potential of the turfgrass plant to survive extended periods of combined drought and heat stress.

Unlike TE, the plant activator ASM does not have a direct impact on disease control and stress reduction. It does, however, trigger the natural defense proteins found in plants. Research with ASM has revealed that it helps regulate stomatal opening and closure to prevent water loss in plants. Additionally, levels of pathogenesis-related proteins (PR proteins) and stress-related proteins (ATP synthase, dehydrin and heat shock proteins) are increased with the use of ASM. Daconil Action and Heritage Action fungicides are currently the only means of treating turfgrass plants with ASM. To attain the full benefit of ASM, these fungicide applications must be initiated prior to the onset of disease or stress, and re-treated on regular intervals of 14 to 21 days throughout the growing season.

Application timing

The final part of a decision tree is determining application timing. Disease life cycles, environmental conditions favoring disease development, and optimal application intervals



should all be considered. When deliberating disease life cycles, be aware that fungicide applications for preventive disease control should be applied prior to the onset of disease. Preventive fungicide rates are lower than rates of curative applications and present a lower risk of fungicide resistance. When considering environmental conditions that can affect disease, the easiest method is a calendar-based approach that relies on recent historical data, though actual applications will likely vary depending on weather conditions.

When determining proper application intervals, consider the area of the golf course, the target disease and your fungicide selection. Contact fungicides are typically applied on a seven- to 14-day spray interval, whereas acropetal penetrant fungicides are typically applied on a 14- to 28-day spray interval. If you are spraying to control anthracnose on greens, application intervals should not exceed 14 days, but applications for summer patch on greens can be extended up to 28 days. Fungicide applications on fairways or clubhouse grounds are typically made in wider intervals than applications on greens, as these areas tend to be mowed less frequently, which means the fungicides are mowed off less frequently and have more time to work effectively.

Putting pen to paper

Converting the information from your decision tree into an actionable plan is the final step in creating an agronomic program. On a blank piece of paper or in a spreadsheet, make five columns and label them:

1. Date (estimate application date)
2. FRAC group
3. Fungicide
4. Plant growth regulator
5. Target pest

Fill out your chart starting with the diseases that are the most problematic. For example, in the Mid-Atlantic region, one of the most common diseases on annual bluegrass greens is anthracnose. The first fungicide application should begin when seedhead control is initiated, with follow-up applications scheduled on a 14-day spray interval. When treating for anthracnose, do not water in the fungicide, but do select water volumes and spray nozzles that deliver the fungicide to the crown and leaf of the plant. Because anthracnose has a high risk for resistance, use a low-risk fungicide and tank-mix it with a moderate- to high-risk fungicide.

In most cases, a carefully planned anthracnose program will also provide protection from dollar spot and brown ring patch infection. It is recommended that applications for the control of summer patch be made separately, because the application target is the upper soil zone and plant crown. For this reason, these applications are best made on alternate weeks. Timing applications this way allows for watering in or using higher water volumes to deliver the fungicides to the site of activity.

Keeping your axe sharp

At the end of each season, every agronomic program should be evaluated for efficacy. If an unexpected disease outbreak occurred during the season, the superintendent and staff should conduct a thorough review of management practices, fungicide applications and weather conditions. Additionally, if fungicide resistance is suspected, infested turf samples should be sent to a reputable disease diagnostic lab and screened for potential resistance to the fungicide in question. These steps will allow for revisions to a future agronomic program so that it achieves maximum efficacy.

While developing a detailed agronomic program can be time-intensive, making a plan to preventively treat for pests and increase turf quality can help save time and resources midseason, when stress is at its highest. To assist superintendents with the process, Syngenta has researched and developed more than 42 agronomic programs to help optimize turf results. In addition to fungicide programs, Syngenta also offers several agronomic programs for insect control. To find a tailored program for your turf type and region, go to www.greencastonline.com/programs.

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Sources

1. Inguagiato, J.C., J.A. Murphy and B.B. Clarke. 2008. Anthracnose severity on annual bluegrass influenced by nitrogen fertilization, growth regulators, and verticutting. *Crop Science* 48:1595-1607. doi: 10.2135/cropsci2007.06.0343.
2. Inguagiato, J.C., J.A. Murphy and B.B. Clarke. 2009. Mowing and rolling strategies to manage anthracnose on annual bluegrass greens. *Golf Course Management* (5):111-116.
3. Latin, R. 2011. A Practical Guide to Turfgrass Fungicides. APS Press, St. Paul, Minn.
4. McCann, S.E., and B. Huang. 2007. Effects of trinexapac-ethyl foliar application on creeping bentgrass responses to combined drought and heat stress. *Crop Science* 47:2121–2128.
5. Murphy, J.A., J.C. Inguagiato, B.B. Clarke, B.S. Park and T.J. Lawson. 2007. Cultural management of anthracnose disease on annual bluegrass. *USGA Green Section Record* 45(6):8-13. (http://gsrpdf.lib.msu.edu/ticpdf.py?file=/2000s/2007/071108.pdf). Accessed March 9, 2016.
6. Murphy, J., F. Wong, L. Tredway, J. Crouch, J. Inguagiato, B. Clarke, T. Hsiang and F. Rossi. 2008. Best management practices for anthracnose on annual bluegrass turf. *Golf Course Management* 76(8):93-104.
7. Roberts, J.A., and J.A. Murphy. 2014. Anthracnose disease on annual bluegrass as affected by foot traffic and sand topdressing. *Plant Disease* 98:1321-1325. (http://apsjournals.apsnet.org/doi/pdf/10.1094/PDIS-08-13-0877-RE). Accessed March 9, 2016.
8. Shekoofa, A., P. Rosas-Anderson, D.S. Carley, T.R. Sinclair and T.W. Rufty. 2016. Limited transpiration under high vapor pressure deficit of creeping bentgrass by application of Daconil Action. *Planta* 243(2):421-427. doi: 10.1007/s00425-015-2417-y. (www.ncbi.nlm.nih.gov/pubmed/26438219). Accessed March 9, 2016.
9. Smiley, R.W., P.H. Dernoeden and B.B. Clarke. 2005. Compendium of Turfgrass Diseases, 3rd edition. APS Press, St. Paul, Minn.